

高等学校理工科参考丛书

·曹忠良 王珍云编·



无机化学反应方程式手册



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湖南科学技术出版社

内 容 简 介

本书收编了无机化学及分析化学方面的重要化学反应方程式八千余个。按元素周期表中元素的自然分类规律，将各族元素的单质和化合物的重要化学反应方程式，有规律地编排成册，便于查阅。

这是一本基本的化学工具书，资料新颖，内容全面，编排合理。可供从事化学及有关工作的同志，包括大专院校师生、中学化学教师、化学研究人员、各行业化验室工作人员、化工厂技术人员等查阅。

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曹忠良 王珍云 编

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编 者 的 话

化学反应方程式是最集中、最简明表示化学变化内容的一种形式，是化学工作者一种特殊的语言。为了满足广大的化学工作者从事科研、教学和生产的需要，编者广泛地收集和整理了具有实用价值的无机化学反应方程式八千余个汇编成册，以供查阅。

一、本手册是按元素周期表中元素的自然分类规律编排的。根据同族元素具有相似的化学性质这一特点，我们对每族元素中具有代表性的一、二个元素各类化学反应方程式收集较全面，而对其它元素只选择一些特征性的反应方程式。这样就能使本手册既具有较强的实用性，又不至于篇幅过大。

二、本手册共分十六章，编排顺序是：先非金属，后金属；先单质，后化合物。化合物又依照氢化物、氧化物、碱、酸、盐等顺序排列。

三、对于卤化物、硫酸盐、硝酸盐、磷酸盐、碳酸盐等，因种类繁多，涉及面广，如果将有关化学反应式集中放在卤素、硫、氮、磷、碳等章节中，这些部分便会显得过于拥挤，因此，我们将这些反应方程式适当分散在其它各有关章节中。

四、读者在查找某一化学反应方程式时，只要知道反应物分子中的主要元素是属于哪一类，就可在有关章节中找到。例如要查



就可在十三章“铁”元素的化合物〔 FeSO_4 〕一栏中找到。

五、反应条件的简要说明，附在反应方程式的“ —— ”上下方。文字说明较多的，附在反应方程式的下面（ ）内。反应物为气体或固体的化学反应方程式，在其分子式的后面标上（气）（固）字。但常温常压下，人们一般熟知的气态物质如 CO_2 、 SO_2 、 H_2S 、 N_2 、 Cl_2 、 O_2 ……则不加标示。生成物中的“固体”或“气体”用“ \downarrow ”或“ \uparrow ”来表示。一些不太常见的化合物的名称，注明在其化学式的下面（ ）内。

六、由于篇幅所限，本手册以收集氧化-还原反应方程式为主。常见的反应方程式省略了一部分。文字叙述仅作关键性的说明，力求简明扼要。

我们在编写本手册过程中，曾得到湖南师范学院刘明清、张惠元二位副教授的具体指导，还得到肖仰云、潘正卿、黄忠道等同志的帮助。初稿完成后，经湖南教育学院李朝略同志逐条审阅、修改、增删定稿。在此表示衷心的感谢！

编者 1981年12月

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常见阳离子与常用试剂的反应表

常见阴离子与常用试剂的反应表

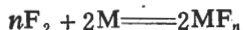
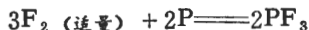
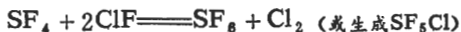
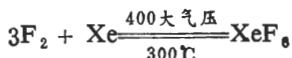
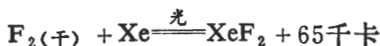
各种盐类的溶解情况表

第一章 卤素

1.1 氟 $2s^2 2p^5$ $F=18.9984$



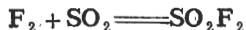
(在冷暗情况下也能发生剧烈反应)



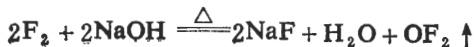
(M表示大多数金属, $n=1, 2, 3, \dots$)

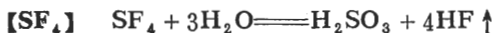
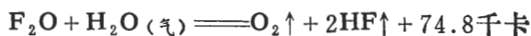
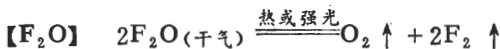
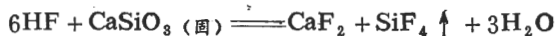
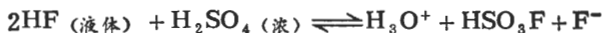


(反应剧烈, 甚至还可产生 O_3 。在极低温下 20°K , F_2 与 H_2O 作用能生成 HFO , 但 HFO 很不稳定, 易分解放出 O_2)

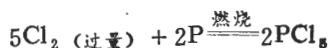
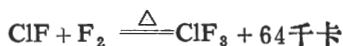
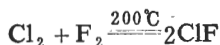
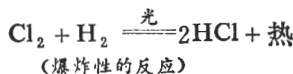


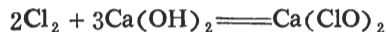
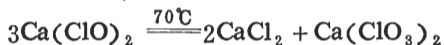
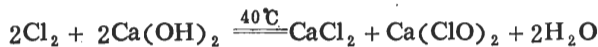
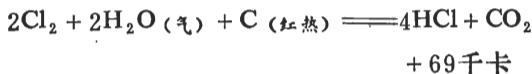
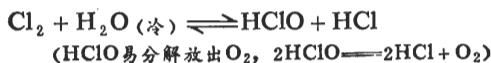
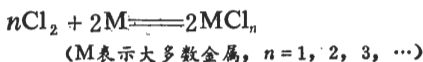
(F_2 在 SO_2 中燃烧的反应)



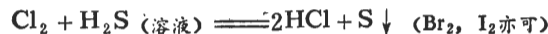
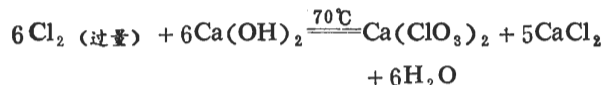


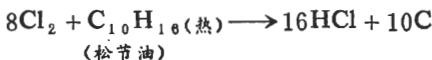
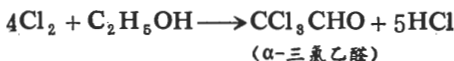
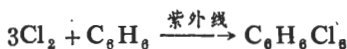
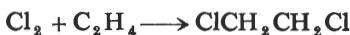
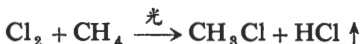
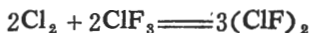
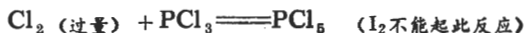
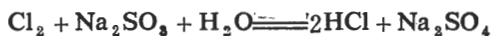
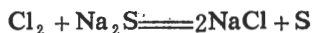
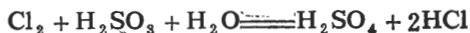
1.2 氯 $3s^2 3p^5$ $\text{Cl} = 35.453$





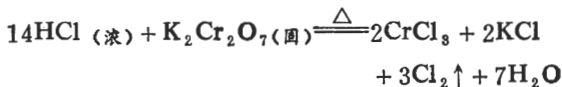
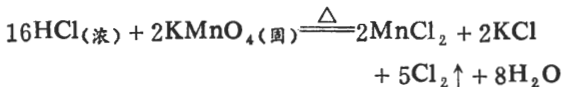
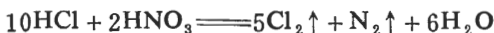
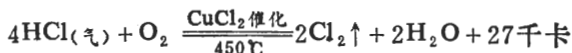
(漂白粉的漂白原理)



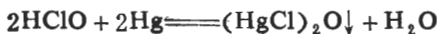
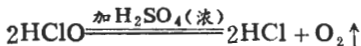
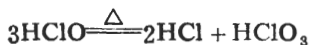
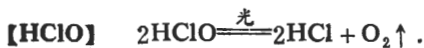
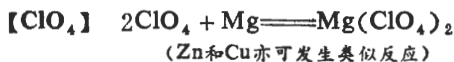
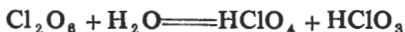
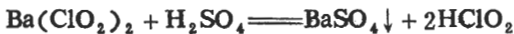
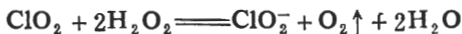
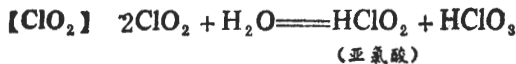
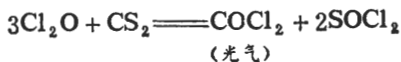


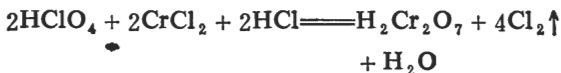
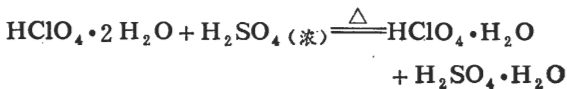
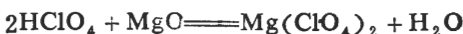
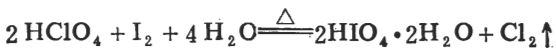
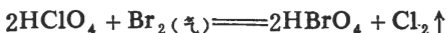
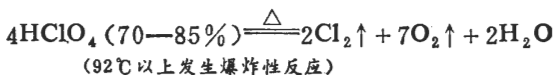
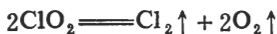
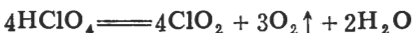
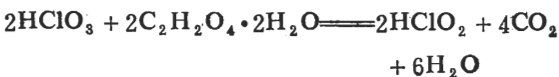
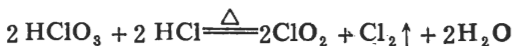
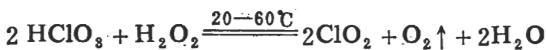
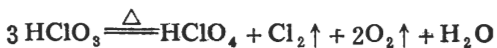
【HCl】 HCl(气)——氯化氢

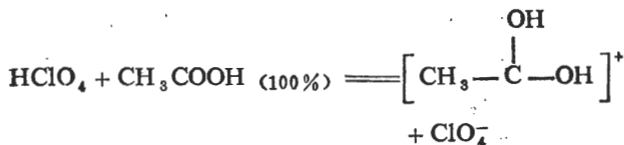
HCl——盐酸



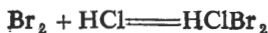
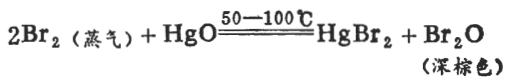
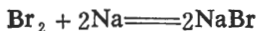
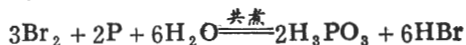
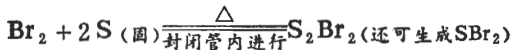
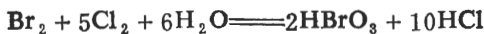
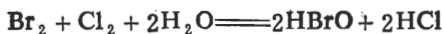
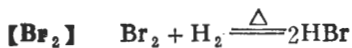
【Cl₂O】 Cl₂O + H₂O \rightleftharpoons 2HClO

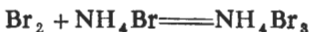
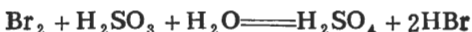
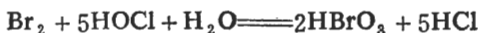
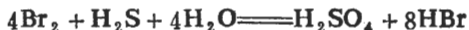




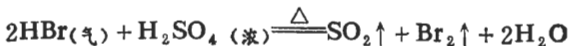
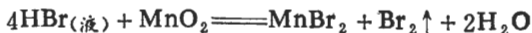
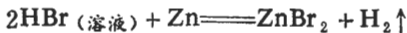
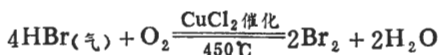
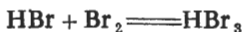
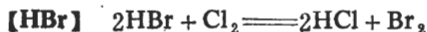
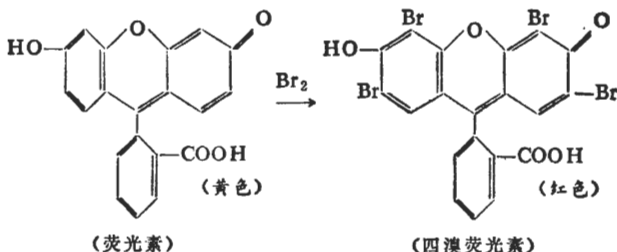


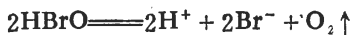
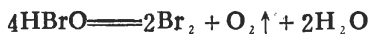
1.3 溴 $4s^2 4p^5$ Br = 79.904



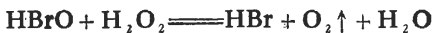


(制取 NaBrO_3 的反应方程式)

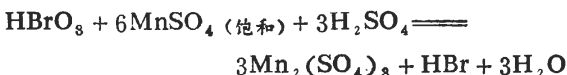
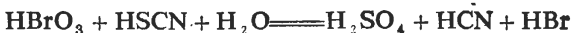
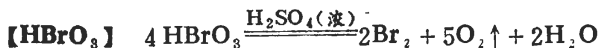
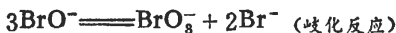




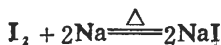
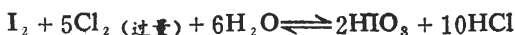
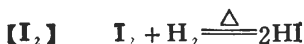
(HBrO转化为HBrO₃时的中间过程)

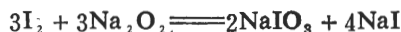
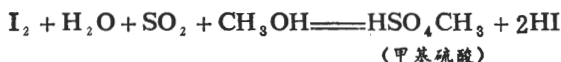
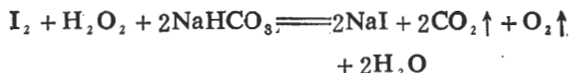
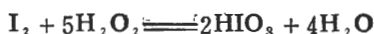
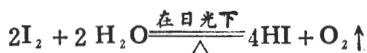


(HBrO溶液内自动发生的中间过程)

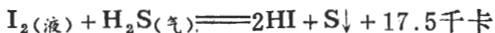
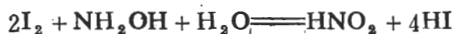
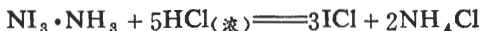
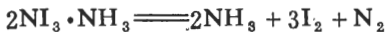
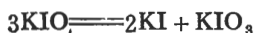
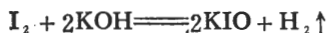
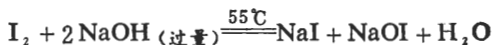


1.4 碘 $5s^2 5p^5 \quad I = 126.9045$

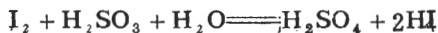
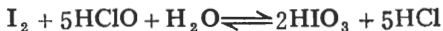


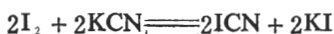
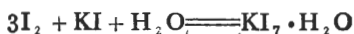
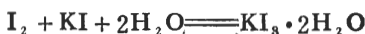
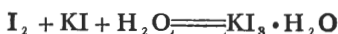
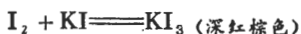
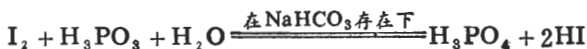
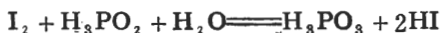
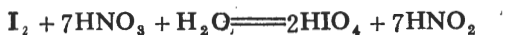


(反应物在混合时必须冷却)

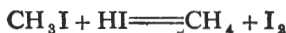
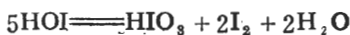


(反应在酸性溶液中进行。将 I_2 悬浮于水内通入 H_2S)



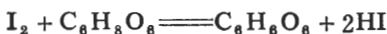


(先将 I_2 溶于醚中, 再与过量的 $\text{Hg}(\text{CN})_2$ 反应)



(葡萄糖)

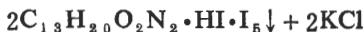
(葡萄糖酸)

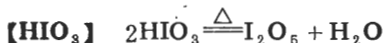
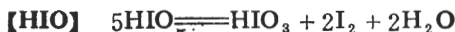
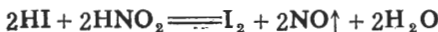
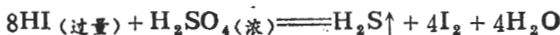
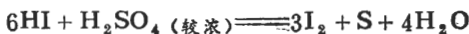
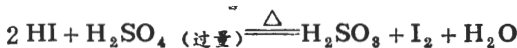
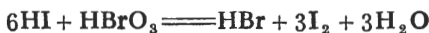
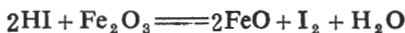
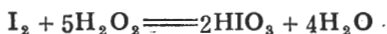
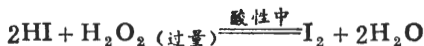
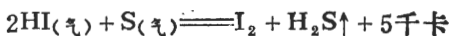
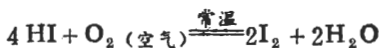
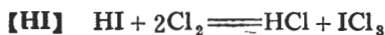


(抗坏血酸)

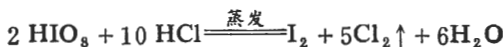
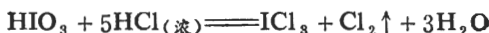
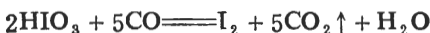
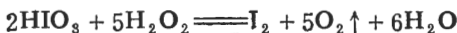


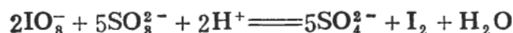
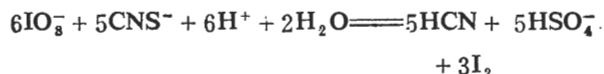
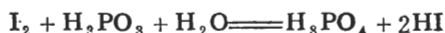
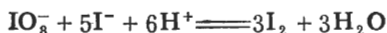
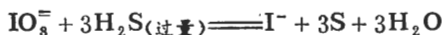
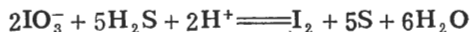
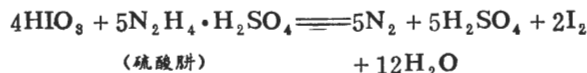
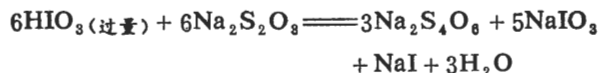
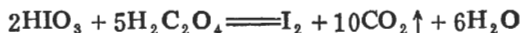
(盐酸普鲁卡因)



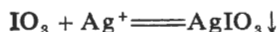


(I_2O_5 为白色粉末, 加热至 300°C 以上分解为 I_2 和 O_2)

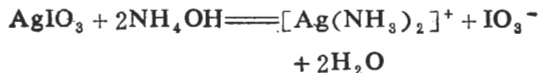




(若 SO_3^{2-} 过量时,则无 I_2 ,因为,

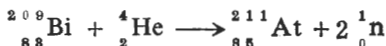


(AgIO_3 沉淀难溶于稀 HNO_3 , 易溶解于 NH_4OH)

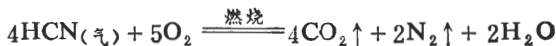
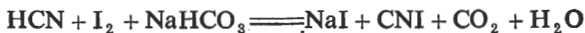
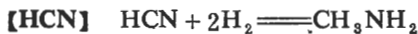
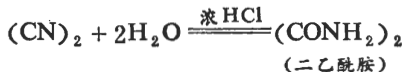


1.5 砹 $6s^2 6p^5$ At=210

有关砹的研究目前甚少，因为砹极不稳定，在自然界中砹可能作为核衰变系中的一个短寿命中间体而存在，故来源极稀少，无法对它进行研究。一九四二年，人们用高速 α 粒子轰击铋，第一次制得砹。

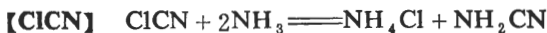
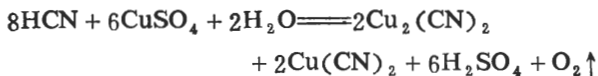
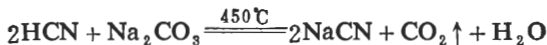
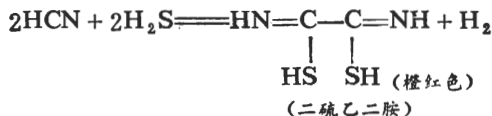
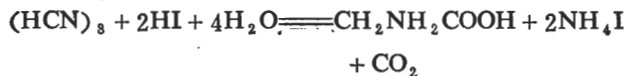
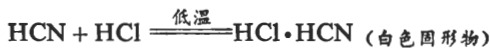
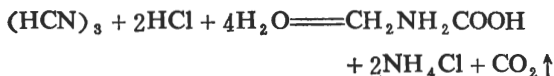
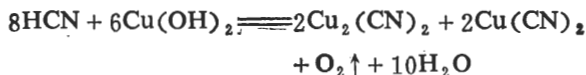
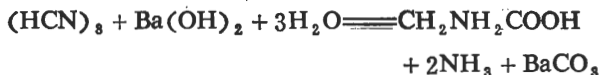


1.6 氰和氰化物

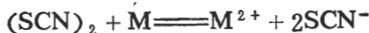
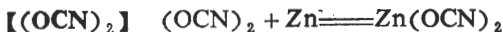


(或生成 HCOONH_4)

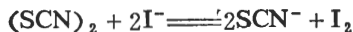
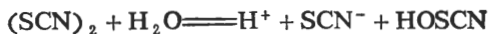


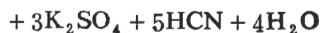
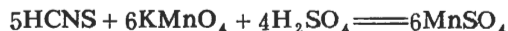
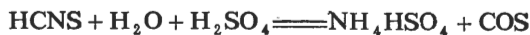
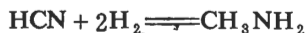
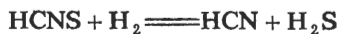
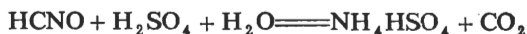
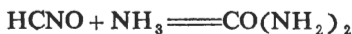
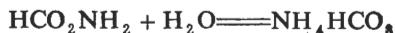
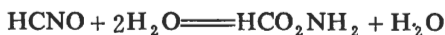
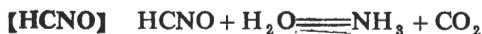
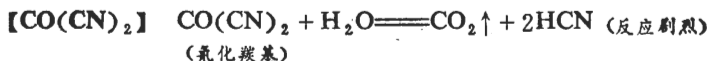
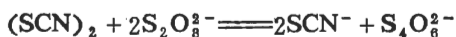


(B:CN、ICN均可发生类似反应)



(M为二价的金属元素)





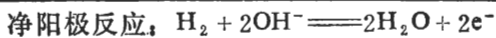
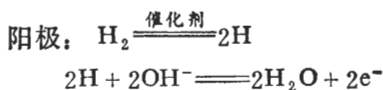
其他氰化物详见各章。

第二章 氧 族

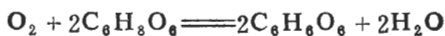
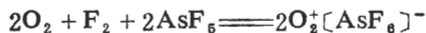
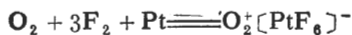
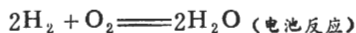
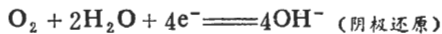
2.1 氧 $2s^2 2p^4$ $O = 15.9994$



附：燃料电池：

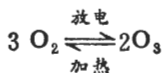


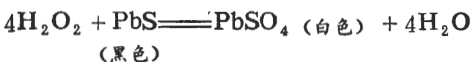
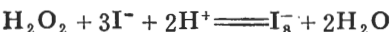
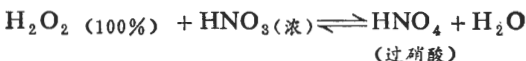
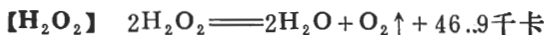
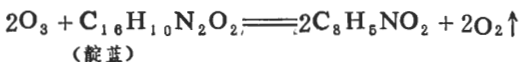
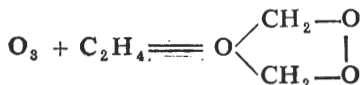
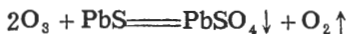
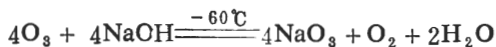
总电池反应是：



(抗坏血酸)

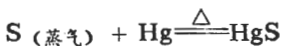
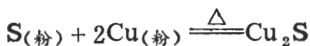
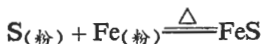
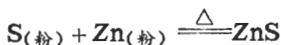
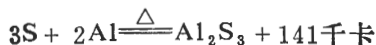
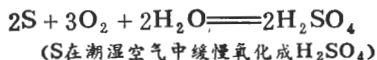
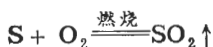
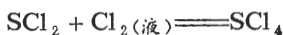
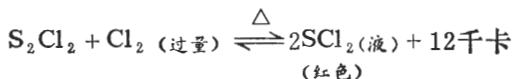
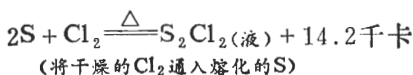
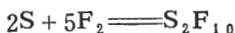
(利用此反应可除去水中的氧)





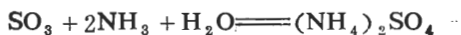
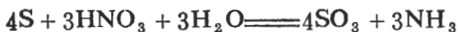
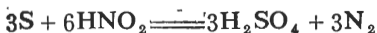
2.2 硫 $3s^2 3p^4 \quad S = 32.064$

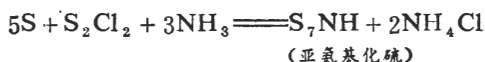
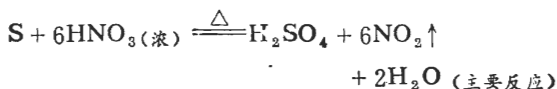




总之: $m\text{S} + n\text{M} \xrightarrow{\Delta} \text{M}_n\text{S}_m$

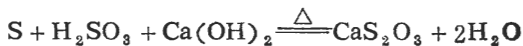
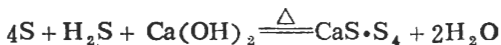
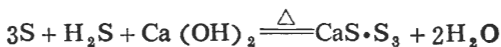
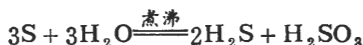
(M为大多数金属, 除Au、Pt外)



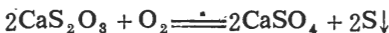
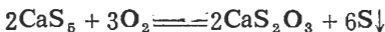


附：石硫合剂

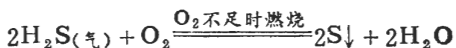
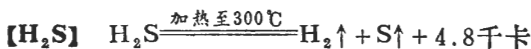
配制时将生石灰、硫磺(粉)、水按照1:2:10混合，在搅拌下煮沸一小时，发生下列反应：



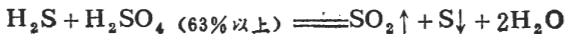
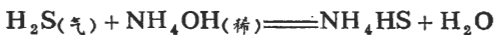
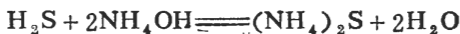
石硫合剂在空气中的变化：

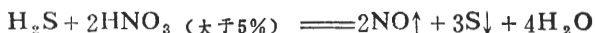
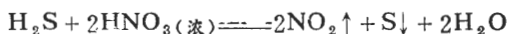


(上两个方程式中 $x=4$ 或 $x=5$)

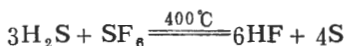
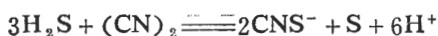


(当H₂S溶液暴露在空气中也发生类似的缓慢的反应)

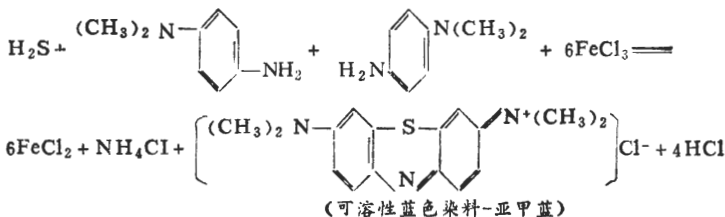




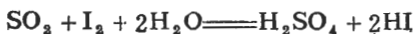
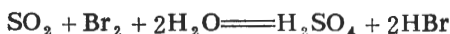
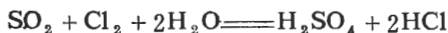
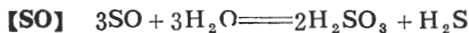
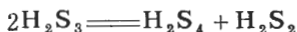
(去掉乙炔气体中的 H_2S 的反应)

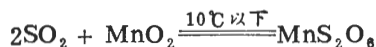
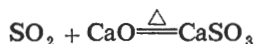
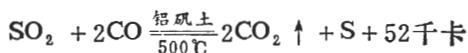
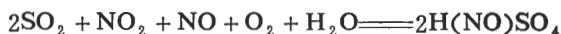
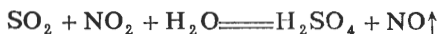
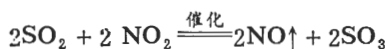
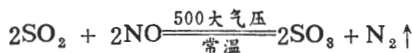
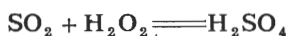
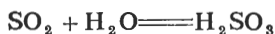
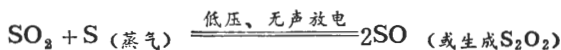
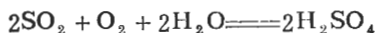
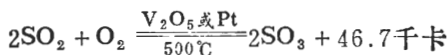


亚甲蓝试验:

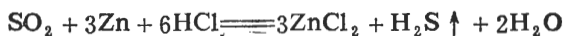
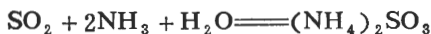
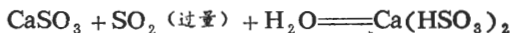
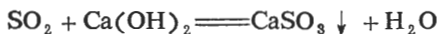
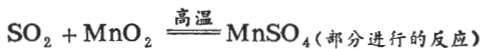


【 H_2S_2 、 H_2S_3 、 H_2S_4 、 H_2S_5 】多硫化氢皆为弱酸，但酸性较 H_2S 强，在高温或有碱金属存在时都易分解为 H_2S 和 S ，还可发生歧化作用。





(将 SO_2 通入 MnO_2 的悬浮液中)



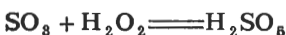
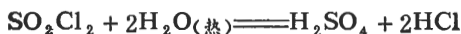
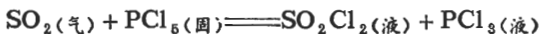
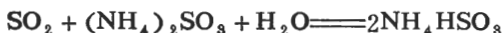
(在常温时反应慢)

将 H_2S 通入 SO_2 的溶液内,得到的是各种连多硫酸的混合

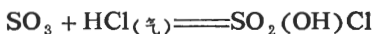
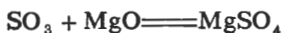
溶液。如 $\text{H}_2\text{S}_4\text{O}_8$ 、 $\text{H}_2\text{S}_6\text{O}_8$ 、 $\text{H}_2\text{S}_2\text{O}_8$ 、 $\text{H}_2\text{S}_3\text{O}_8$ 等。



(铅室法制硫酸的反应原理)

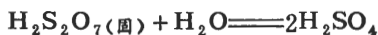
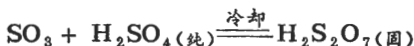
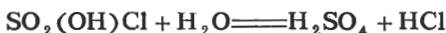
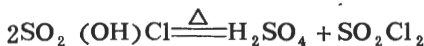


(过氧硫酸)

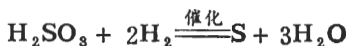
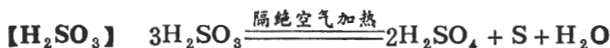
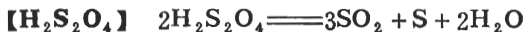
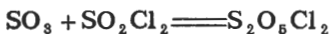
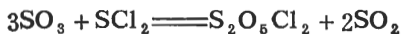


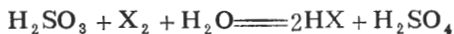
(氯磺酸即 HSO_3Cl)

(发烟 H_2SO_4 与 HCl 气体的反应也得到 $\text{SO}_2(\text{OH})\text{Cl}$)

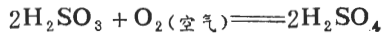


(二氟氧化硫)

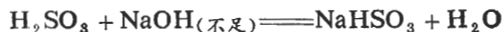
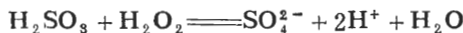




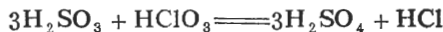
(X_2 表示 F_2 、 Cl_2 、 Br_2 、 I_2)



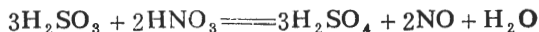
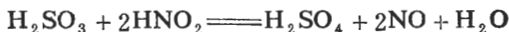
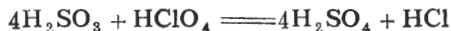
(有 Fe^{2+} 和 As^{2+} 存在时反应更快)



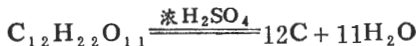
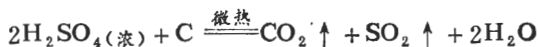
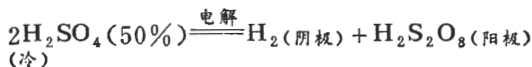
(HBrO 也有类似的反应)



(HBrO_3 、 HIO_3 亦有类似的反应)



【 H_2SO_4 】 (查看其他各章)



【 $\text{H}_2\text{S}_2\text{O}_7$ 】 $\text{H}_2\text{S}_2\text{O}_7 \xrightarrow{\Delta} \text{H}_2\text{SO}_4 + \text{SO}_3 \uparrow$
(焦硫酸)



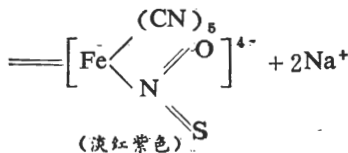
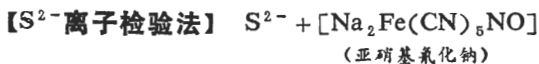
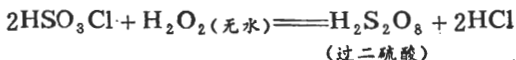
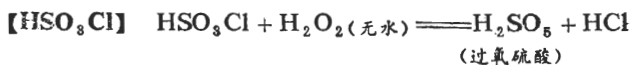
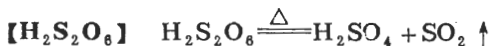
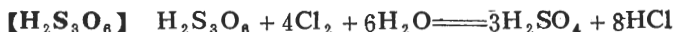
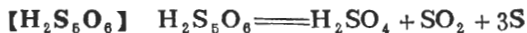
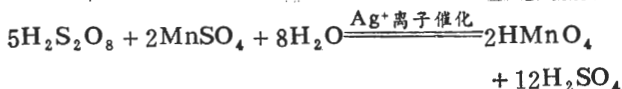
(反应时放出大量的热量)

【 $\text{H}_2\text{S}_2\text{O}_8$ 】 $\text{H}_2\text{S}_2\text{O}_8 + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{SO}_4 + \text{H}_2\text{SO}_5$

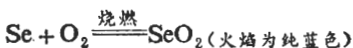
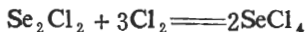
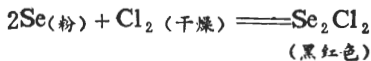
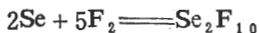
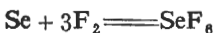
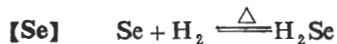
(过氧硫酸)

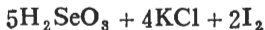
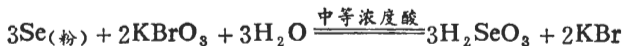
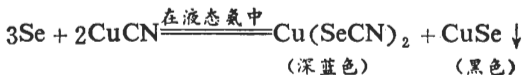
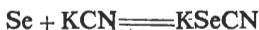
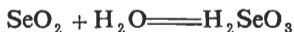
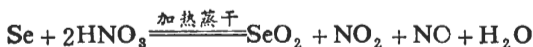
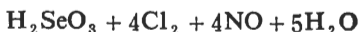
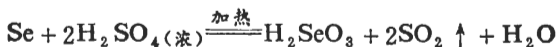
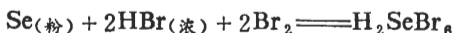
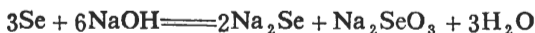
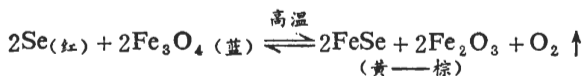
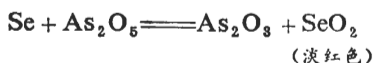
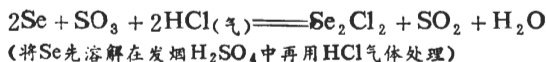
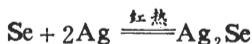


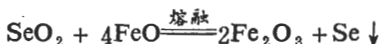
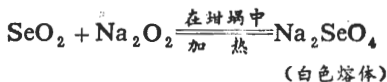
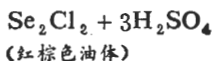
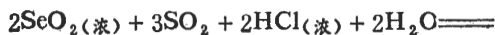
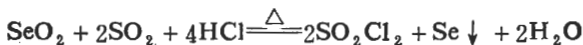
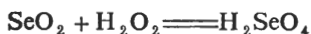
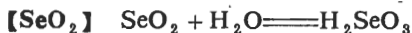
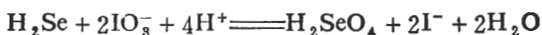
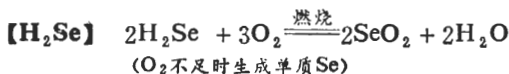
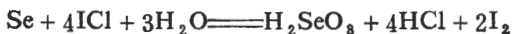
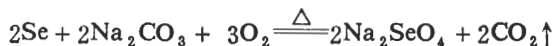
(工业上制 H_2O_2 的反应)



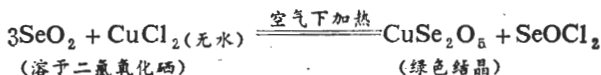
2.3 硒 $4s^2 4p^4$ Se = 78.96

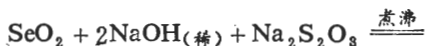
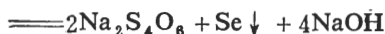




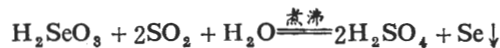
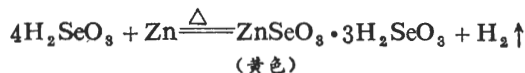
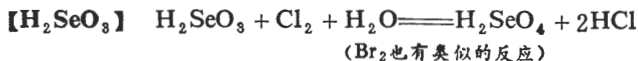
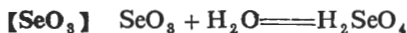
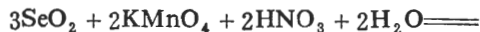
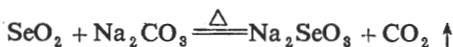
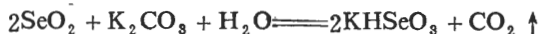
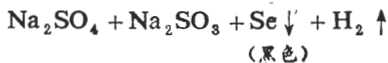


(还可形成加成物SeO₂·2HCl, SeO₂·4HCl)



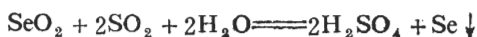
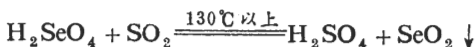
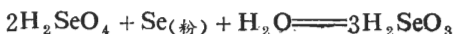
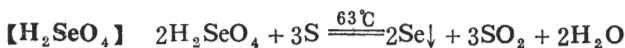
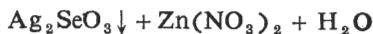
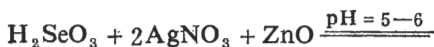
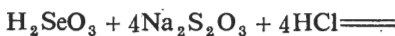
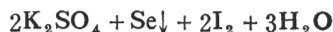
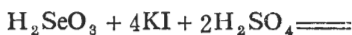
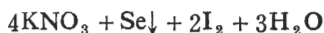
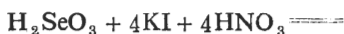
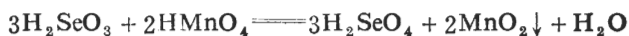
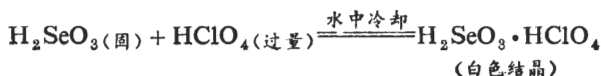
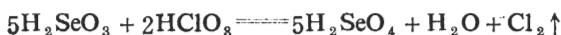
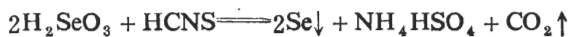


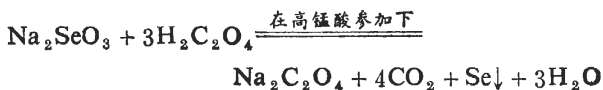
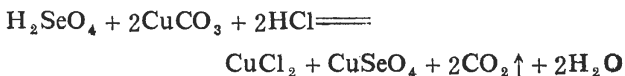
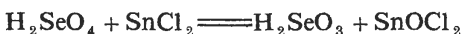
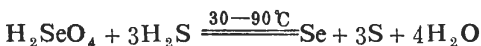
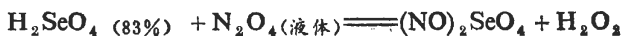
(微过量)



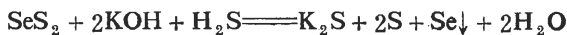
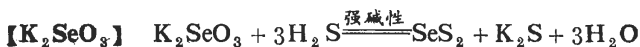


(反应后得黄色沉淀, 加热变红)





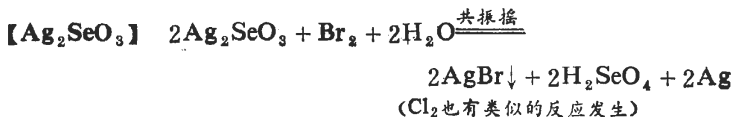
(淡蓝绿色结晶)



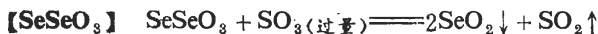
(在冷而稀的 K_2SeO_3 溶液中加入固体硫脲则得红色粉末硒)

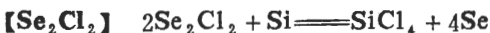
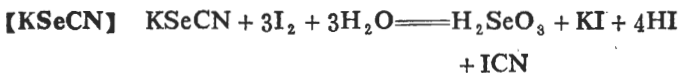
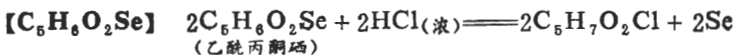
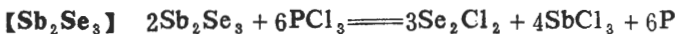
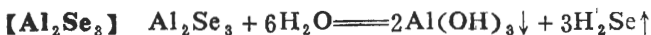
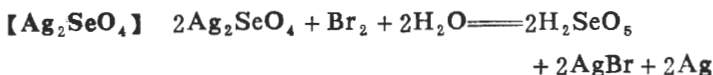
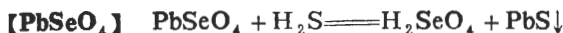
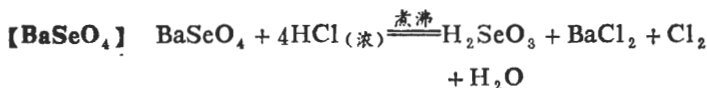
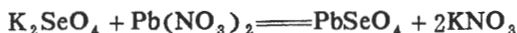
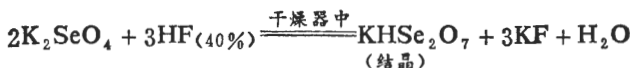
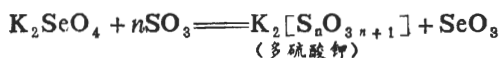
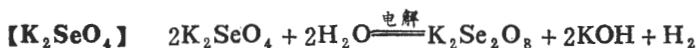
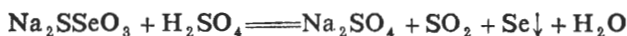
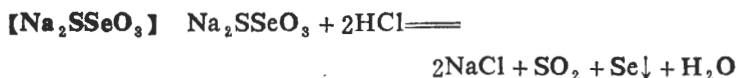


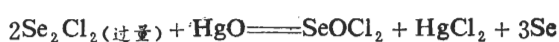
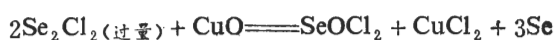
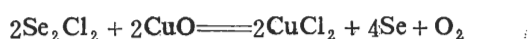
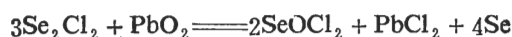
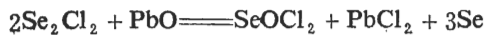
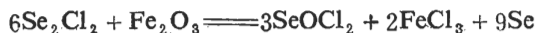
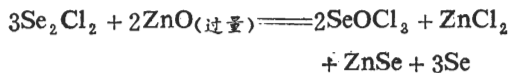
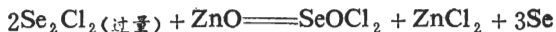
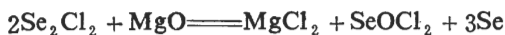
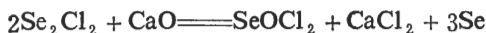
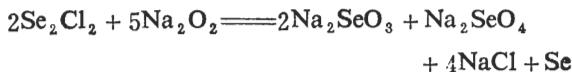
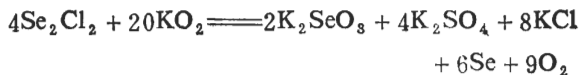
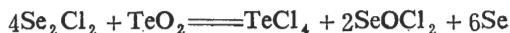
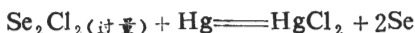
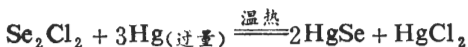
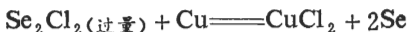
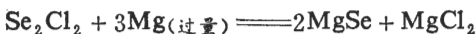
(白色沉淀溶于稀 H_2SO_4)

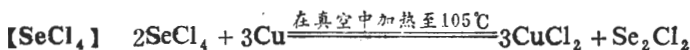
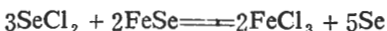
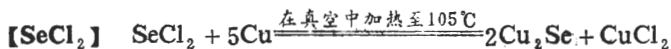
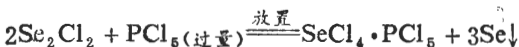
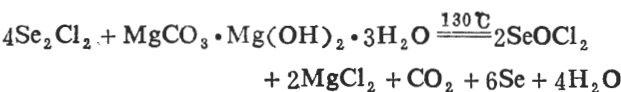
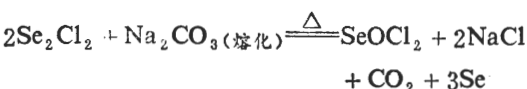
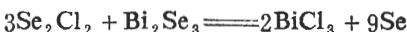
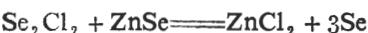
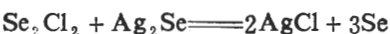
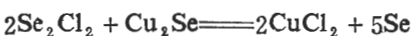
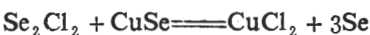
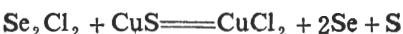
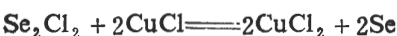
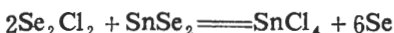
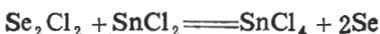
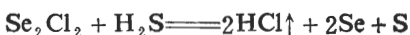
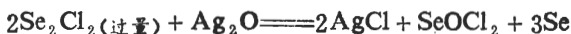


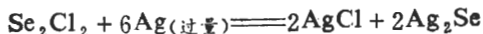
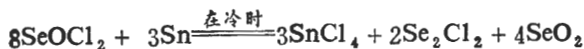
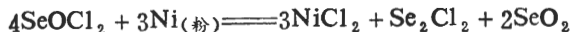
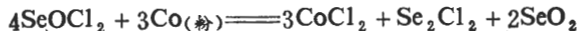
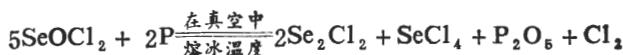
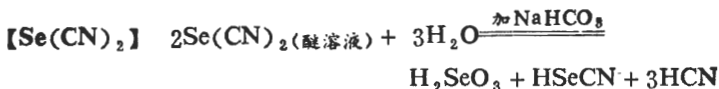
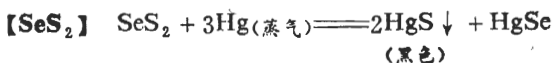
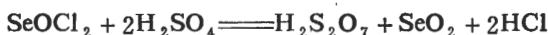
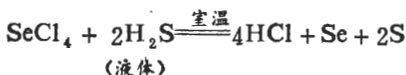
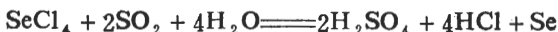
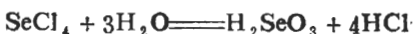
(Cl_2 也有类似的反应发生)

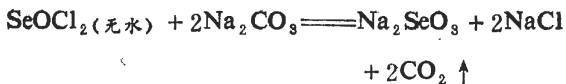
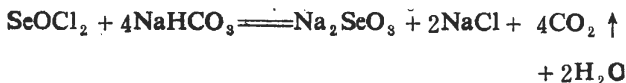
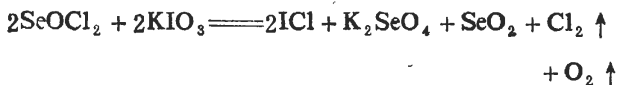
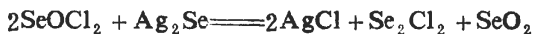
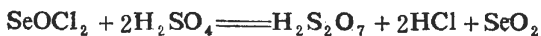
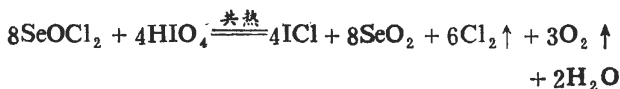
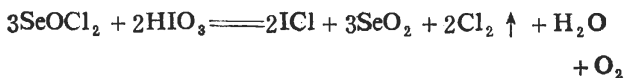
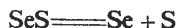
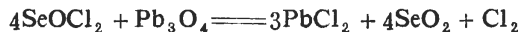
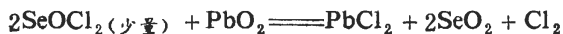
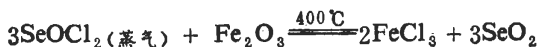


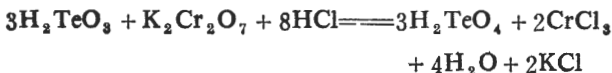
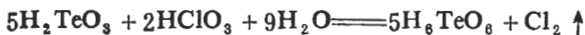
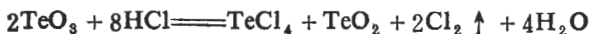
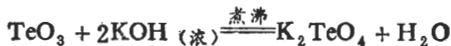
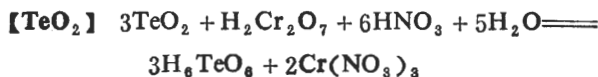
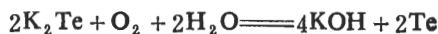
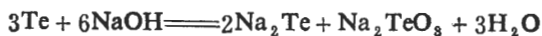
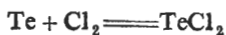










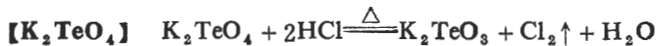
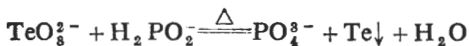
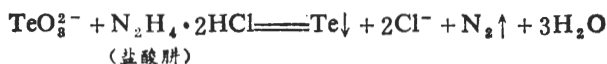
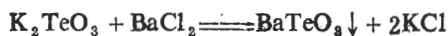
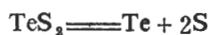
2.4 碲 $5s^2 5p^4$ $Te = 127.60$ 

(碲酸)

(H_6TeO_6 酸性很弱, 为强氧化剂)

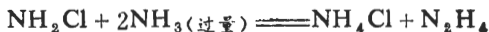
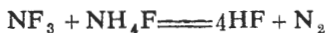
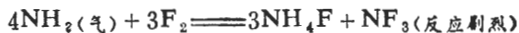
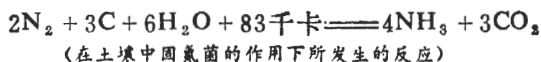
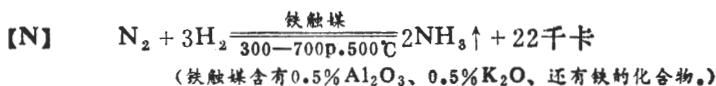


(沉淀可溶于过量的稀盐酸中)

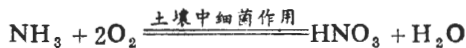


第三章 氮 族

3.1 氮 $2s^2 2p^3$ $N = 14.0067$



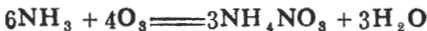
(Br₂的水溶液也有类似的反应)



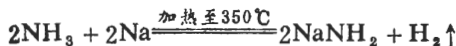
(土壤中亚硝酸菌作用所发生的反应)



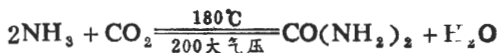
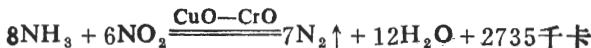
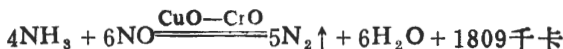
(此反应只能在纯氧中燃烧, 跟空气中的氧不能反应)



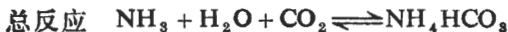
(有AgI存在时反应向右进行到底)



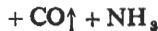
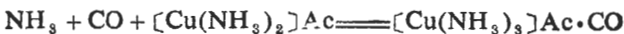
(碱金属和碱土金属均可以发生)



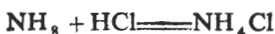
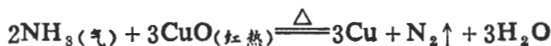
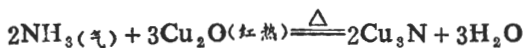
(生产尿素的反应原理)



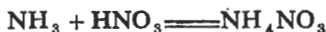
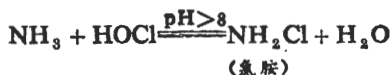
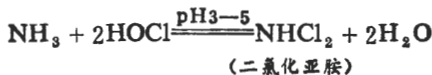
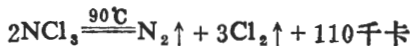
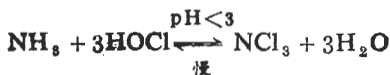
(在过量的CO₂存在之下)



(铜洗去CO的原理。Ac⁻表示CH₃COO⁻)



(HF也有类似的反应)



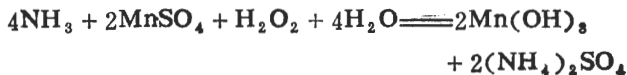
[还可生成 $\text{NH}_4\text{H}_2\text{PO}_4$ 或 $(\text{NH}_4)_2\text{HPO}_4$]



(KOCl也有类似的反应)

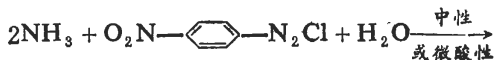
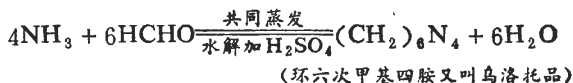
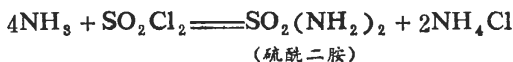


(肼)

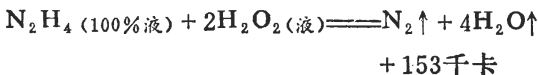
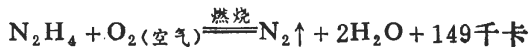
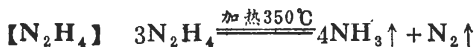
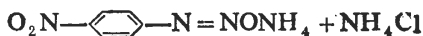


(氨基氯化汞)

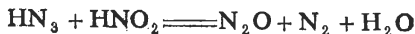
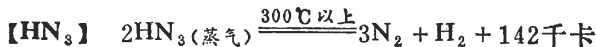
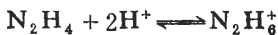
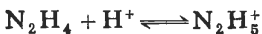


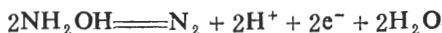
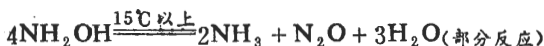
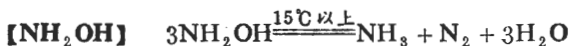


(氯化对硝基重氮苯)



(叠氮酸)

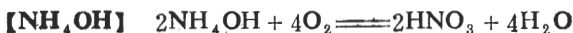
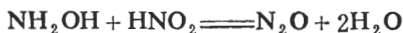




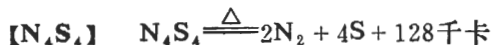
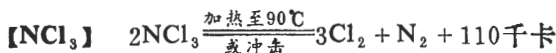
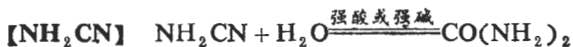
(在酸性溶液中发生的反应)



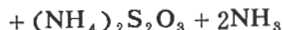
(在碱性溶液中发生的反应)



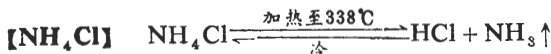
(在土壤中硝化菌作用下进行的反应)



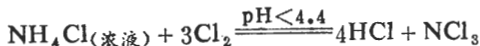
(爆炸性的分解反应)



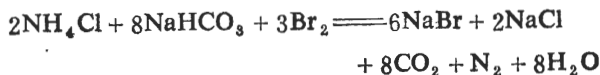
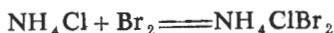
(慢慢的分解)

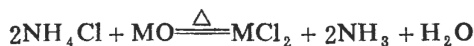


(NH_4Br 也有类似的反应, NH_4F 在 110°C 分解)

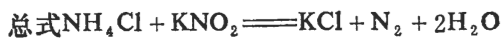
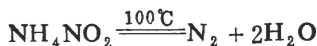
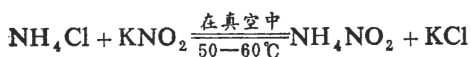
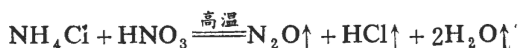
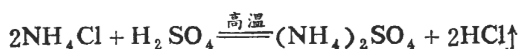
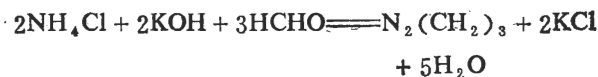


(当 $\text{pH} > 8.5$ 时生成 NH_2Cl , 当 $\text{pH} = 4.5-5$ 时, 生成 NHCl_2)

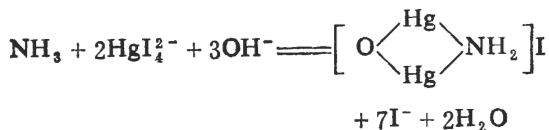
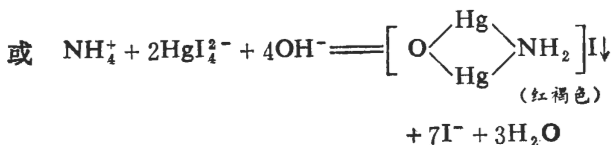
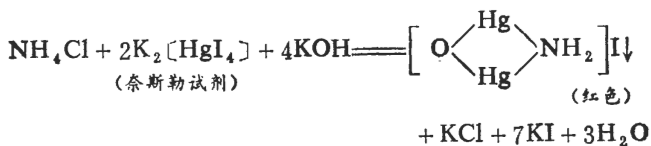
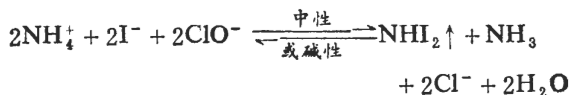
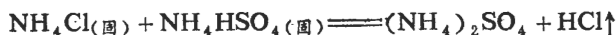




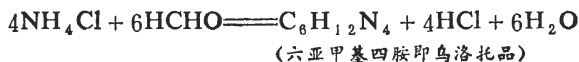
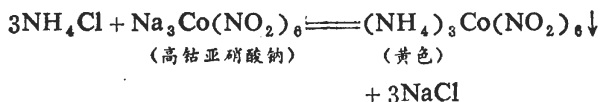
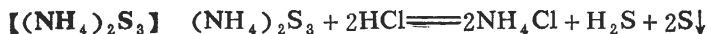
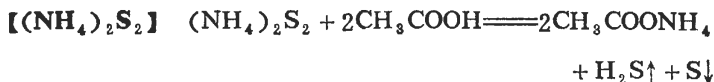
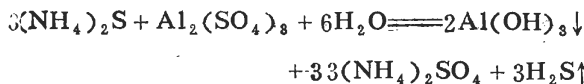
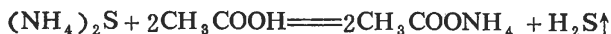
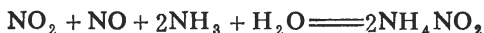
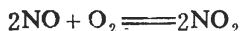
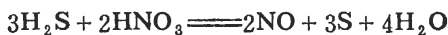
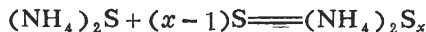
(MO表示二价的金属氧化物)

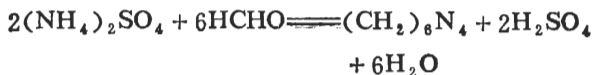
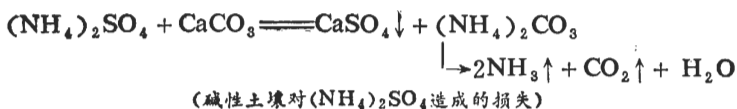
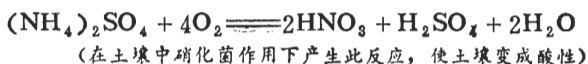
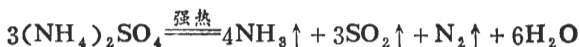
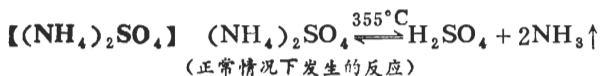
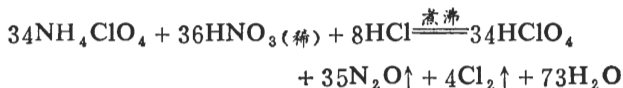
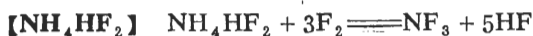
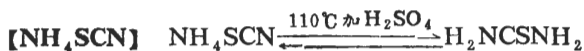


(NaNO_2 有类似的反应)

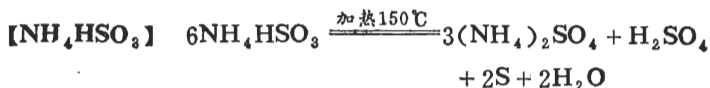


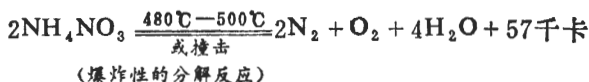
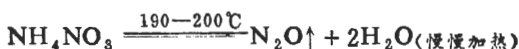
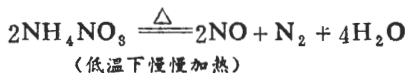
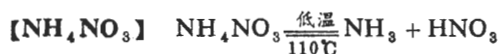
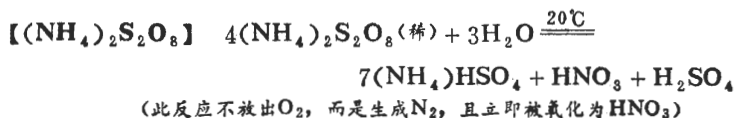
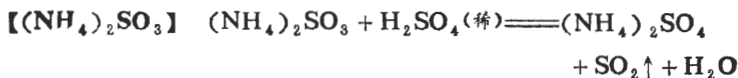
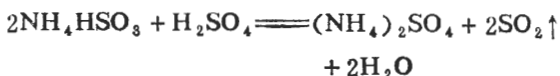
附：奈氏试剂配制

【 $(\text{NH}_4)_2\text{S}$ 】



注: NH_4HSO_4 加热不分解, 在 490°C 时沸腾。

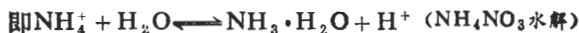
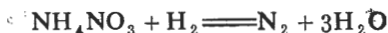


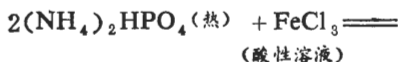
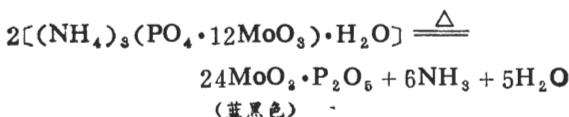
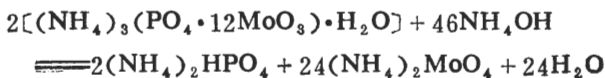
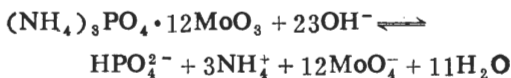
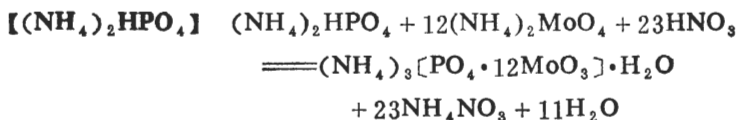
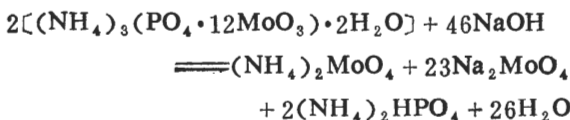
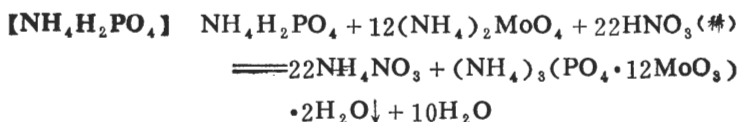
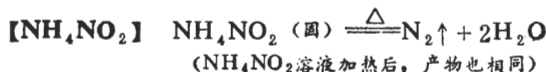
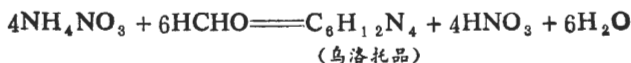


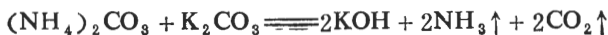
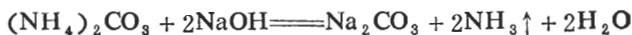
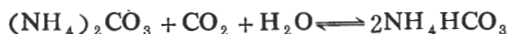
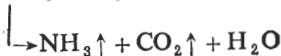
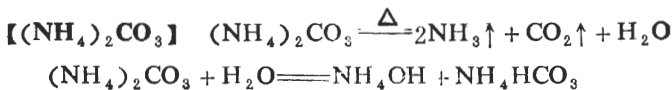
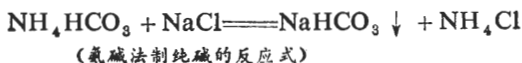
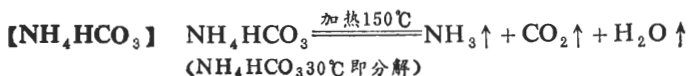
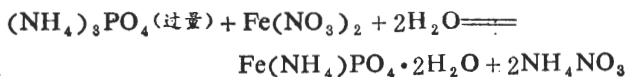
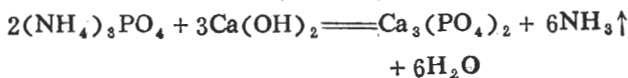
在上述 NH_4NO_3 受热分解反应中，因 NH_4NO_3 受热分解出来的 NH_3 被 HNO_3 氧化而生成氮或氮的氧化物。在反应中 HNO_3 有催化作用。所以 NH_4NO_3 的分解因温度不同而有不同的反应。



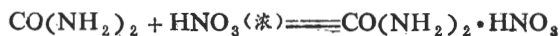
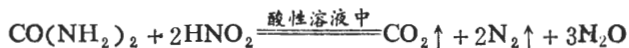
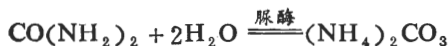
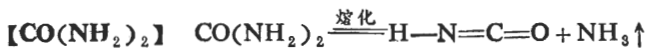
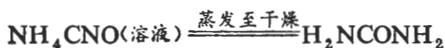
(在土壤中硝化菌作用下发生的反应，使土壤变酸性)

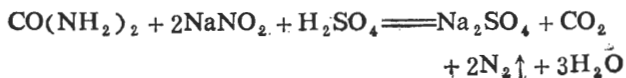




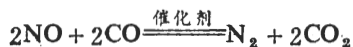
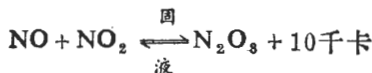
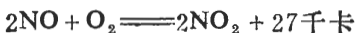


(铵态氮肥不能跟草木灰混和使用的原由)

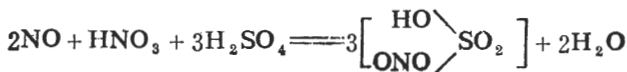
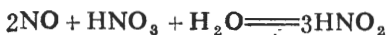
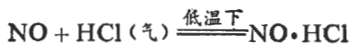
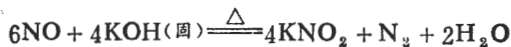


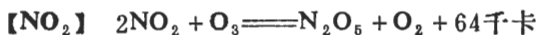
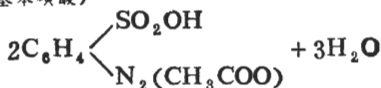
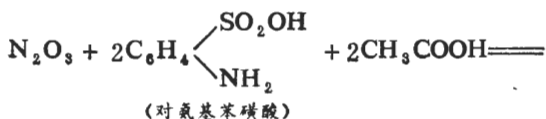
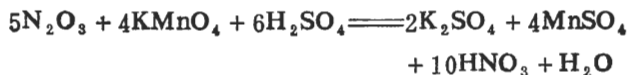
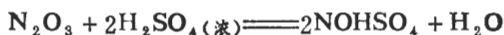
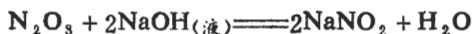
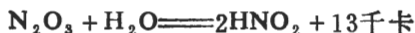


(Br₂有相类似的反应发生)

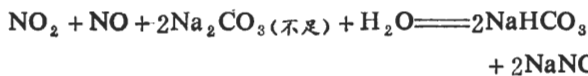
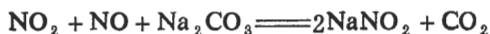
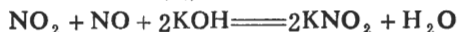
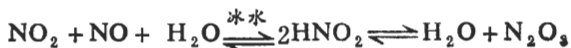
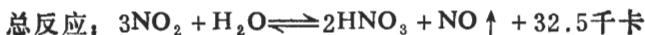
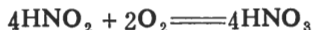


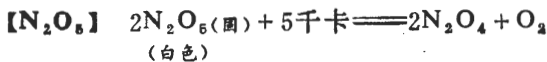
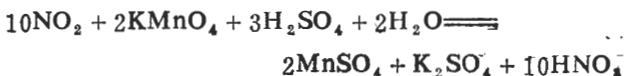
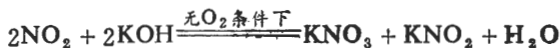
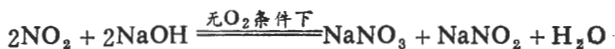
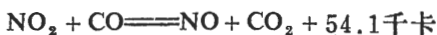
(处理污染空气的反应)



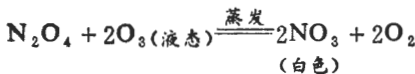
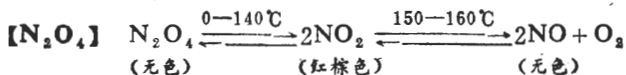
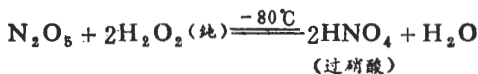
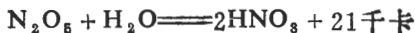
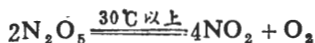
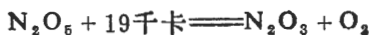


注：(在有充足的氧气存在下， HNO_2 全部转为 HNO_3)

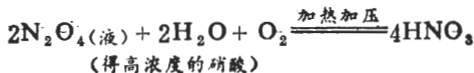




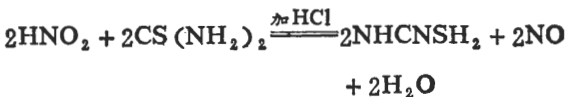
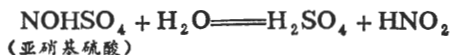
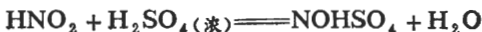
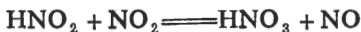
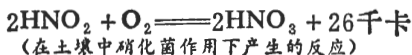
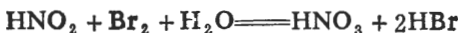
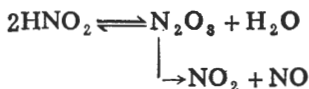
(N₂O₅超过30℃时大量分解)

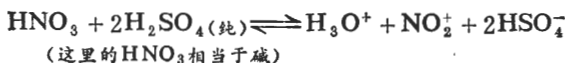
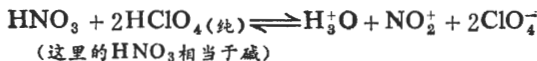
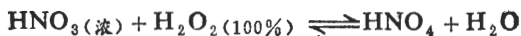
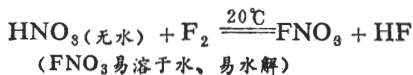
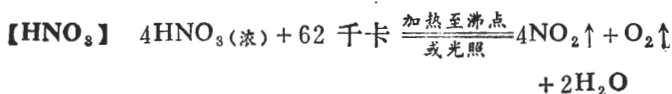
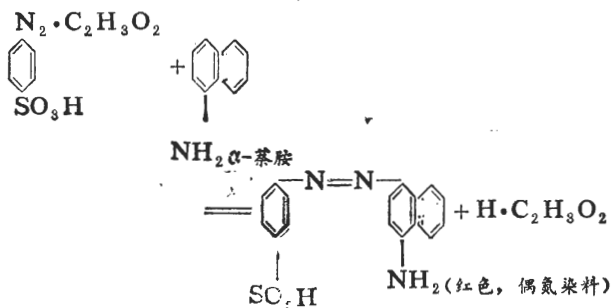
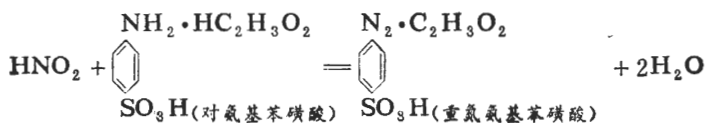


(NO₃过氧化氮, 很不稳定)

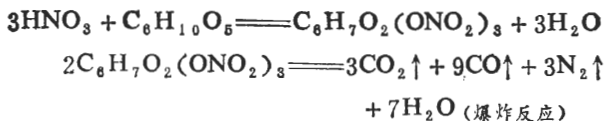
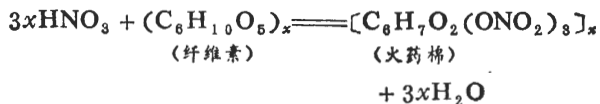


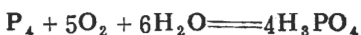
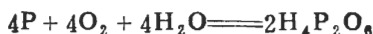
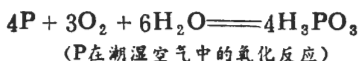
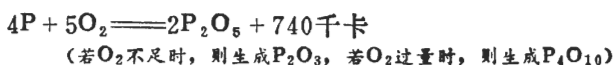
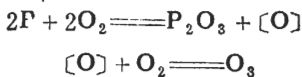
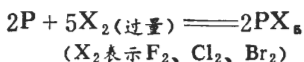
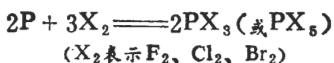
注：所有氮的氧化物与红热铜作用均完全分解成CuO和N₂：





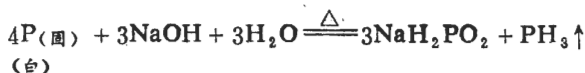
HNO₃与(C₆H₁₀O₅)_x的一系列反应:



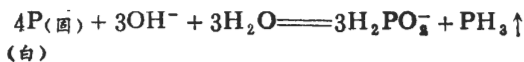


注: P与S的反应, 随反应时P和S相对量的不同, 其产物可能有P₄S₃、P₄S₇、P₄S₁₀、P₄S₈等。

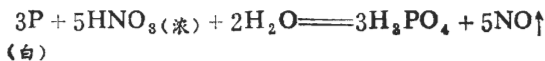
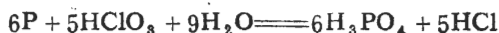
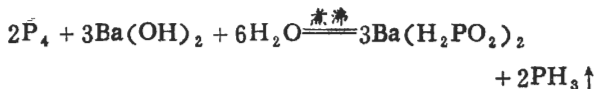
P与N₂不能直接化合, 只能通过间接方法获得PN、P₃N₅、P₄N₆。



(此反应在酒精溶液内进行的, 反应结果也有可能生成Na₂HPO₂和PH₃、少量P₂H₄)

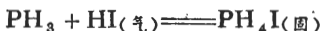
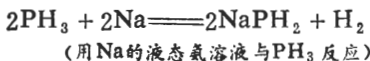
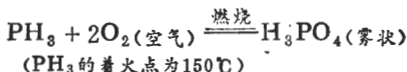
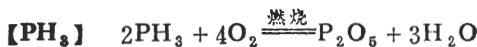


(红磷不能发生此反应)

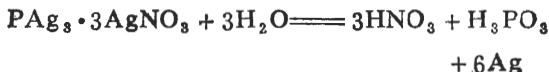
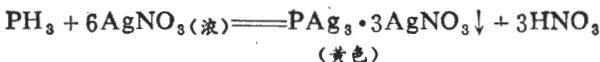


(磷酸的制法之一)

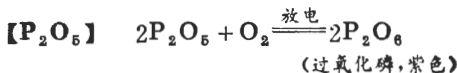
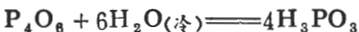
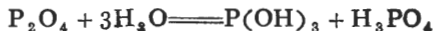
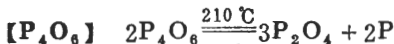
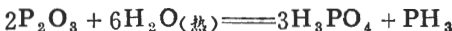
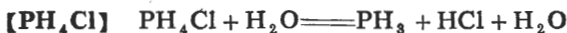
注: P与非氧化性的酸不发生反应。



(去掉乙炔中的PH₃用此反应)

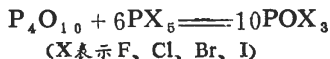
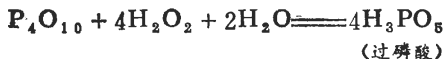
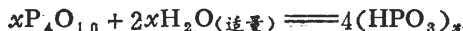
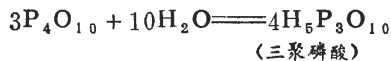
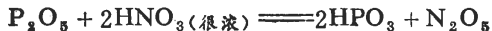
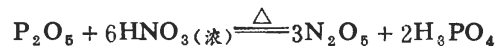
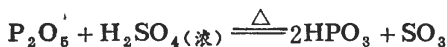
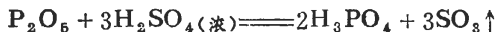
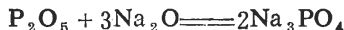
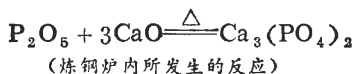
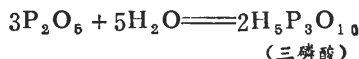
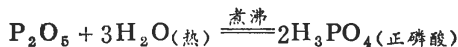
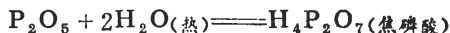
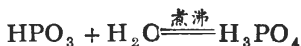
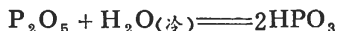


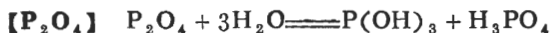
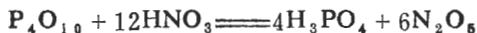
(见光即发生此反应, P₂H₄在空气中能自燃)



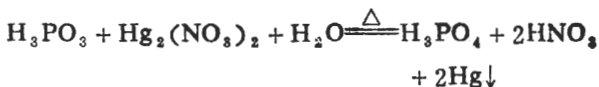
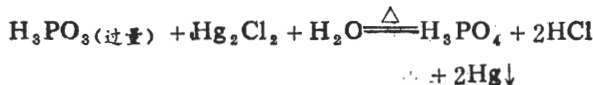
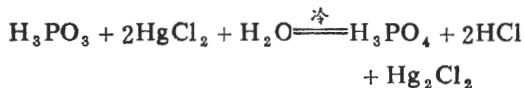
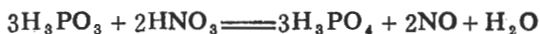
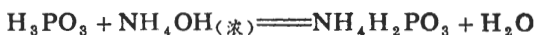
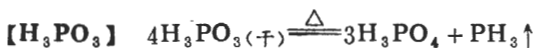
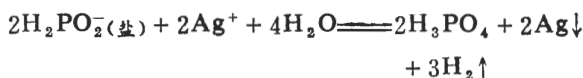
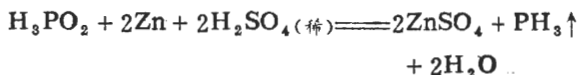
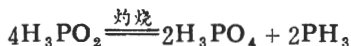


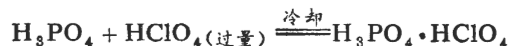
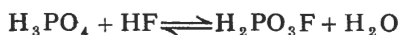
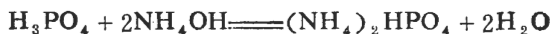
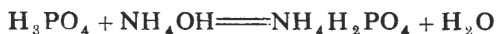
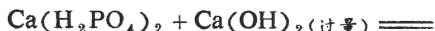
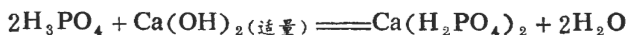
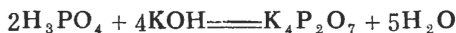
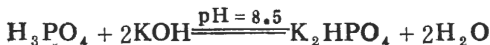
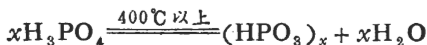
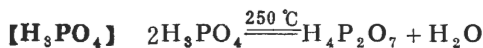
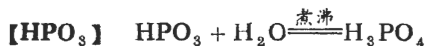
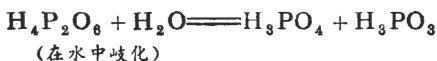
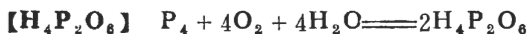
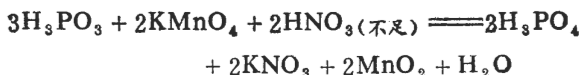
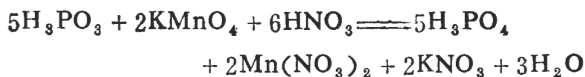
(过二磷酸)

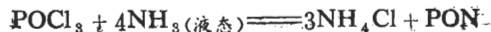
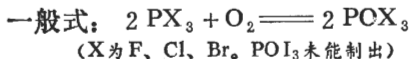
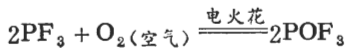
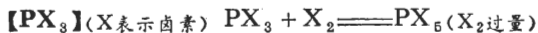
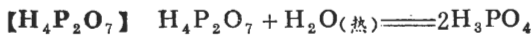
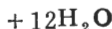
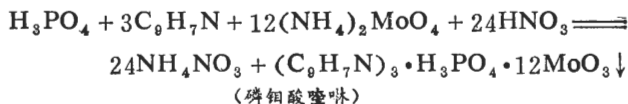
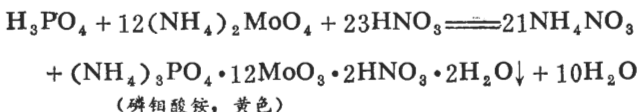
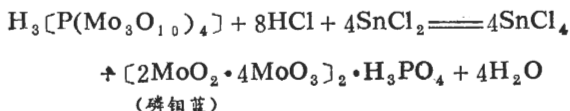
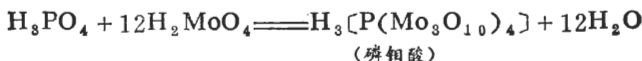
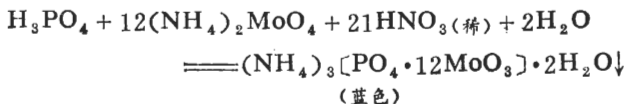
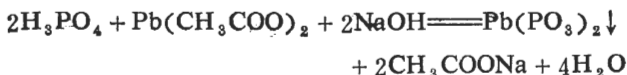
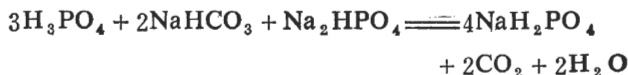


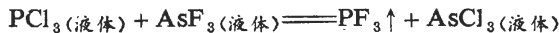
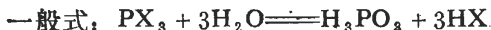
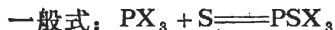


$[H_3PO_2]$ (次磷酸)



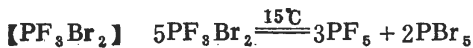
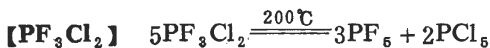
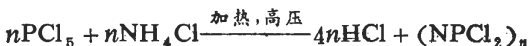
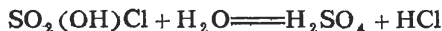
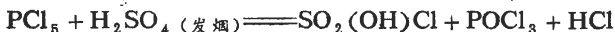
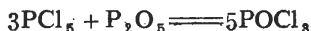
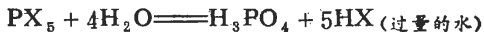
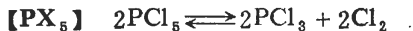






(PF_3 是无色气态, PCl_3 是无色液态, PBr_3 是无色液态, PI_3 是红色晶体)

300 °C

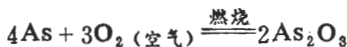
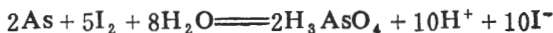


3.3 砷 $4s^2 4p^3$ As = 74.9216

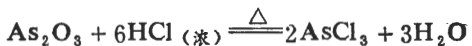
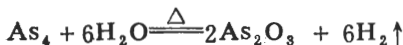




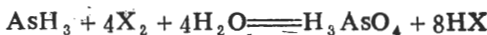
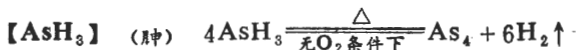
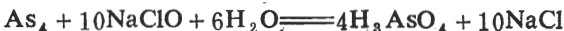
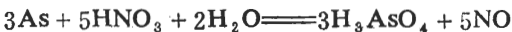
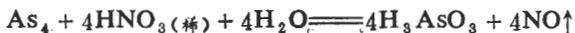
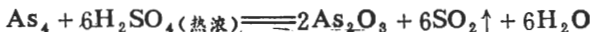
(Br₂亦可以发生类似的反应)



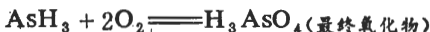
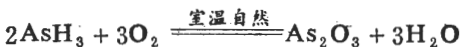
As与热浓HCl反应分二步:



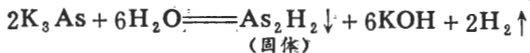
As与冷稀H₂SO₄无反应。



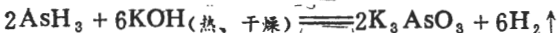
(X₂表示Cl₂、Br₂、I₂)



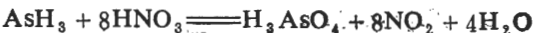
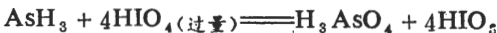
(固体)



(固体)

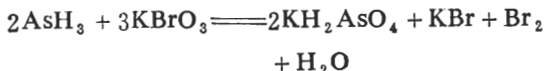


(HIO₃也有类似的反应)

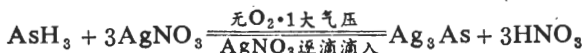
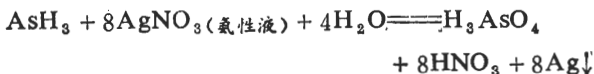
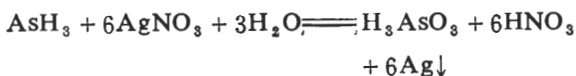
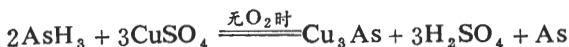
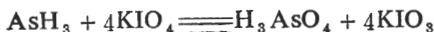




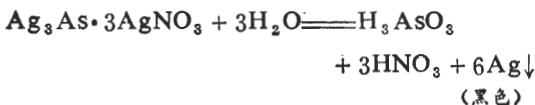
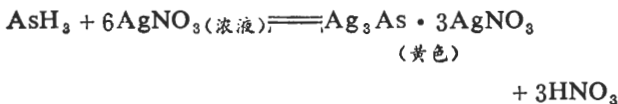
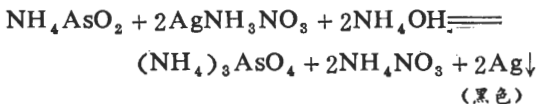
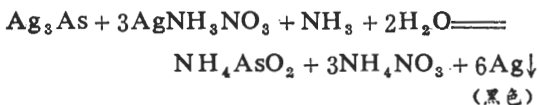
(NaBrO也有类似的反应)

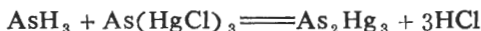
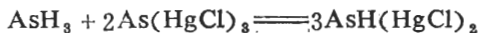
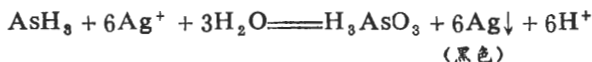


(KIO₃也有类似的反应)

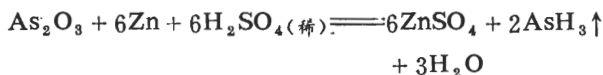


在稀的氨性硝酸银溶液中:

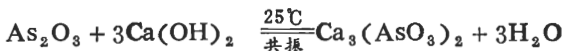
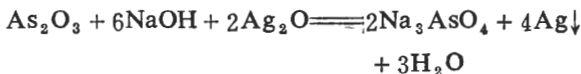
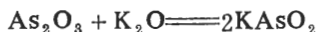
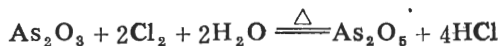


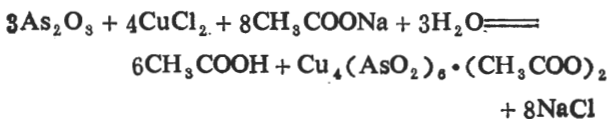
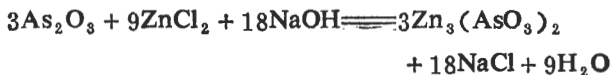
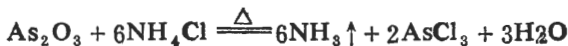
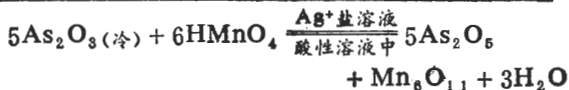
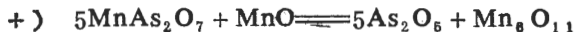
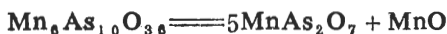
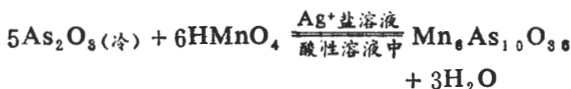
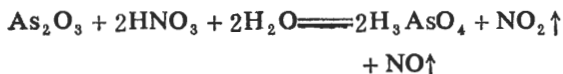
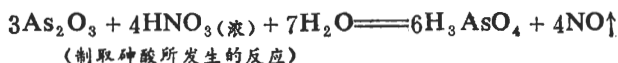
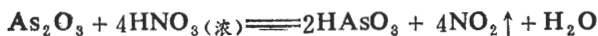
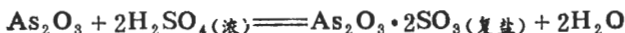
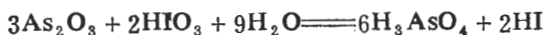
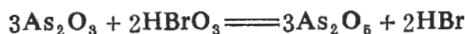
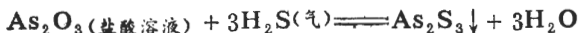
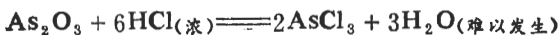
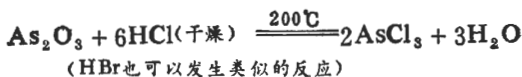
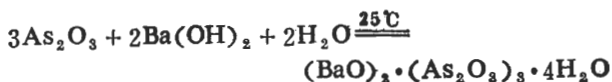


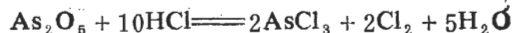
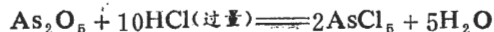
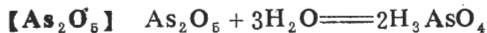
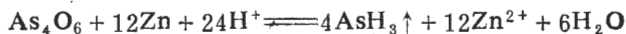
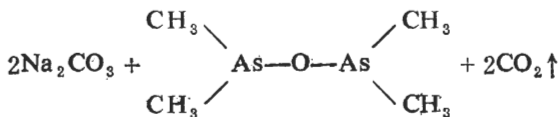
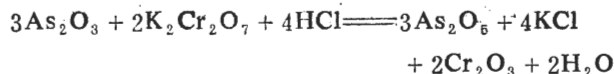
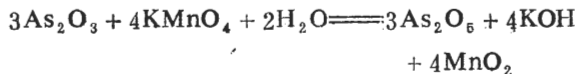
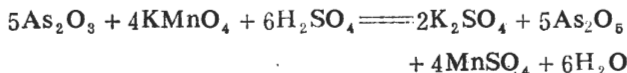
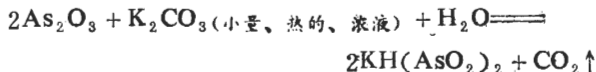
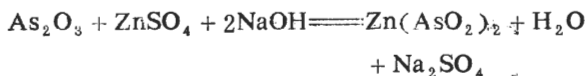
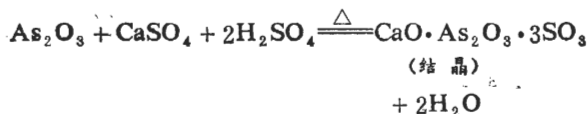
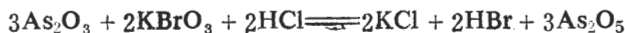
【As₂O₃】 注：As₂O₃具有两性，但偏酸性。

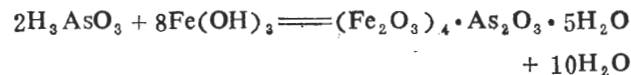
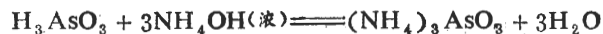
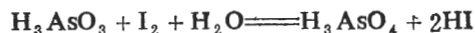
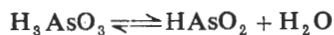
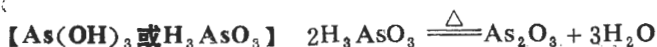
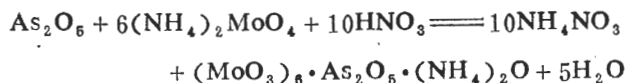
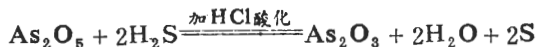


(初生态的氢使As还原的反应)

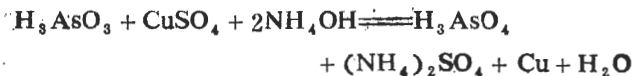
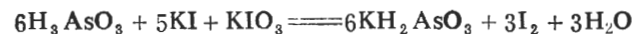
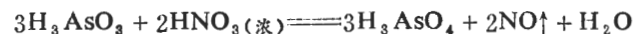
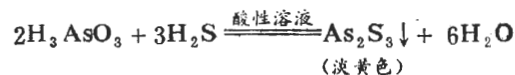


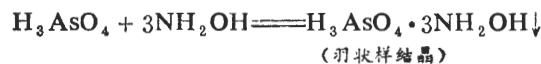
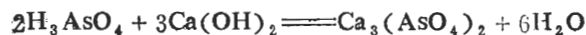
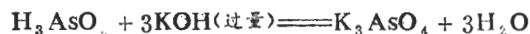
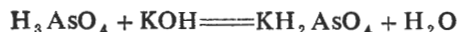
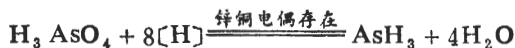
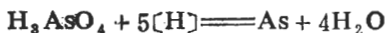
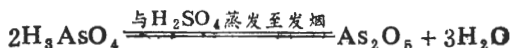
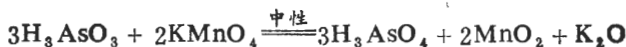
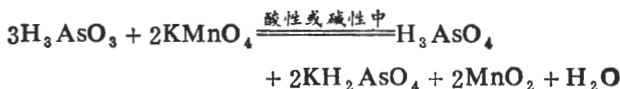
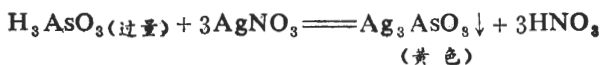
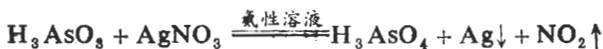
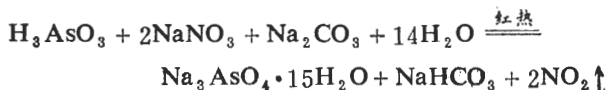




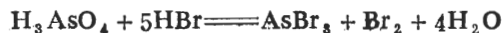


(HCl浓度愈大, 则反应将向右进行)

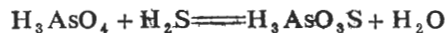


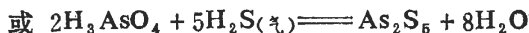
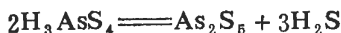
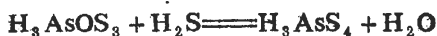


(砷酸液与碳酸钠作用后加羟胺后呈碱性)

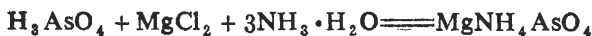
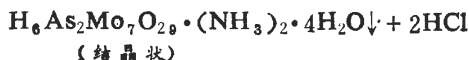
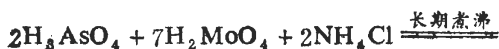
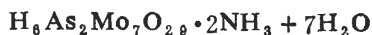
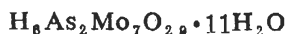
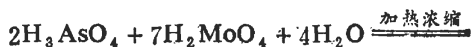
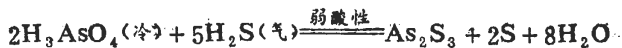
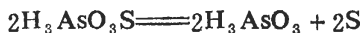
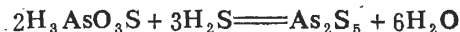
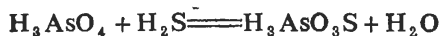


在 H_3AsO_4 溶液中通入过量的 H_2S 发生一系列的反应:



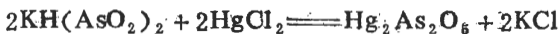
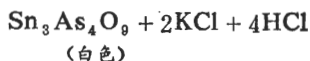
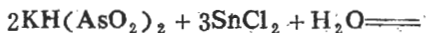
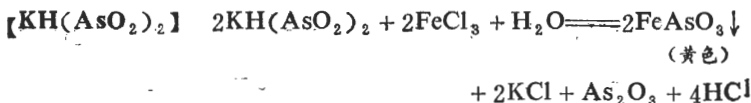
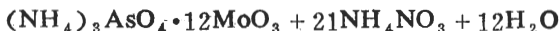
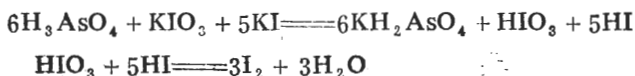
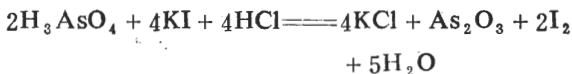
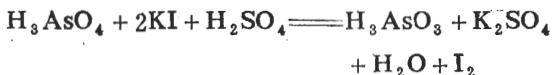
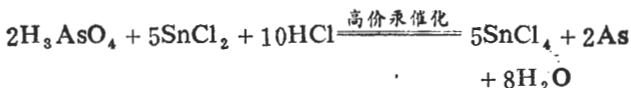
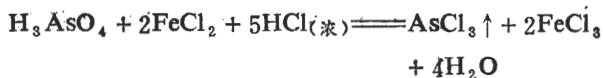


若慢慢通入 H_2S ，且不过量则有：

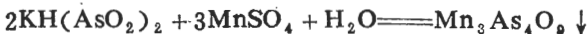
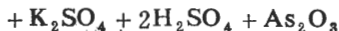
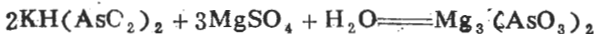
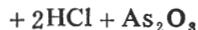


(砷酸铵镁)

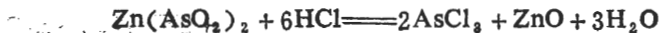
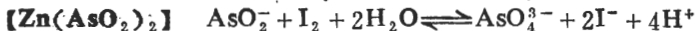
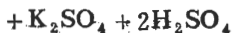


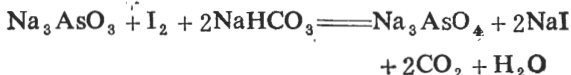
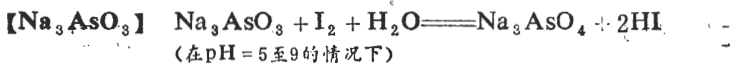
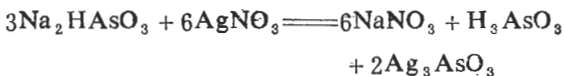
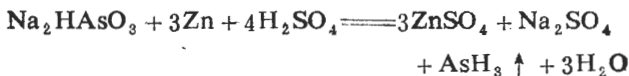
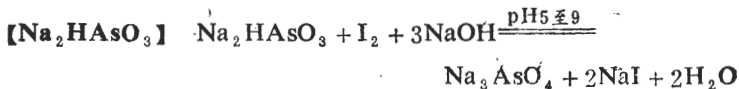
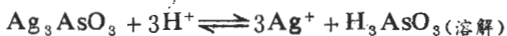
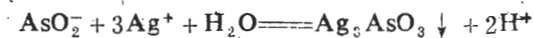
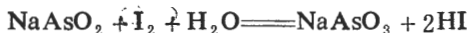
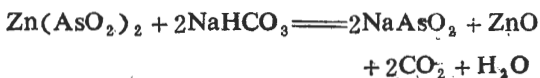


(淡黄白色)

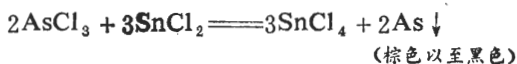
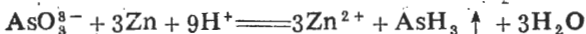
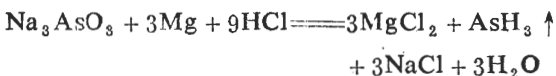
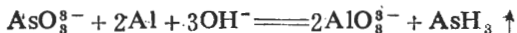


(雪白色凝乳状)

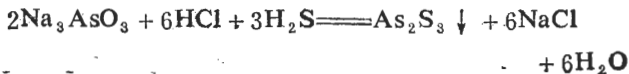


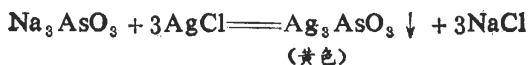
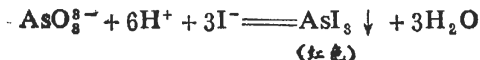


(这里不能用 Na_2CO_3 , 因为 Na_2CO_3 与 I_2 能反应, 如
 $3\text{Na}_2\text{CO}_3 + 3\text{I}_2 \rightleftharpoons \text{NaIO}_3 + 5\text{NaI} + 3\text{CO}_2$)

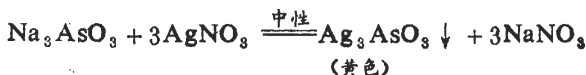
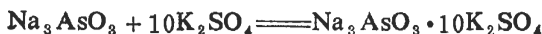
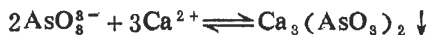


(反应在浓盐酸的存在下)

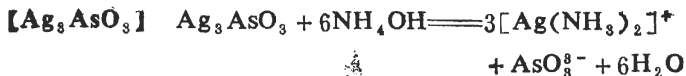




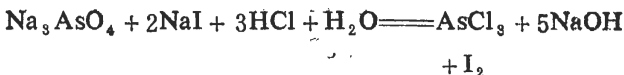
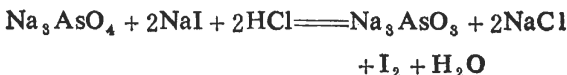
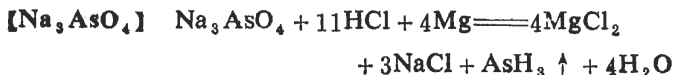
(Ag_3AsO_3 比 AgCl 更难溶解)

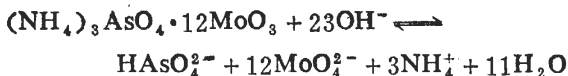
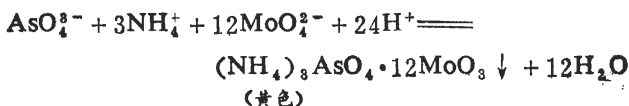
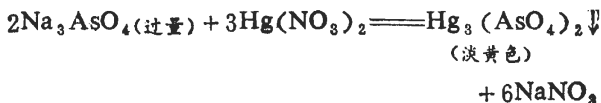
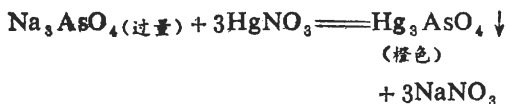
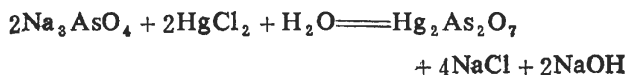
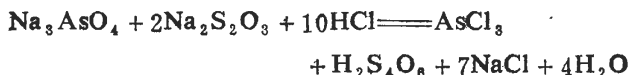


(为了使反应正常进行, 必须有大量的酸存在)

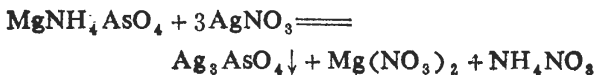
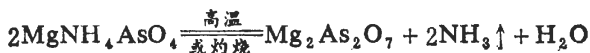
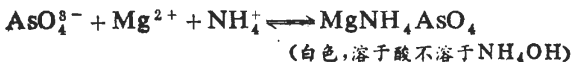
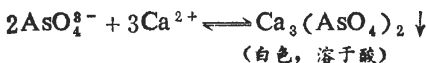


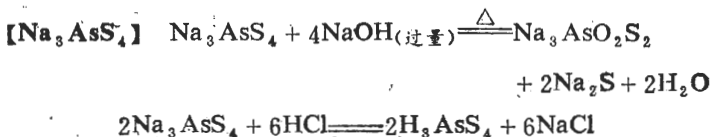
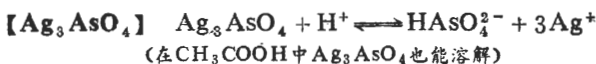
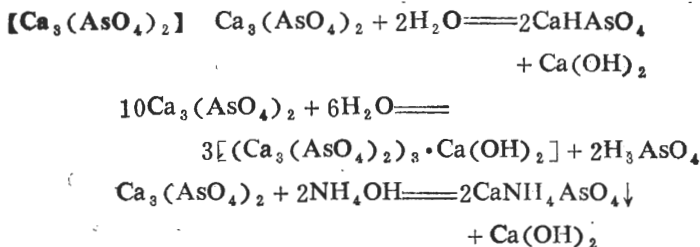
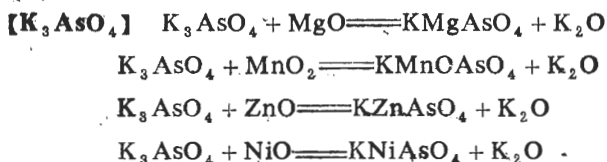
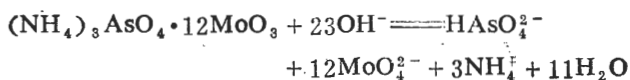
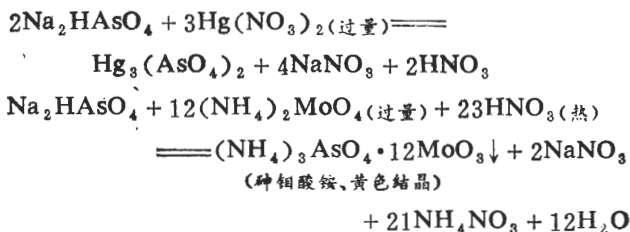
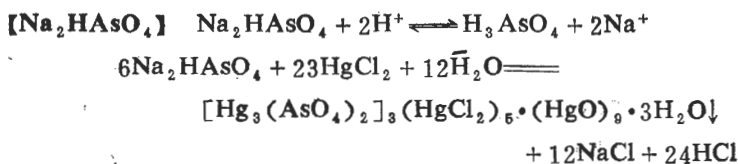
(使 Ag_3AsO_3 溶解)

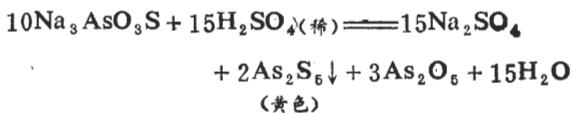
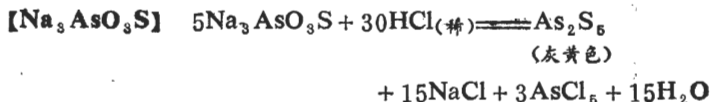
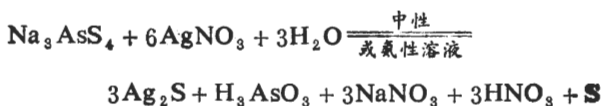
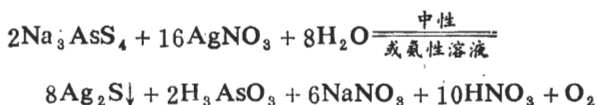
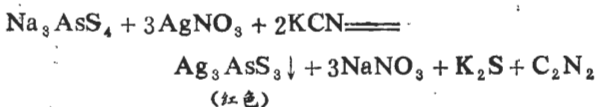
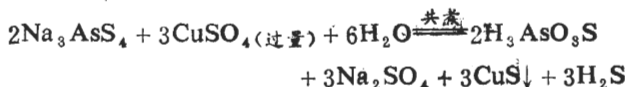
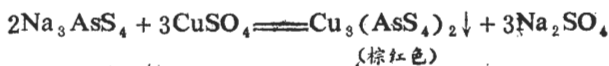
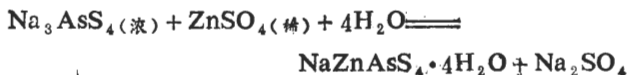
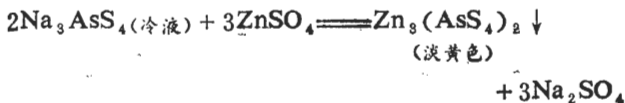
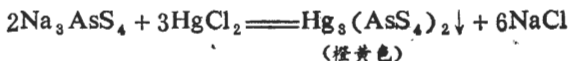
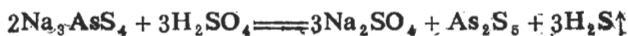


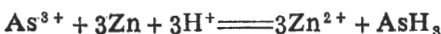
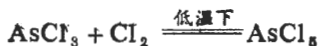
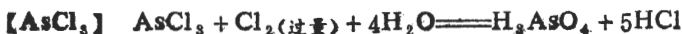


[(NH₄)₃AsO₄·12MoO₃溶于NH₄OH和碱金属
氢氧化物]

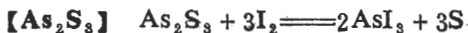
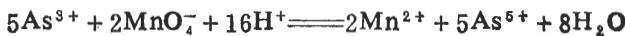
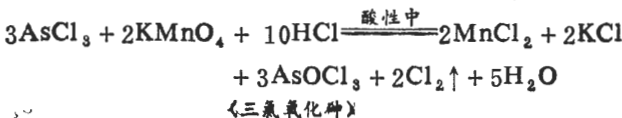
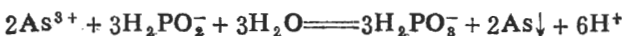
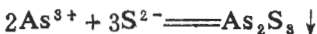
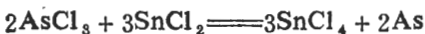
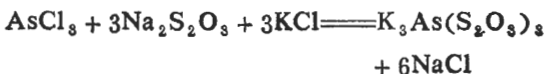
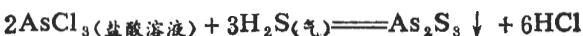
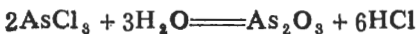






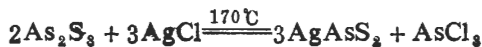
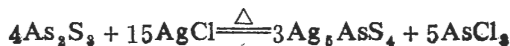
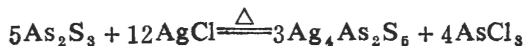
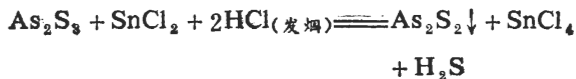
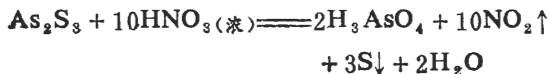
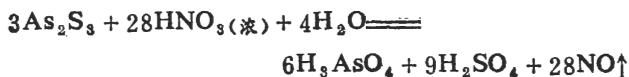
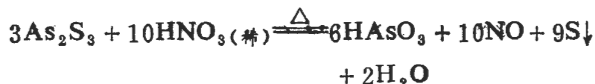
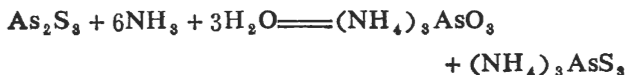
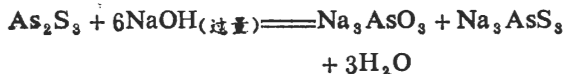
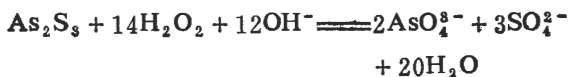


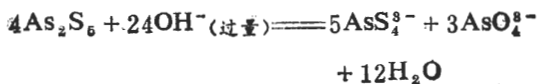
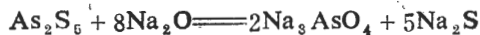
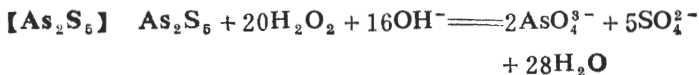
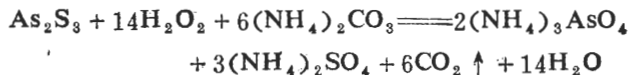
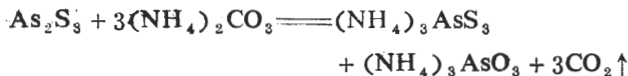
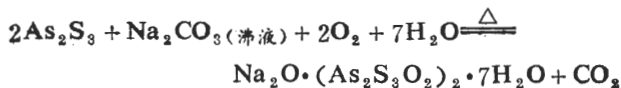
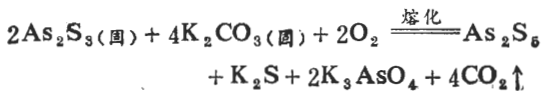
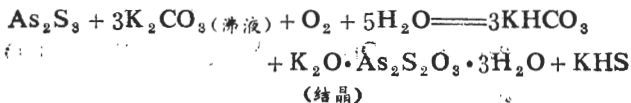
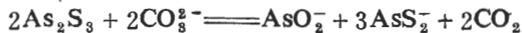
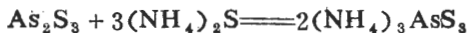
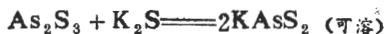
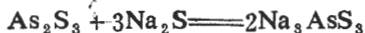
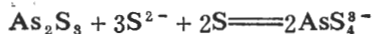
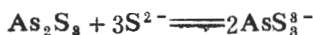
(AsBr₃有类似的反应)

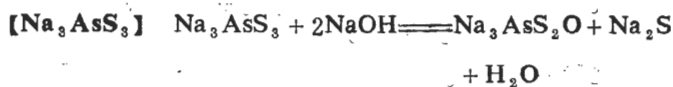
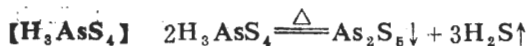
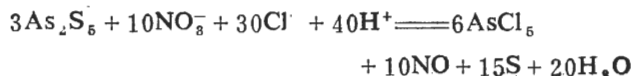
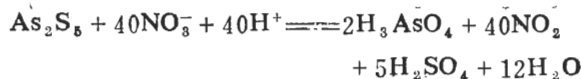
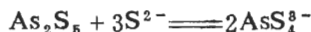
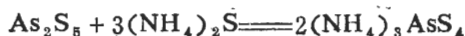
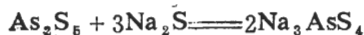
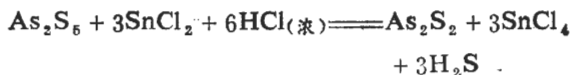
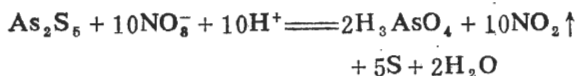
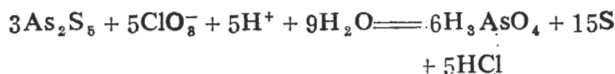
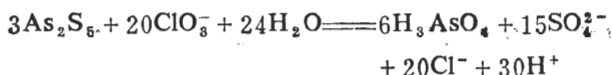


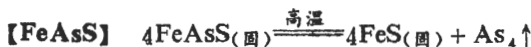
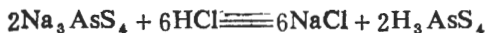
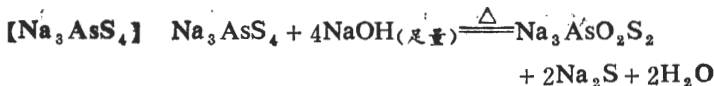


注: As_2S_3 不溶于水和盐酸, 而易溶于碱金属和铵的氢氧化物中, 也溶于浓硝酸、碳酸盐及碱性 H_2O_2 中。如下列化学反应方程式:

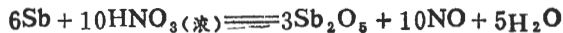
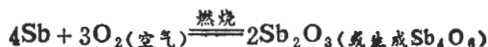




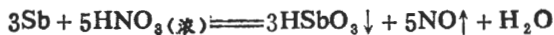




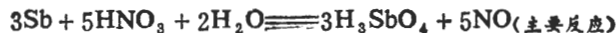
3.4 锑 $5s^2 5p^3$ $\text{Sb} = 121.75$



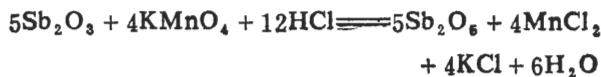
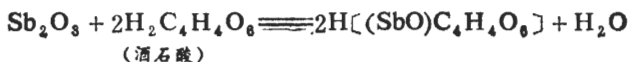
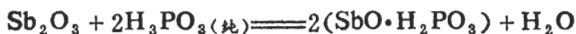
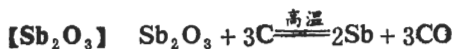
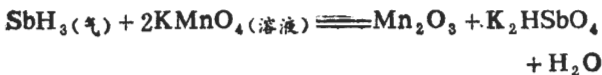
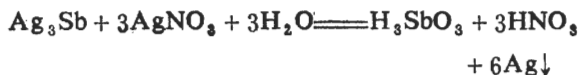
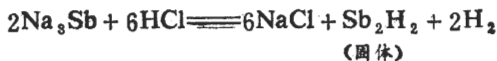
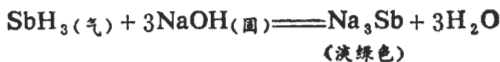
(此反应是中间反应)

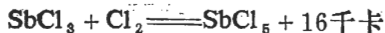
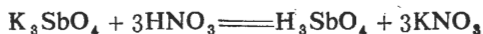
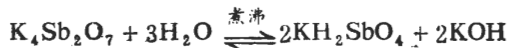
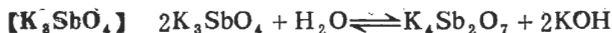
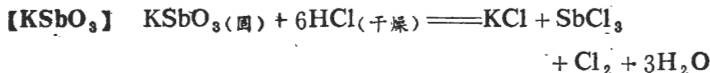
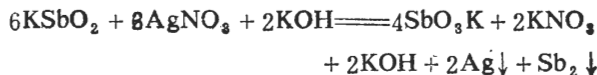
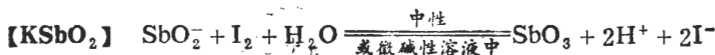
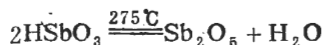
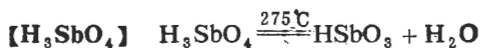
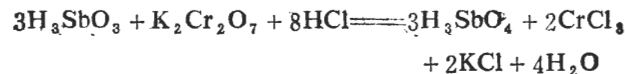
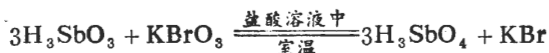
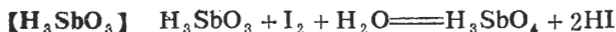
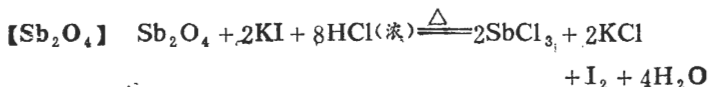
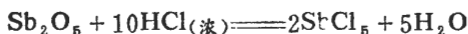


(偏锑酸)



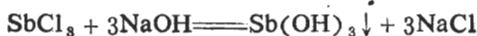
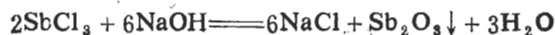
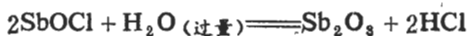
注: Sb与HCl、稀H₂SO₄不发生反应。



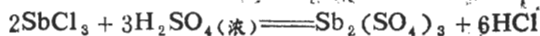
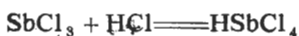




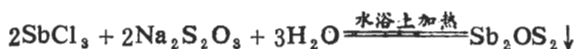
(白色)



(白色)

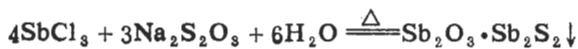


+ 3NaCl



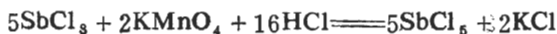
(橘红)

+ 2Na₂SO₄ + 6HCl

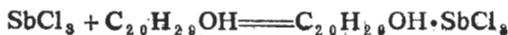


(红色)

+ 3Na₂SO₄ + 12HCl + S



+ 2MnCl₂ + 8H₂O

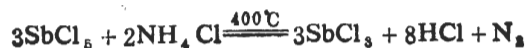
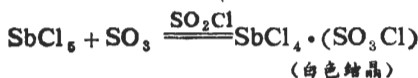
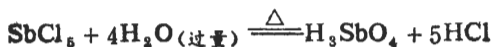
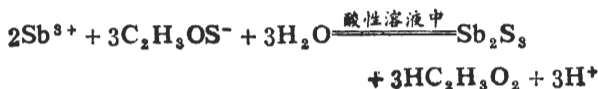
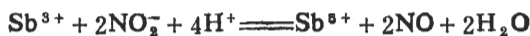
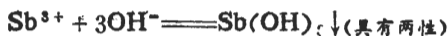
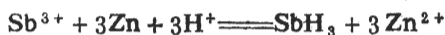


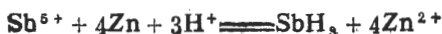
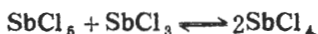
(维生素A)

(蓝色溶液)

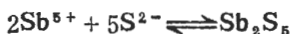
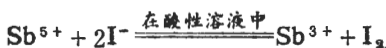


(黑色)

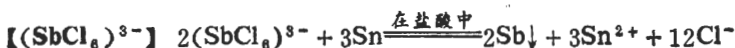
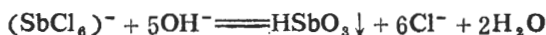




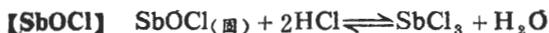
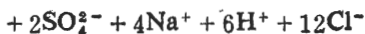
(Sn, Fe均可发生类似反应)



(如铋盐溶液中通入 H_2S)



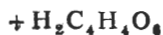
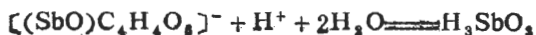
(使锡片上显黑色)



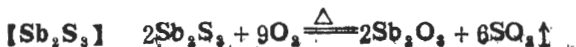
(固体溶解, 若加过量水又有沉淀出现)



(酒石酸盐)

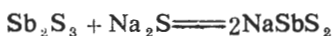
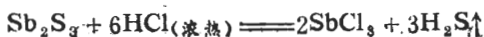
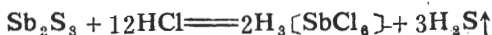
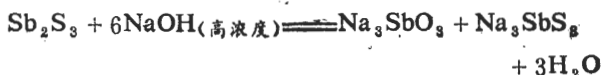


(酒石酸)

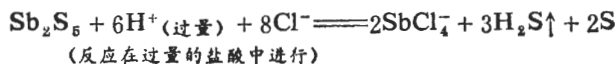
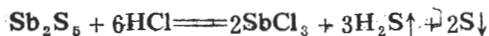
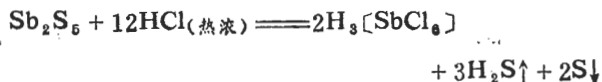
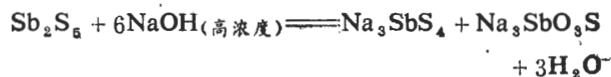
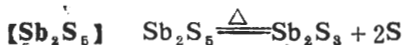
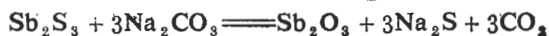
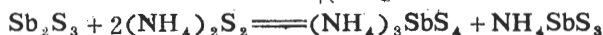


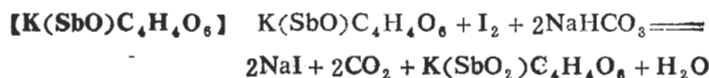
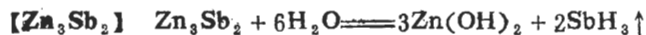
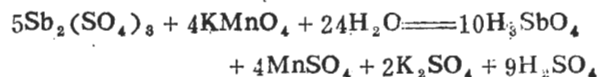
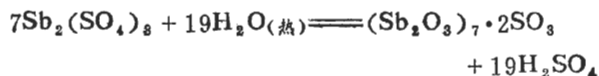
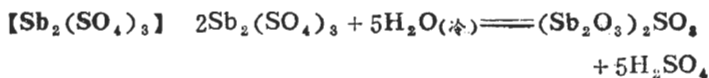
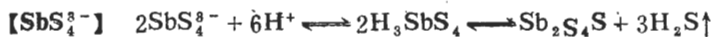
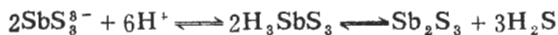
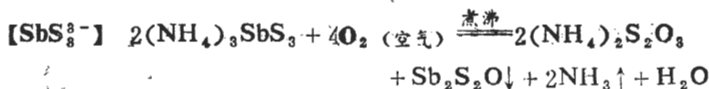
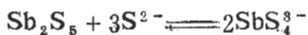
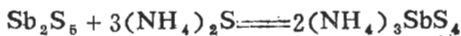
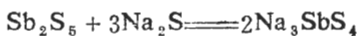


注: Sb_2S_3 难溶于 NH_4OH 或 $(\text{NH}_4)_2\text{CO}_3$ 。

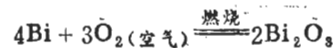
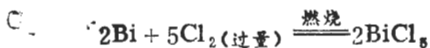
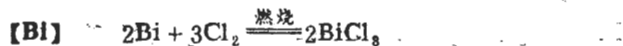


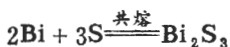
(硫代亚锑酸钠)



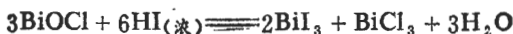
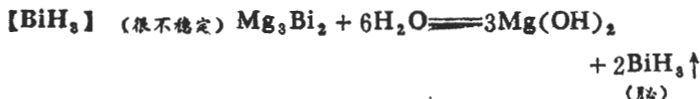


3.5 铋 $6s^2 6p^3$ Bi = 208.9806

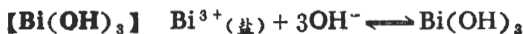
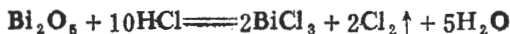
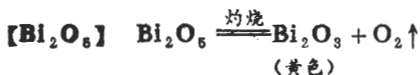
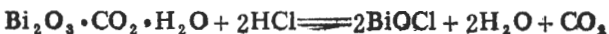




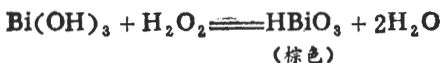
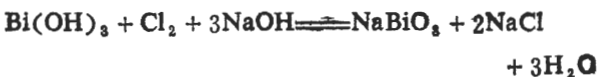
注: Bi在浓 HNO_3 中呈“钝态”。非氧化性的酸与Bi无反应, 加热时才与 H_2SO_4 反应。

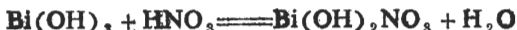


(Bi_2O_3 称为碱酐)



(黄色) (灰黄色)

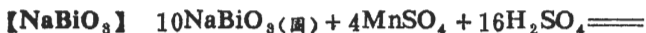




(不完全中和)



注: $\text{Bi}(\text{OH})_3$ 几乎不溶于碱

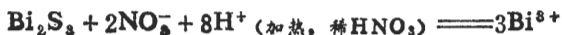
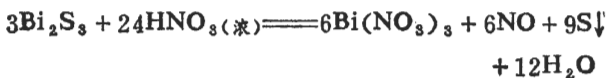
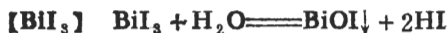
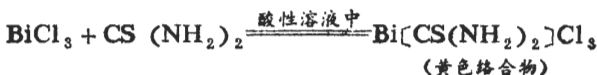
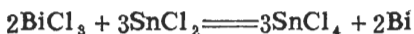


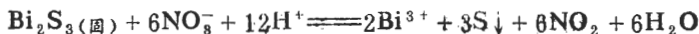
(白色)

(BiCl_3 溶于水后, 用水稀释发生的水解反应, BiBr_3 也有类似的反应)

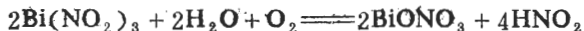
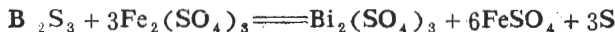
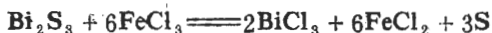


(故配制铋盐溶液应加酸, 防止水解产生的沉淀)

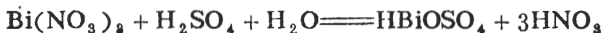
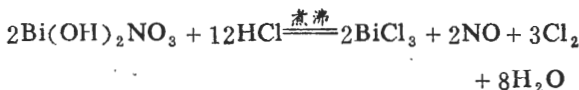




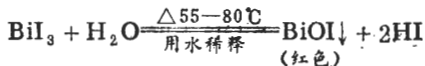
注: Bi_2S_3 不溶于冷的稀强酸, 也不溶于碱金属氢氧化物、硫化物和氢氧化铵。



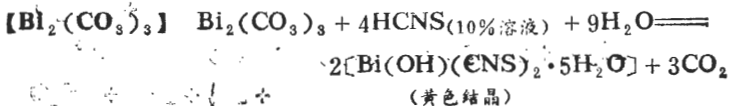
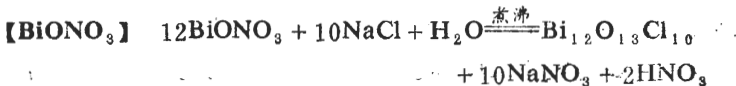
($\text{Bi}(\text{NO}_2)_3$ 暴露在空气中的反应)



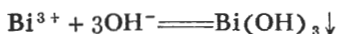
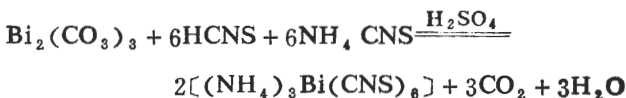
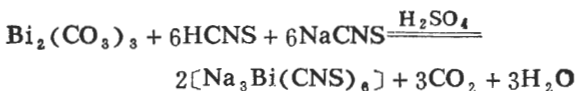
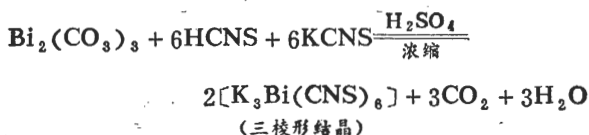
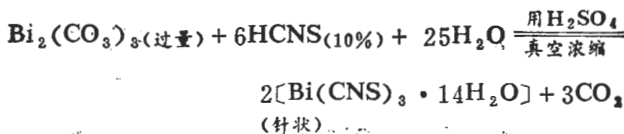
(黑色)



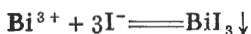
(红色)



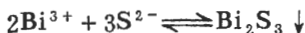
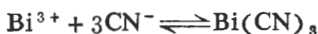
(黄色结晶)



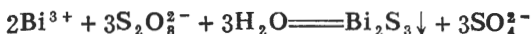
(白色胶性)



(黑色)

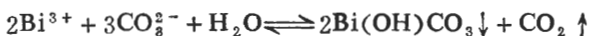


(白色结晶)

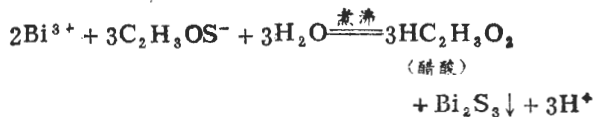
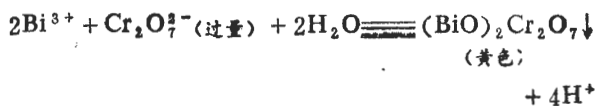
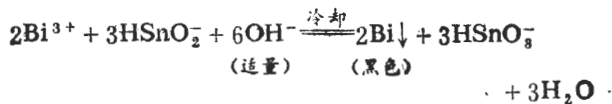


(黑色)

+ 6H⁺

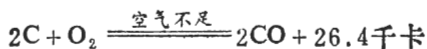
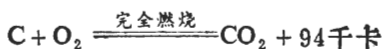
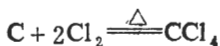
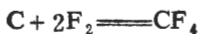


(白色)

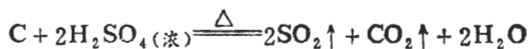
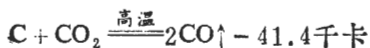
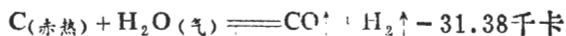
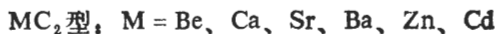


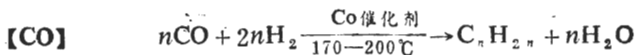
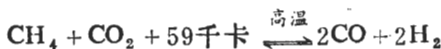
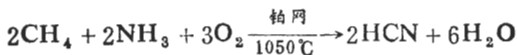
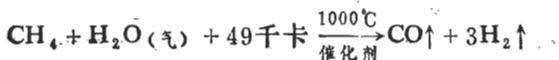
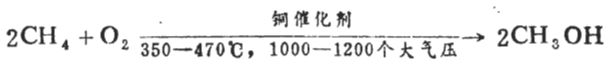
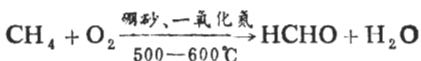
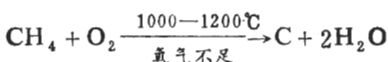
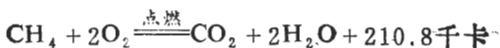
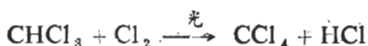
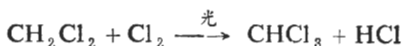
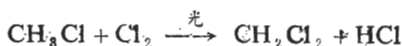
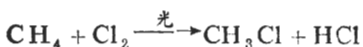
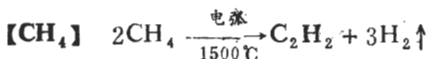
第四章 碳族元素

4.1 碳 $2s^2 2p^2$ C = 12.011

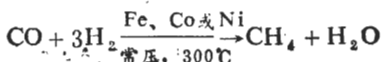
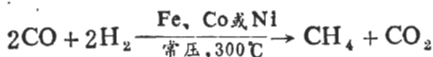


注：许多金属在高温下可与碳形成金属碳化物。常有以下类型：

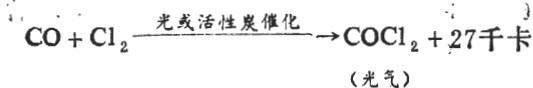
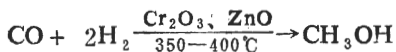




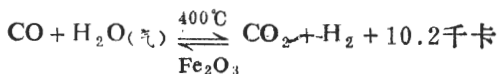
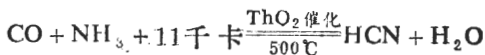
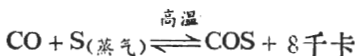
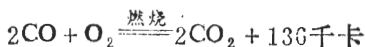
合成汽油 $n = 5$ 至 8



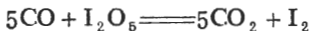
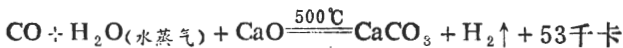
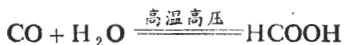
} 制取 CH_4



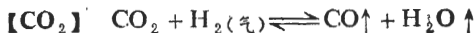
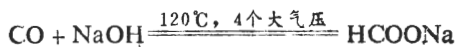
(F₂和Br₂有类似的反应)



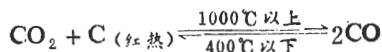
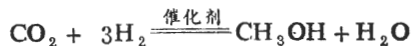
(煤气炉内发生的反应)

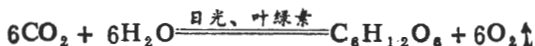
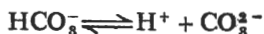


(此反应用于测定CO)

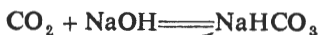


(986℃时, 反应达到平衡)

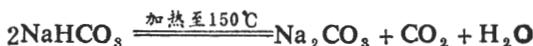
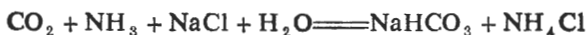




(光合作用所发生的反应)



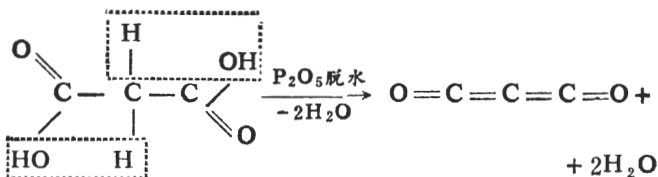
(用来检验 CO_2 的存在)



(氨碱法制碱的原理)



C_3O_2 是无色有味气体、纯者较稳定。

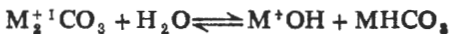


【碳酸盐】 注：具体物质详见其他各章。



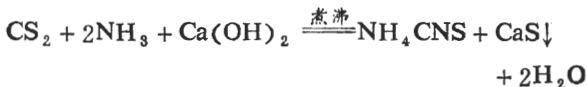
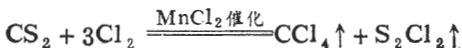
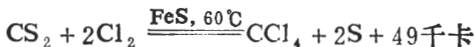
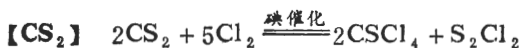
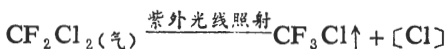
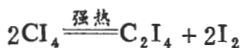
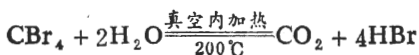
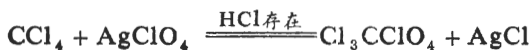
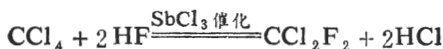
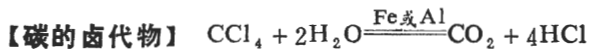
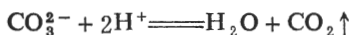
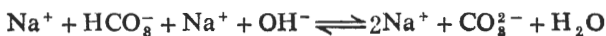
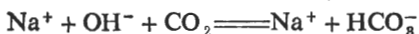
(碱金属碳酸盐例外，如 Na_2CO_3 等，高温下也不会分解)

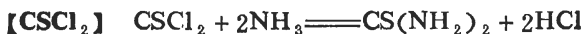
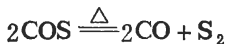
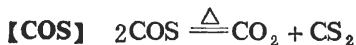
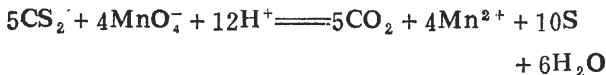
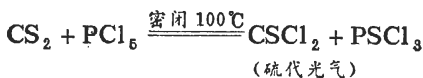
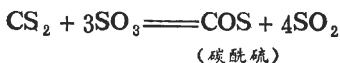
注：在碳酸盐中，除碱金属的正盐外，皆难溶于水。酸式碳酸盐中，常见的碱金属和碱土金属及少数其它二价金属的酸式盐(除 NaHCO_3 外)皆溶解于水。碳酸盐水解后溶液呈碱性：





(M代表碱金属)

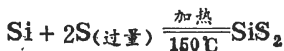
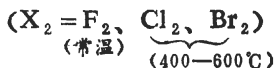
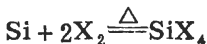


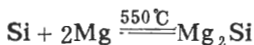
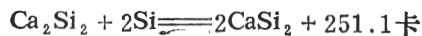
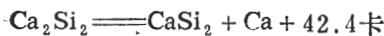
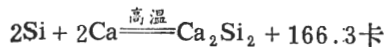
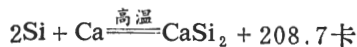
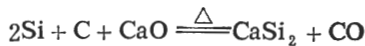
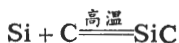
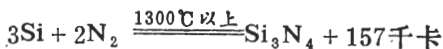


4.2 硅 $3s^2 3p^2$ Si = 28.086



(加热到Si的熔点以上才发生此反应)

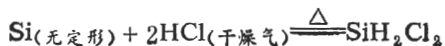
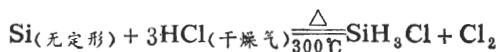
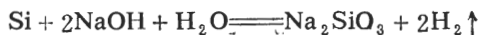
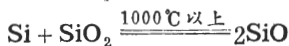


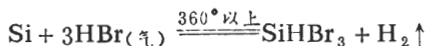
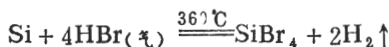
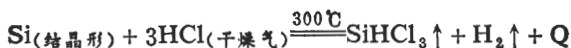


(反应的产物还有SiMn、Si₂Mn)

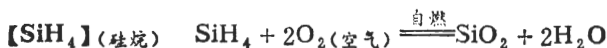
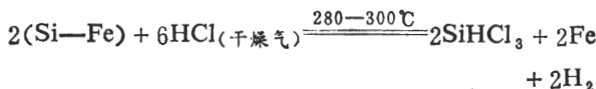
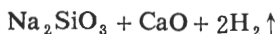
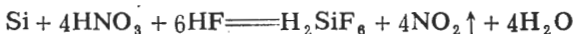


(炼铁炉内所发生的反应)

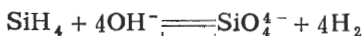
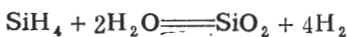




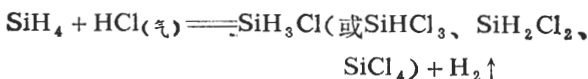
注：Si 几乎不溶于包括氢氟酸在内的所有酸，但能溶于 HNO_3 — HF 的混合酸中：



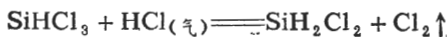
+ 341 千卡



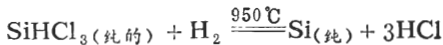
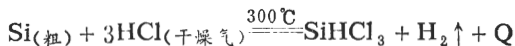
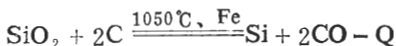
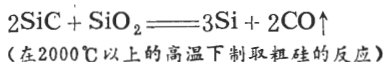
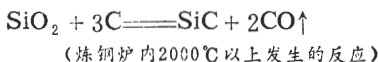
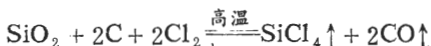
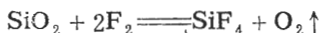
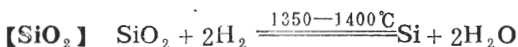
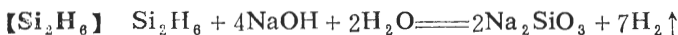
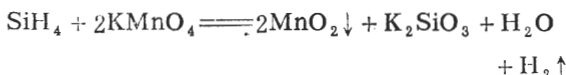
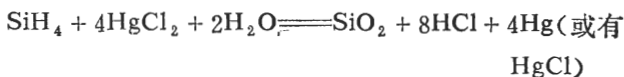
(SiH_4 对碱很敏感)



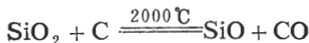
(在无水 Al_2Cl_6 催化下发生此反应)



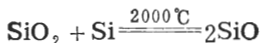
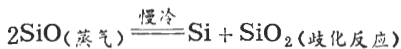
(在无水 Al_2Cl_6 催化下发生此反应)



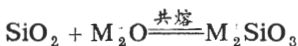
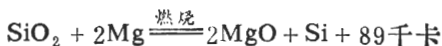
(工业上制纯硅的方法)



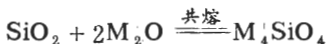
(所得产物需迅速冷却, 否则发生歧化反应)



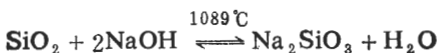
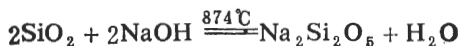
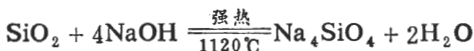
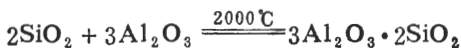
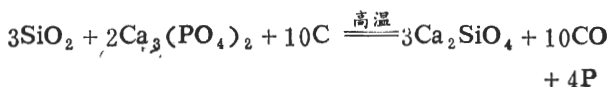
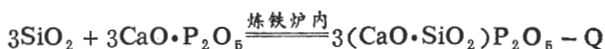
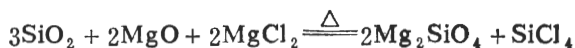
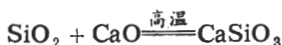
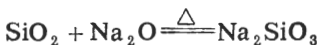
(SiO黄棕色固体, 工业上叫单氧硅)



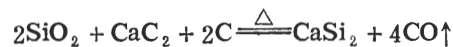
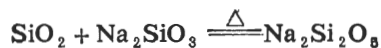
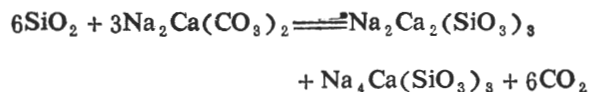
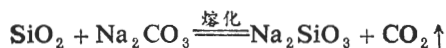
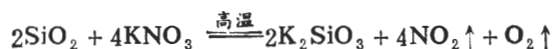
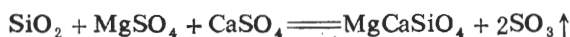
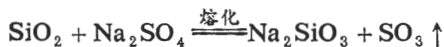
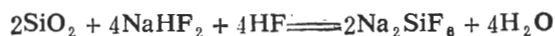
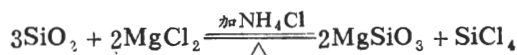
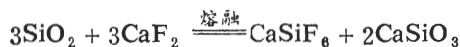
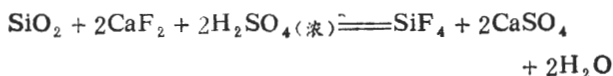
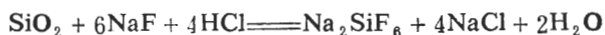
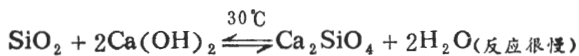
(M_2SiO_3 偏硅酸盐, M 表示碱金属)

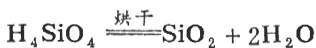
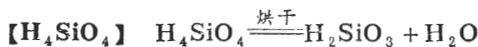
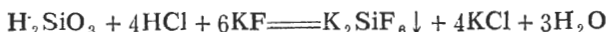


(M_4SiO_4 硅酸盐, M 表示碱金属)

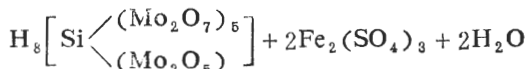
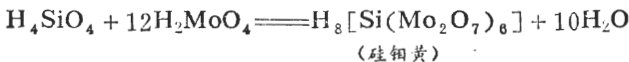


(腐蚀玻璃的反应, 常温反应慢)

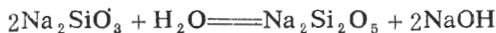




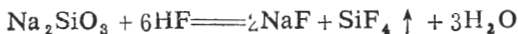
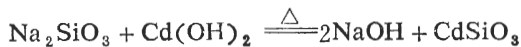
(H_4SiO_4 烘干还可以生成 $\text{H}_2\text{Si}_2\text{O}_5$ 、 $\text{H}_4\text{Si}_3\text{O}_8$ 、 $\text{H}_2\text{Si}_5\text{O}_{11}$ 、 $\text{H}_2\text{Si}_9\text{O}_{19}$)

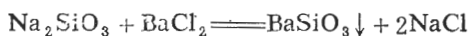
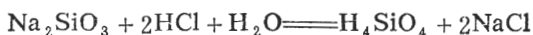


(硅钨蓝)

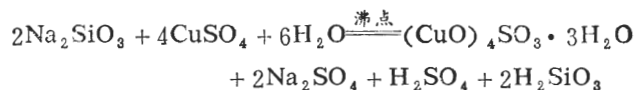
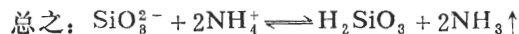
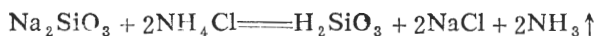
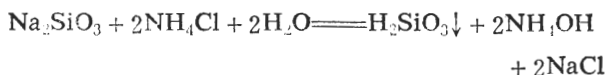


(二偏硅酸钠)

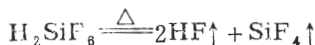
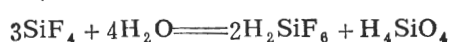
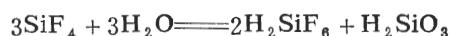
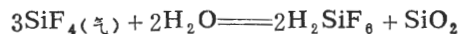
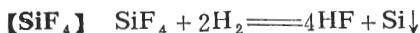
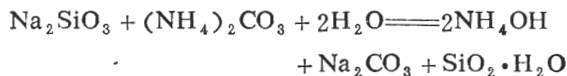
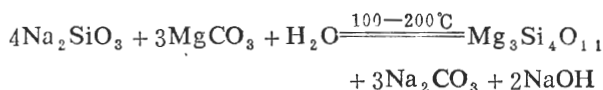


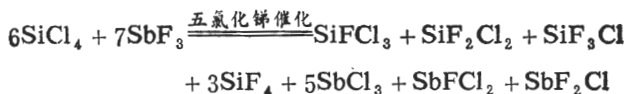
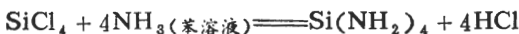
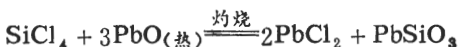
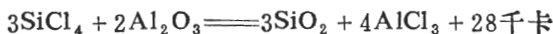
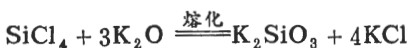
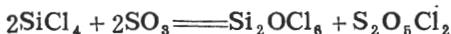
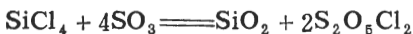
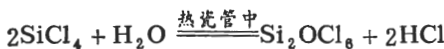
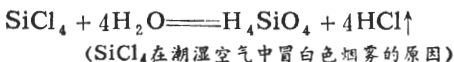
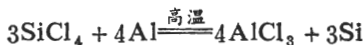
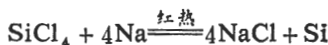
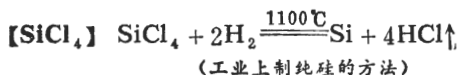
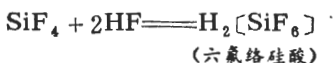


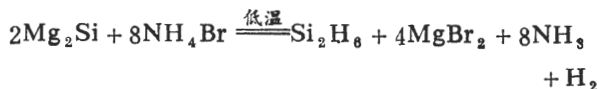
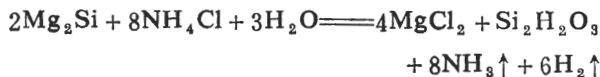
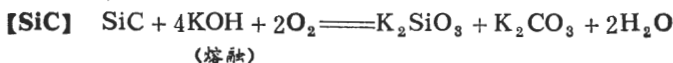
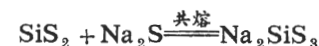
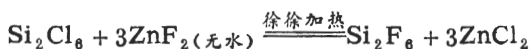
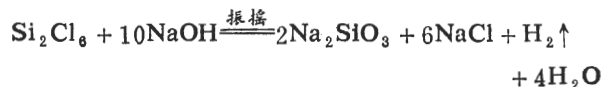
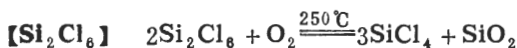
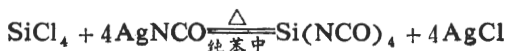
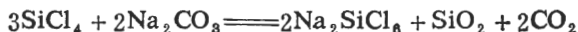
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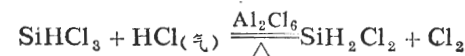
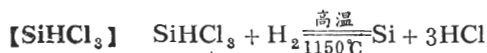
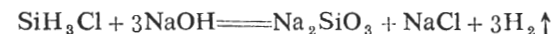
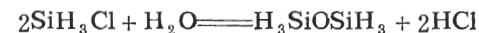
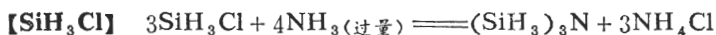
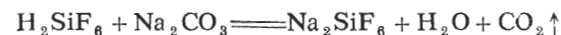
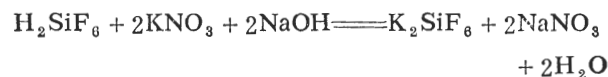
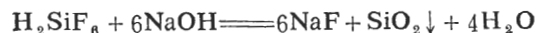
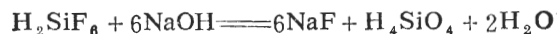
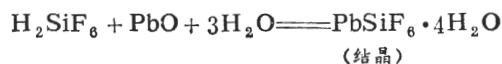
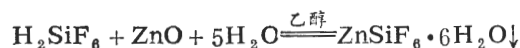
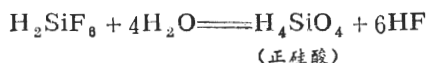


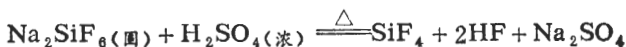
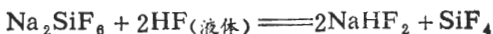
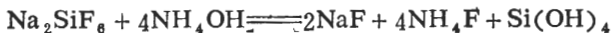
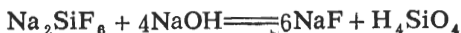
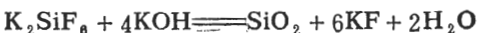
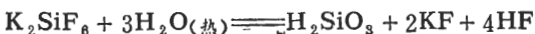
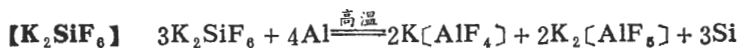
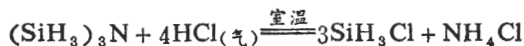
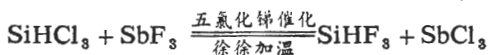
(黄色)



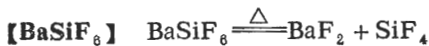
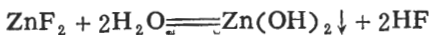








(白色)



附：硅酸盐工业

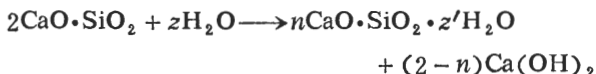
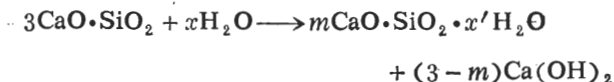




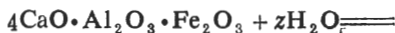
水泥熟料的组成:



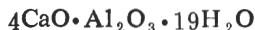
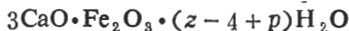
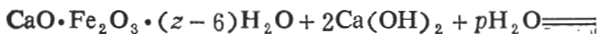
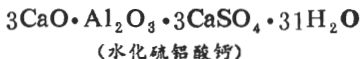
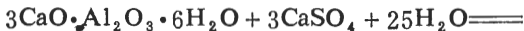
水泥的凝结与硬化: C_3S 、 C_2S 、水化生成胶态·水化硅酸钙:



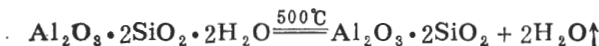
C_3A 、 C_4AF 水化后生成水化硅酸钙、水化铁酸钙晶体:

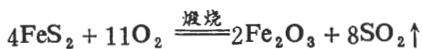
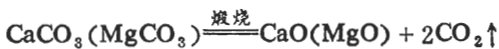


由于水泥中有 $\text{Ca}(\text{OH})_2$ 和 CaSO_4 故还可以有下列反应:

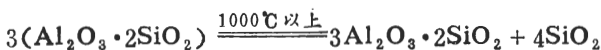


【陶瓷砖瓦】坯体升温排气:



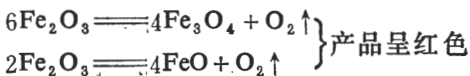


高温烧结:

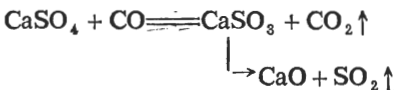
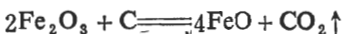
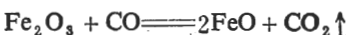


烧结时控制窑内气氛:

氧化性气氛:

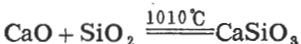
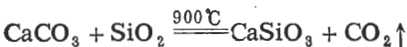
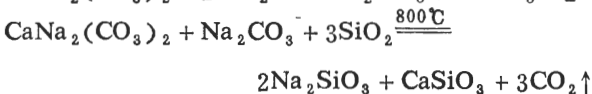
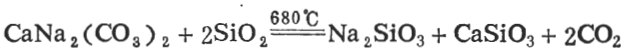
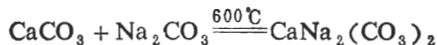


还原性气氛:

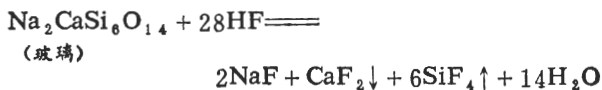
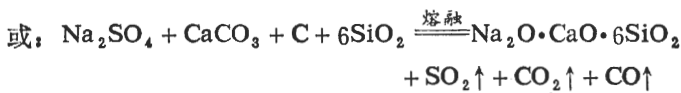
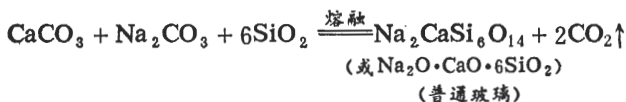


封闭喷水使产品变青色

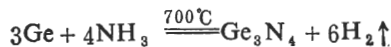
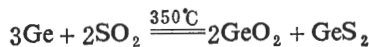
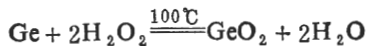
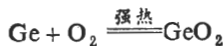
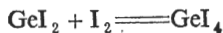
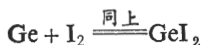
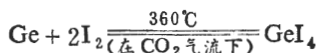
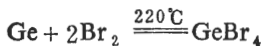
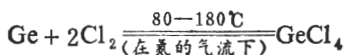
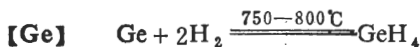
【玻璃】 生产中的主要反应:

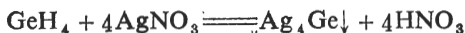
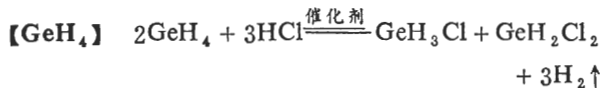
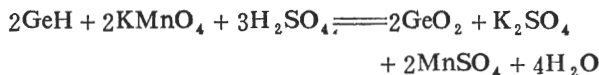
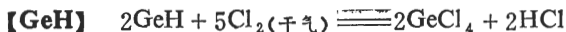
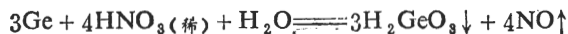
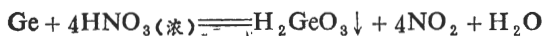
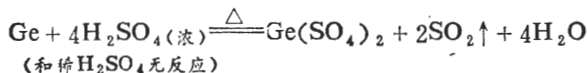
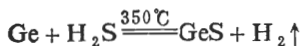
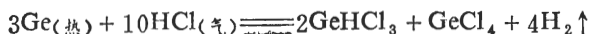
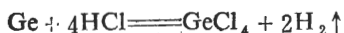


总反应:

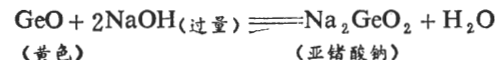


4.3 锗 $4s^2 4p^2$ Ge = 72.59

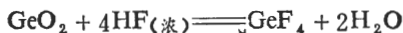


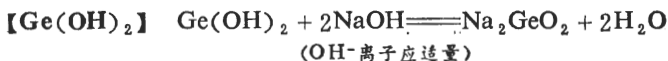
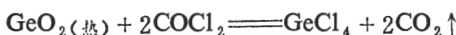
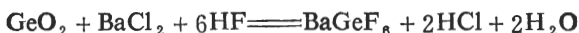
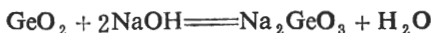
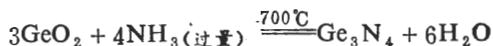
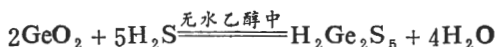
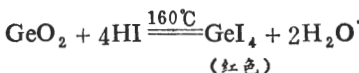
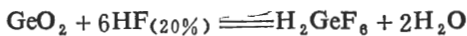


【GeO】 注: GeO为两性, 但碱性较强。

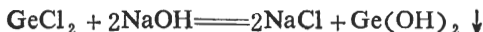
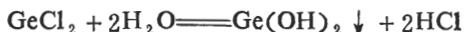
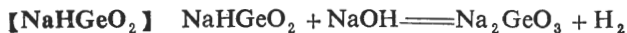
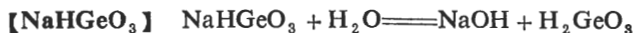
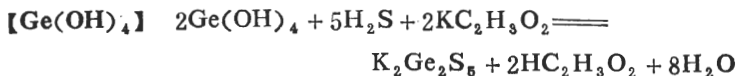


【GeO₂】 注: GeO₂为两性, 但以酸性为主。





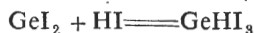
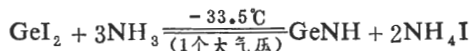
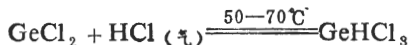
注：Ge(OH)₂显两性。





(黄色)

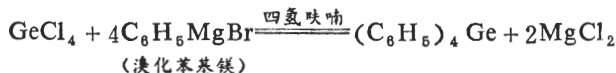
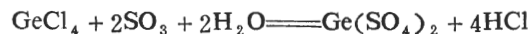
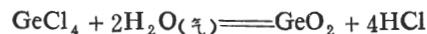
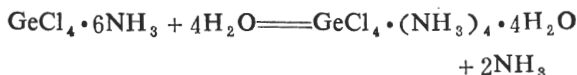
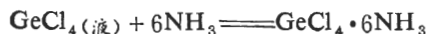
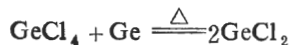
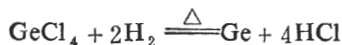
(用 NH_4OH 亦有类似的反应)



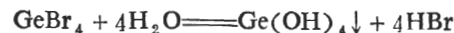
【GeX₄】(X表示卤素)

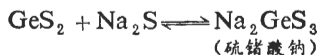
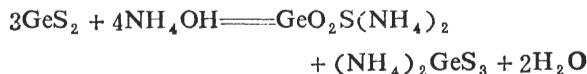
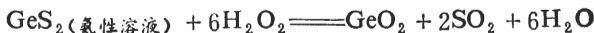
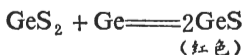
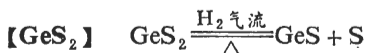
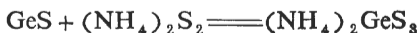
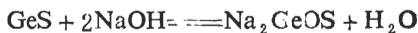
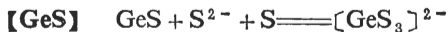


(蒸气)

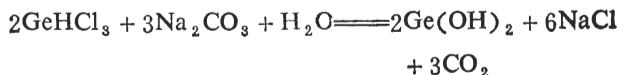
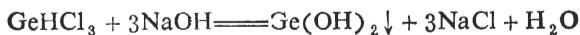
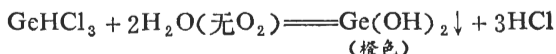
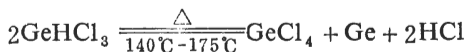
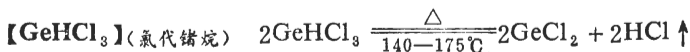


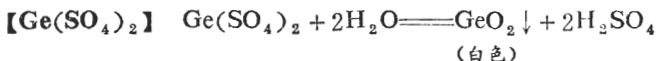
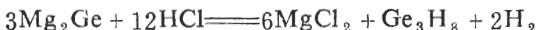
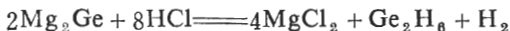
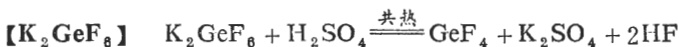
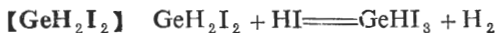
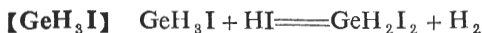
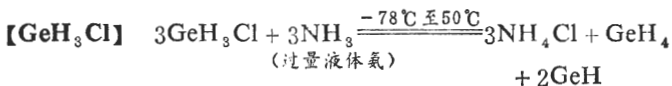
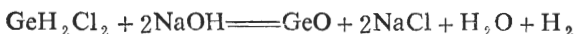
(溴化苯基镁)





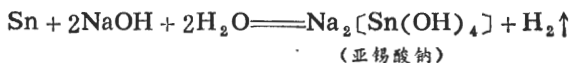
(加浓酸反应向左移, 因放出 H_2S)



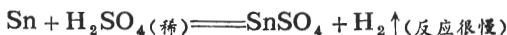
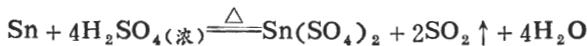
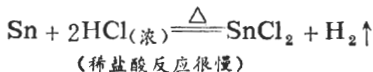


4.4 锡 $5s^25p^2$ Sn = 118.69

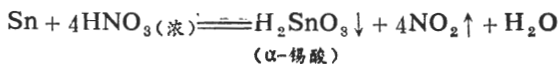




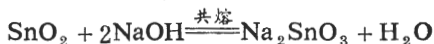
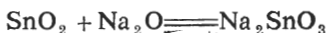
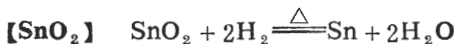
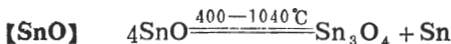
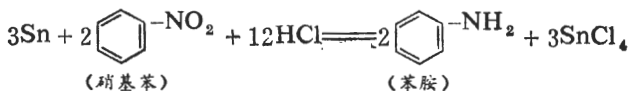
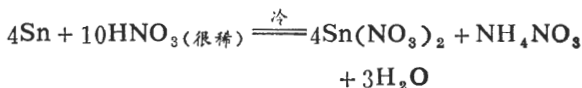
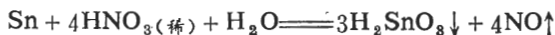
(KOH也有类似的反应)

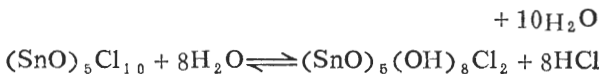
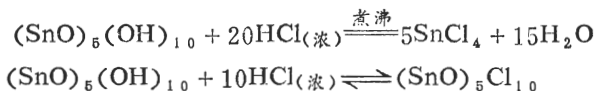
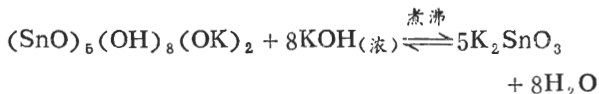
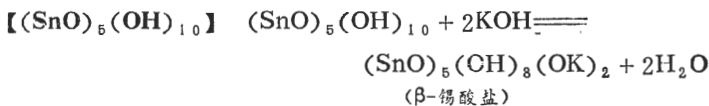
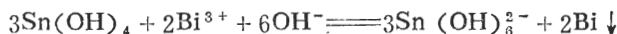
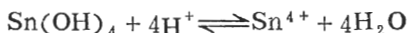


注: 浓 HNO_3 (比重1.2至1.3)并不溶解Sn, 但能将它氧化成白色粉末状。

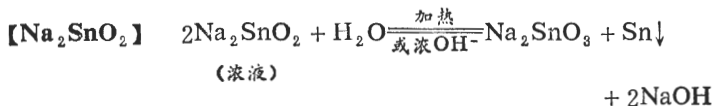
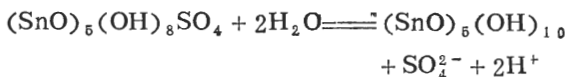
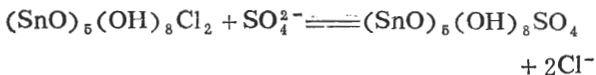
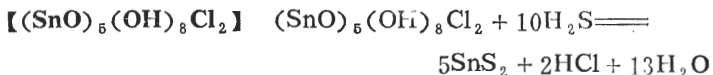
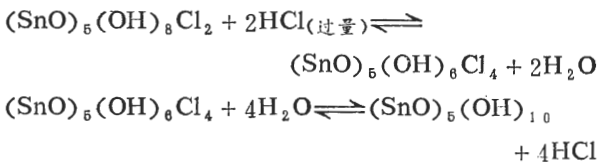


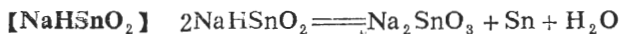
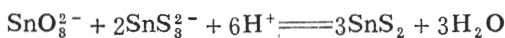
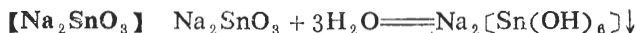
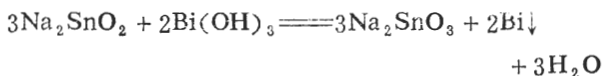
(这是主要反应)



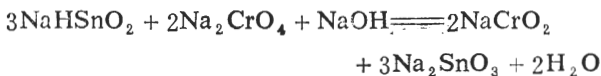
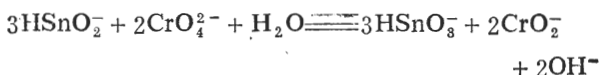
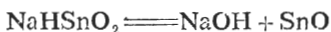


若加过量盐酸:

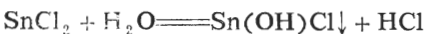
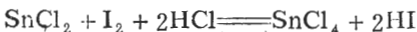
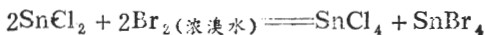
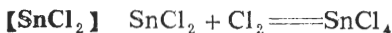
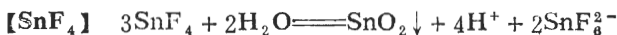
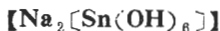




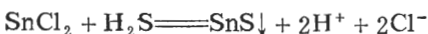
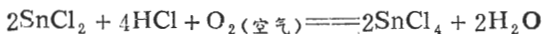
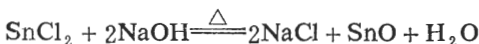
(在过量强碱溶液中的反应)

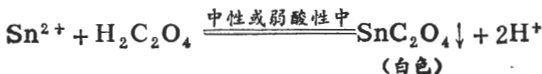
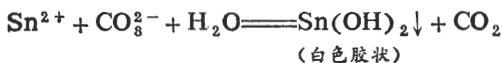
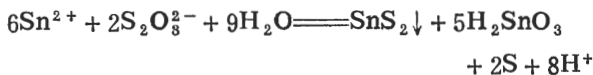
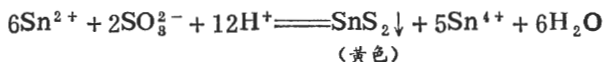
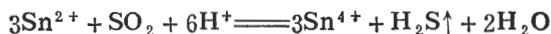
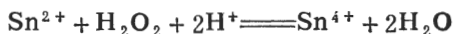
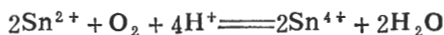
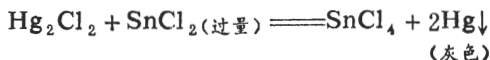
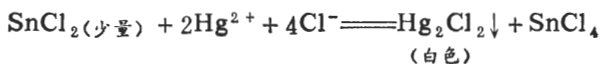
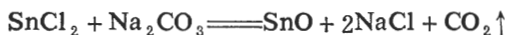
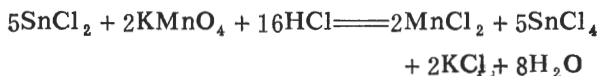
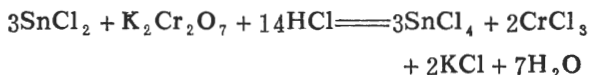
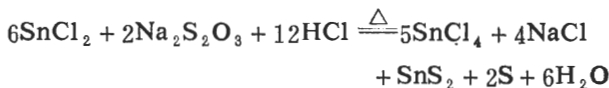


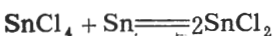
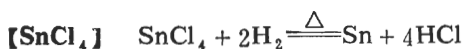
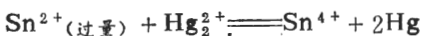
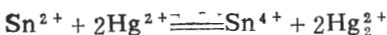
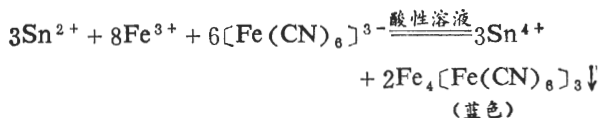
注, NaHSnO₂在碱液中易分解。



(Sn(OH)Cl白色乳浊液, 易溶于盐酸)



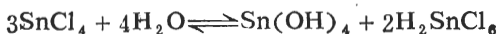




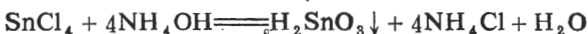
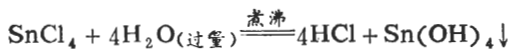
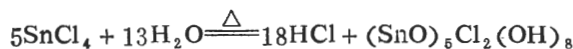
(主要水解反应的形式)



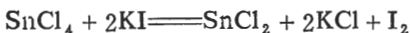
(一般水解反应的形式)



(不完全水解反应的形式)



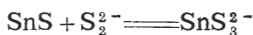
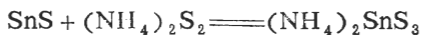
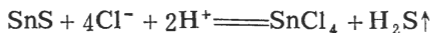
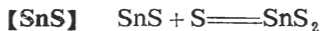
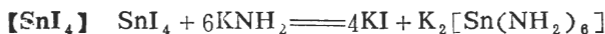
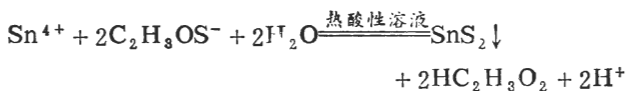
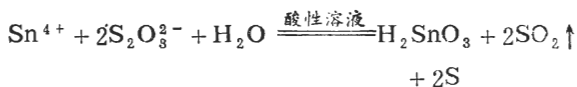
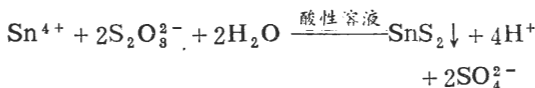
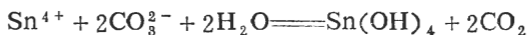
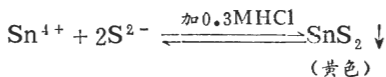
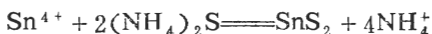
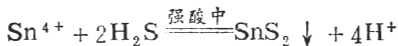
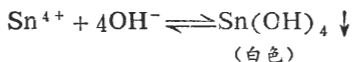
(六氟锡酸)



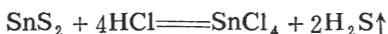
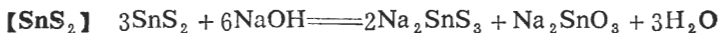
(在沸的锡酸溶液中进行)

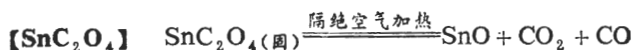
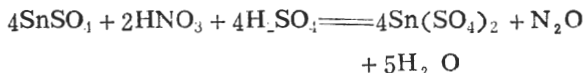
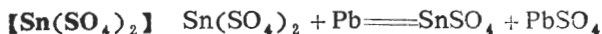
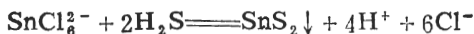
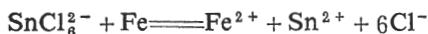
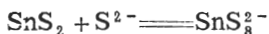
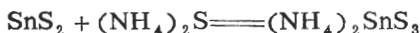
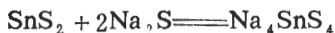
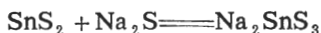


(在沸的锡酸溶液中进行)

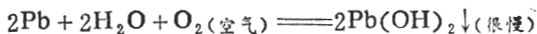
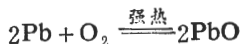


(硫代锡酸根)

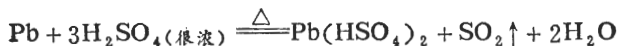
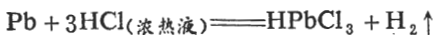




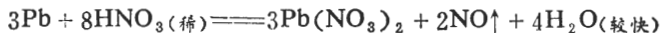
4.5 铅 $6s^2 6p^2$ $\text{Pb} = 207.2$



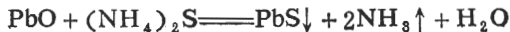
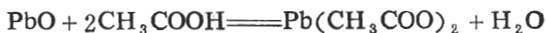
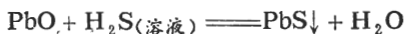
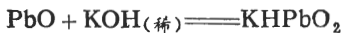
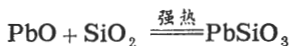
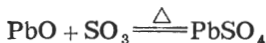
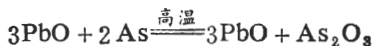
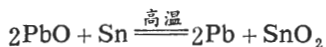
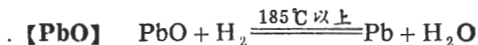
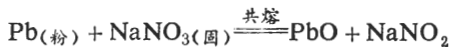
注：Pb与HCl作用生成一层极薄难溶的 PbCl_2 盖于金属表面，阻止反应的进行，但热的浓HCl能反应。

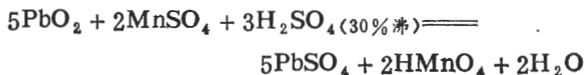
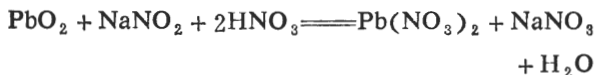
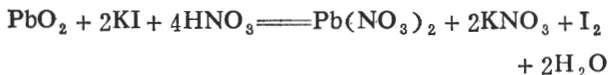
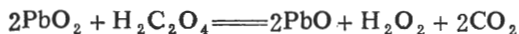
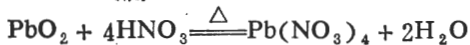
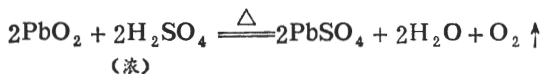
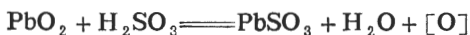
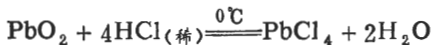
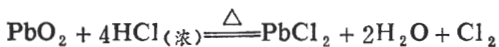
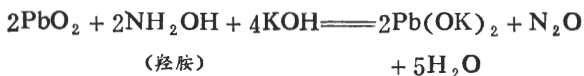
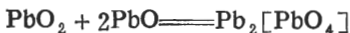
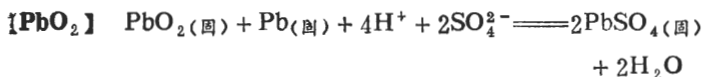


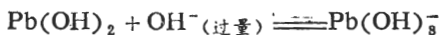
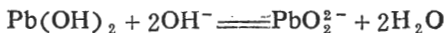
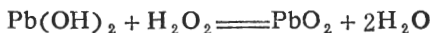
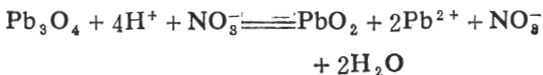
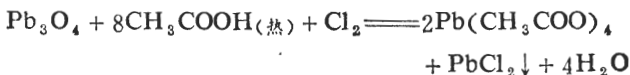
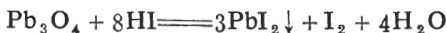
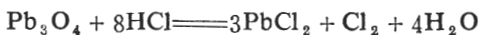
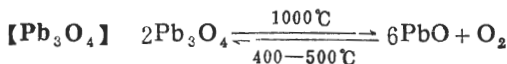
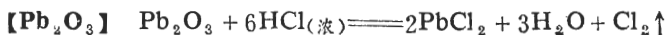
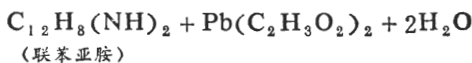
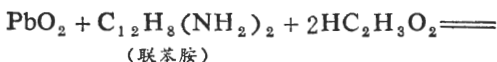
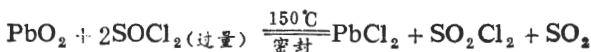
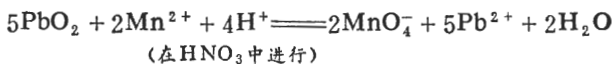
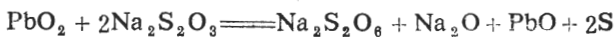
(85%以下的 H_2SO_4 不能与Pb作用, 因为生成的 PbSO_4 不溶于水, 阻止反应的进行)

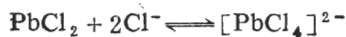
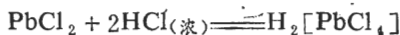
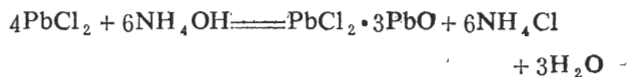
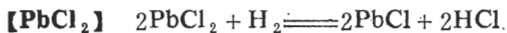
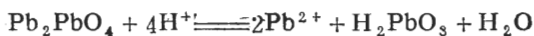
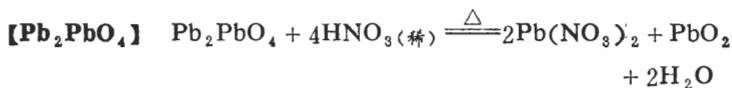
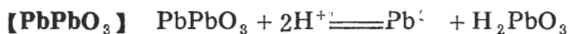
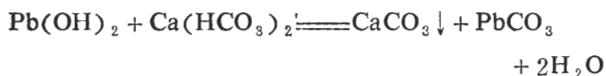
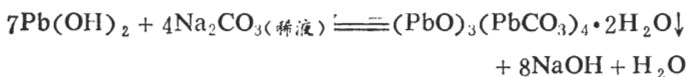
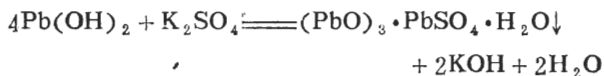
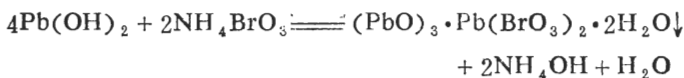
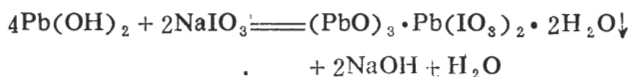
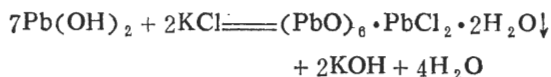
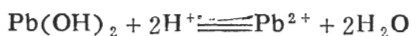
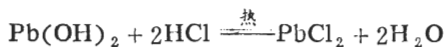


(因为生成的 $\text{Pb}(\text{NO}_3)_2$ 不溶于浓 HNO_3 中)

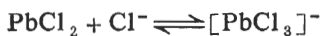




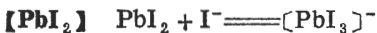
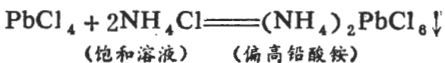
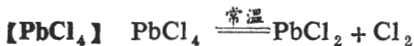
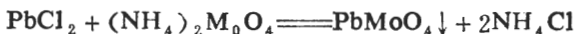
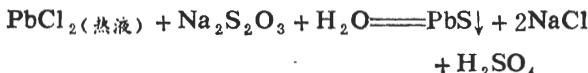
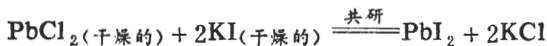
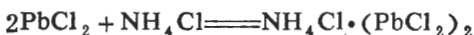
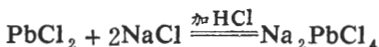
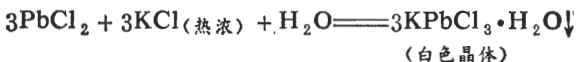
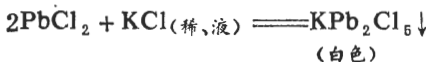
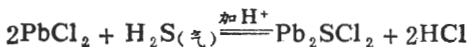


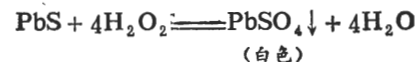
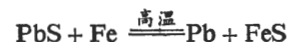
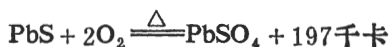
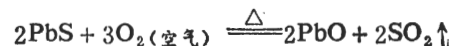
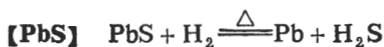
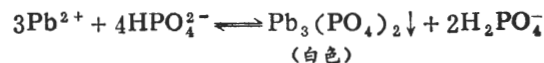
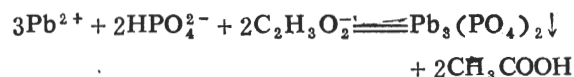
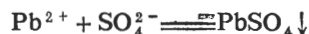
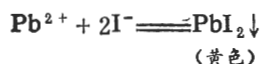
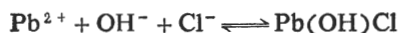
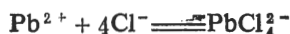
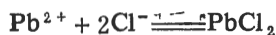
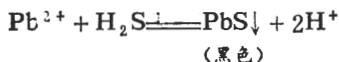
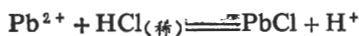


(在浓HCl中的反应)

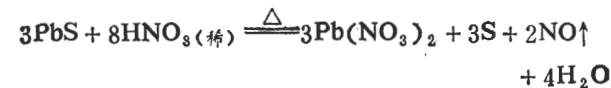


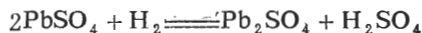
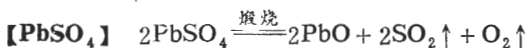
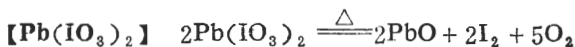
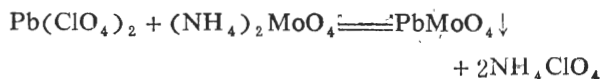
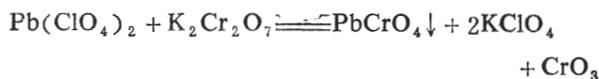
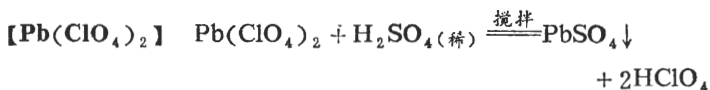
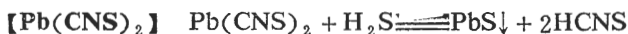
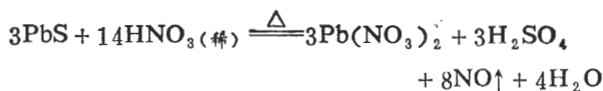
(在浓HCl中的反应)



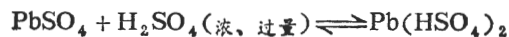
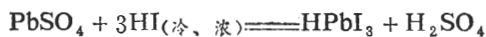
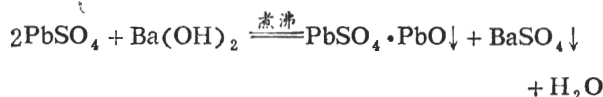
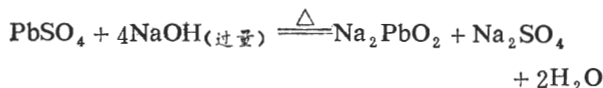
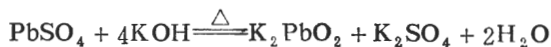
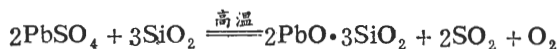
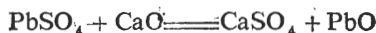


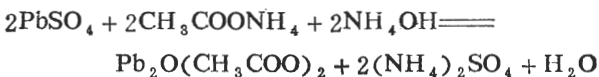
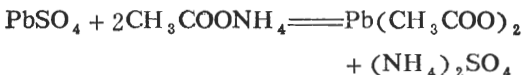
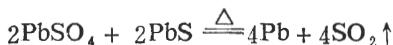
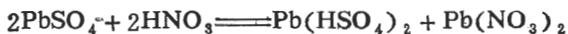
(5%CH₃COOH和15%CH₃COONH₄环境中)





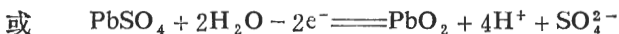
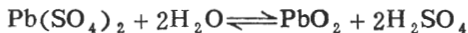
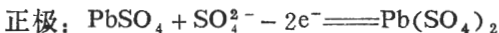
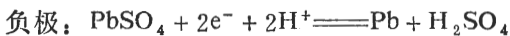
(氢电极发生的反应)



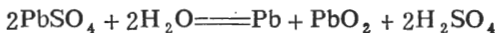


铅蓄电池的工作原理:

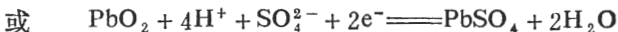
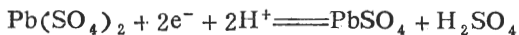
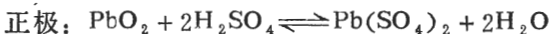
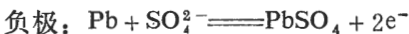
充电:



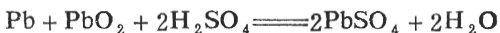
充电总反应:



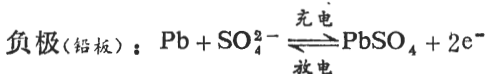
放电:



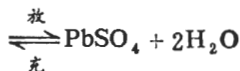
放电总反应:



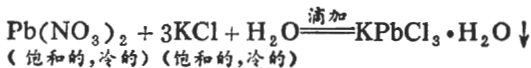
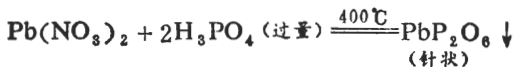
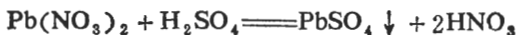
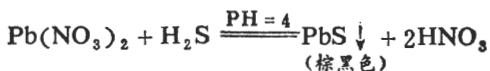
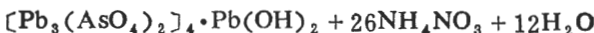
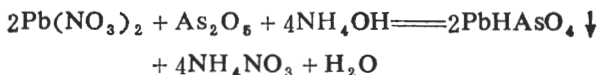
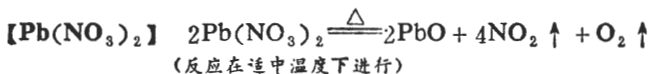
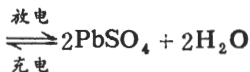
铅蓄电池总反应:

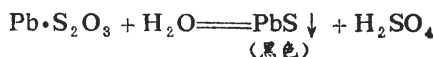
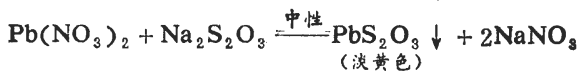
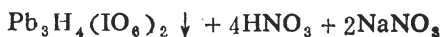
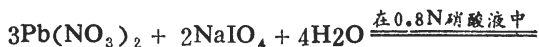
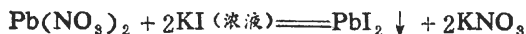
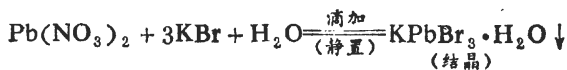


正极(PbO₂板), $\text{PbO}_2 + 4\text{H}^+ + \text{SO}_4^{2-} + 2\text{e}^-$

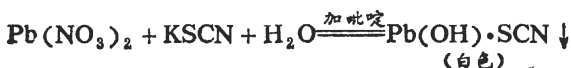
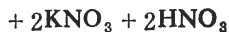
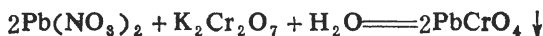
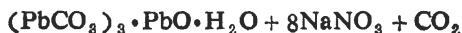
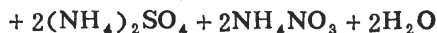
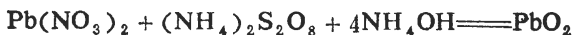


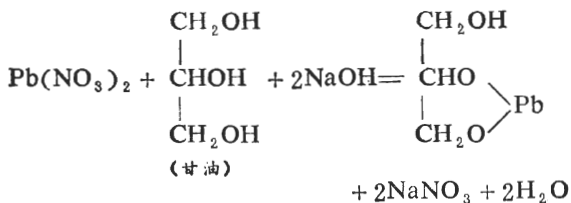
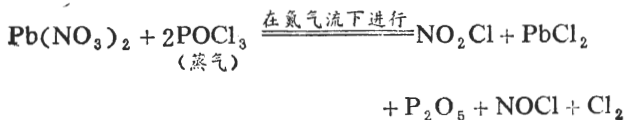
电池内净反应: $\text{Pb} + \text{PbO}_2 + 4\text{H}^+ + 2\text{SO}_4^{2-}$



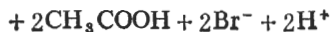
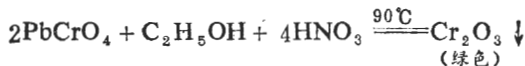
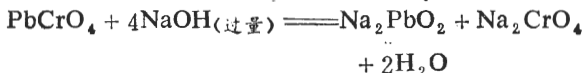
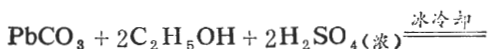
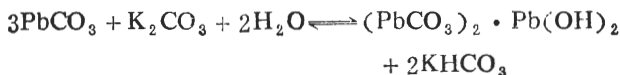
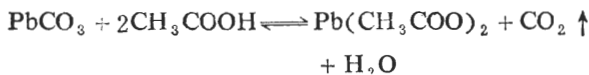


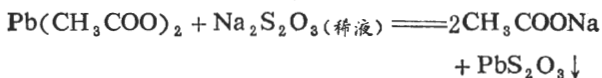
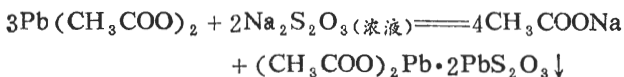
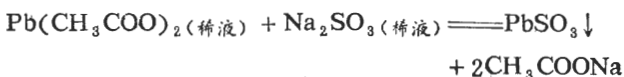
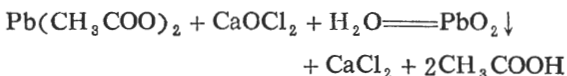
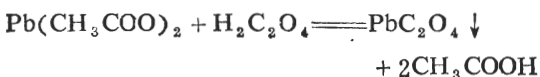
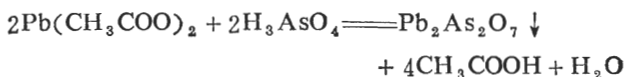
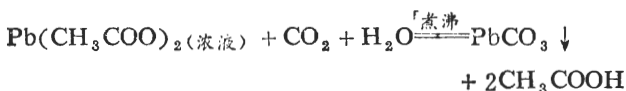
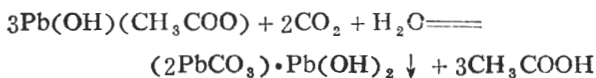
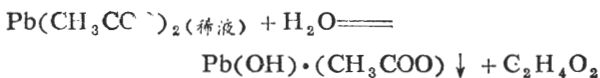
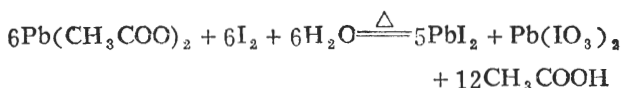
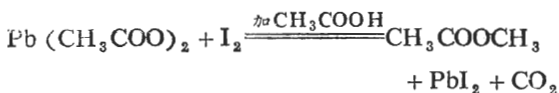
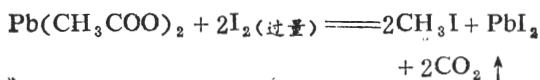
(不完全水解的反应)

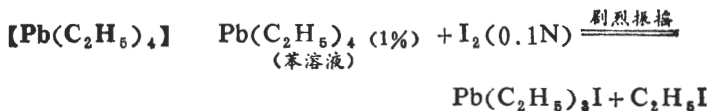
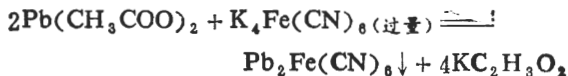
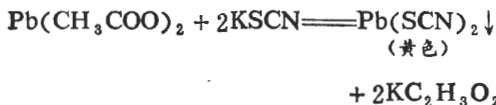
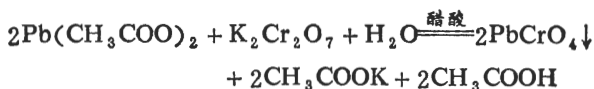
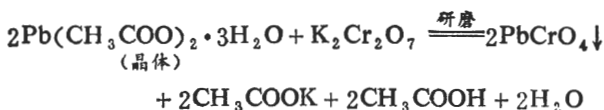
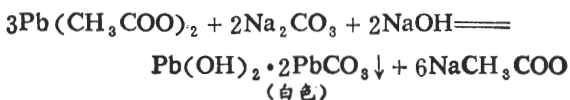
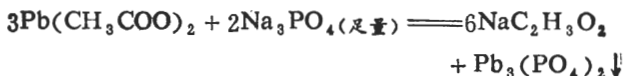
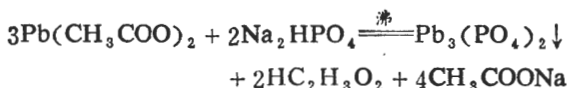
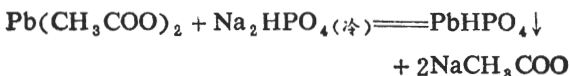
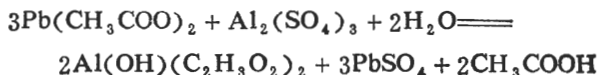
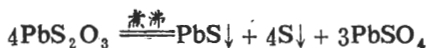
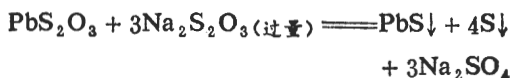


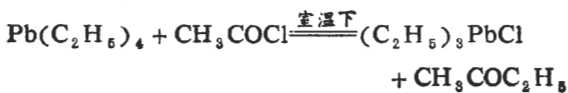
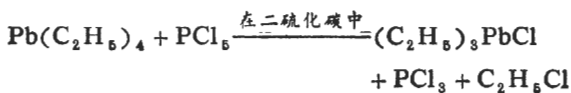
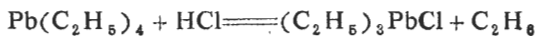


(此反应可以用来检验 pb^{2+})

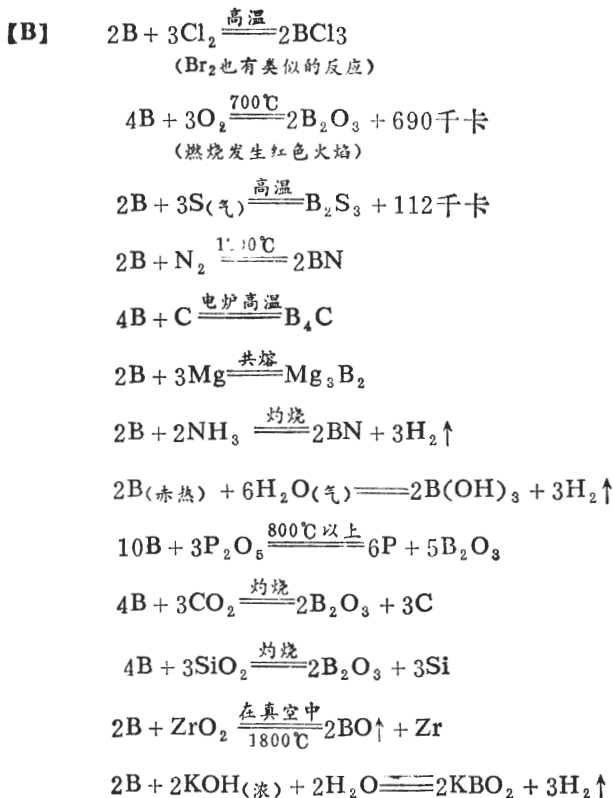


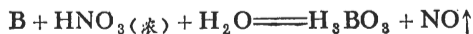




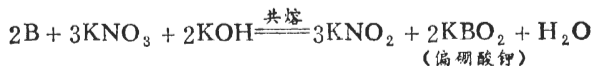


第五章 硼 族

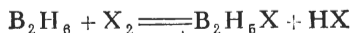
5.1 硼 $2s^2 2p^1$ B = 108.1



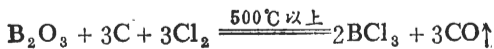
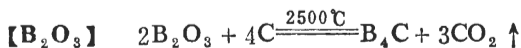
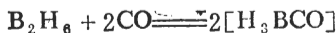
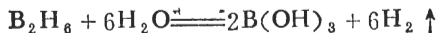
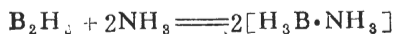
(B与非氧化性的酸无反应)



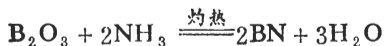
[B₂H₆] (二硼烷) 注: BH₃不存在



(X₂代表F₂、Cl₂、Br₂、I₂)

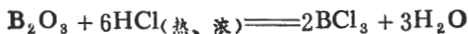
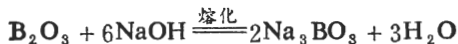
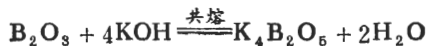


(其他碱金属也有类似的反应)

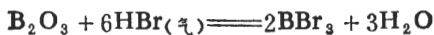




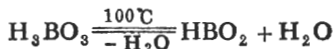
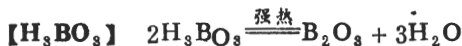
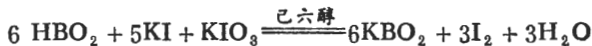
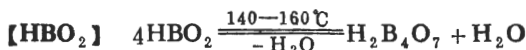
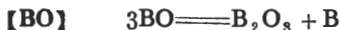
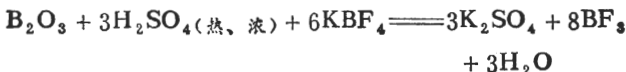
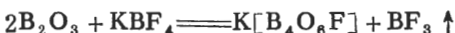
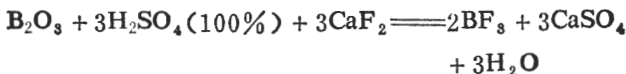
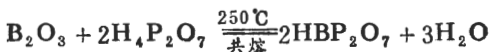
(热时产物显绿色、冷时显兰色)

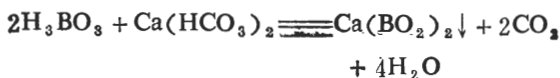
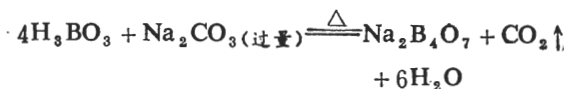
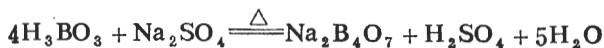
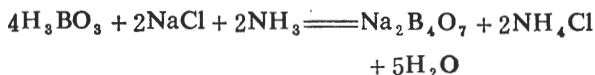
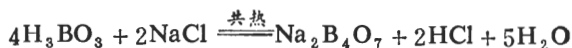
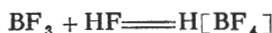
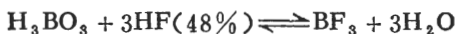
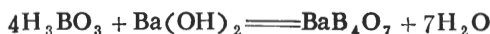
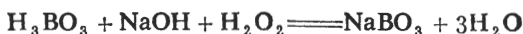
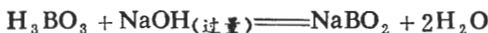
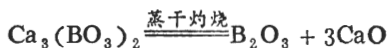
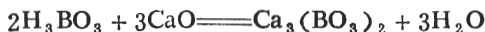
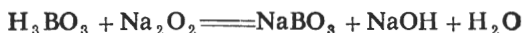
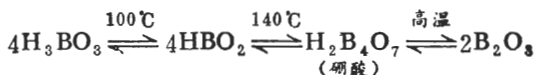


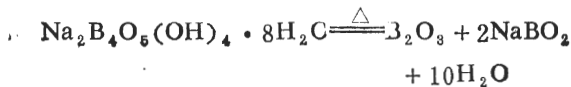
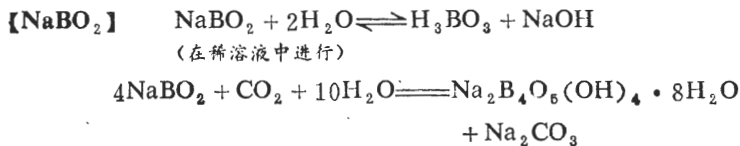
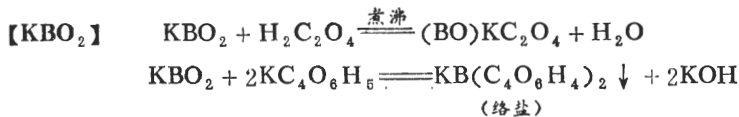
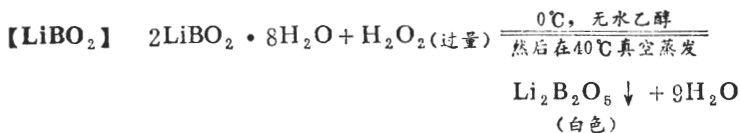
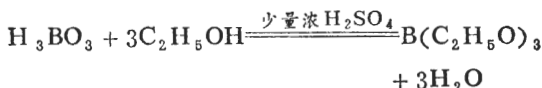
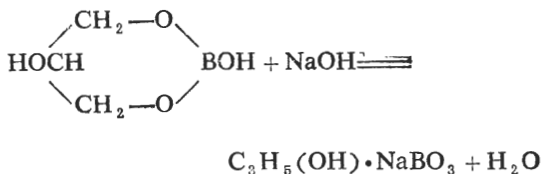
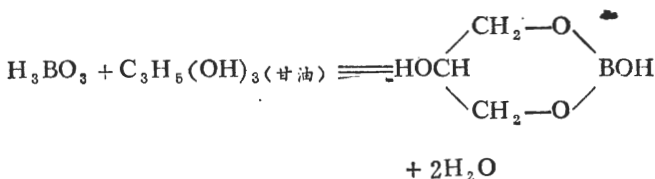
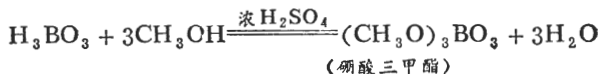
(溶于无水醇)

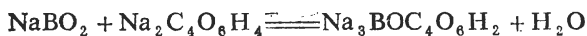
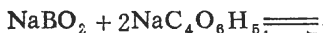
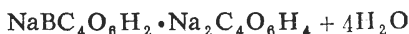
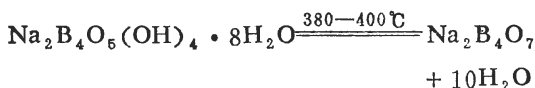


(溶于无水醇)

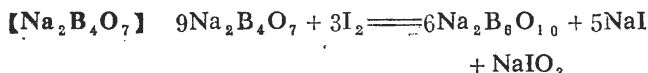
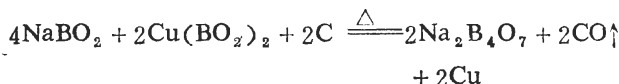




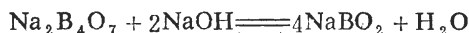




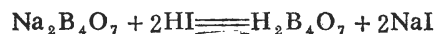
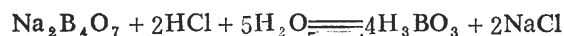
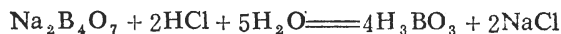
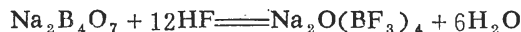
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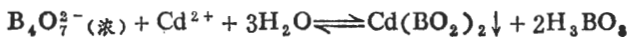
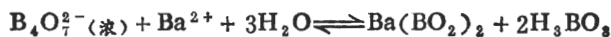
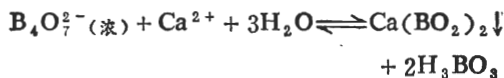
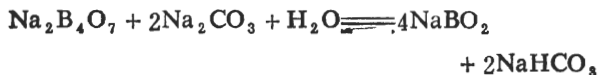
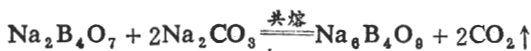
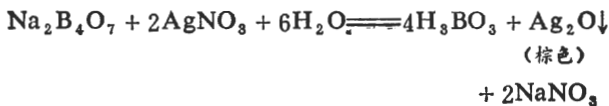
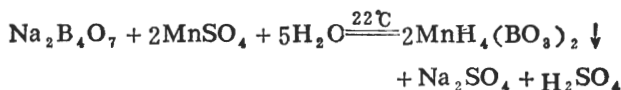
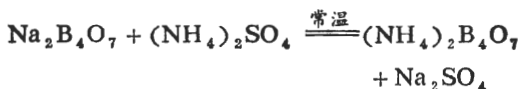
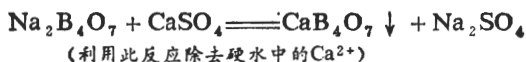
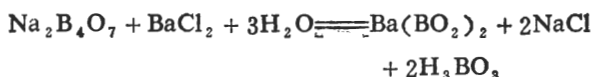
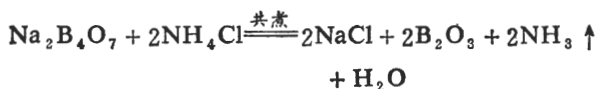
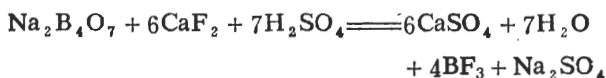
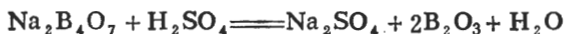
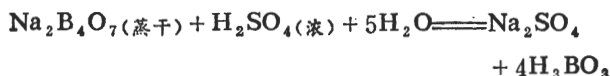


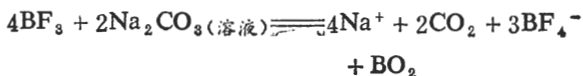
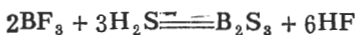
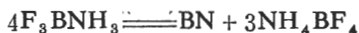
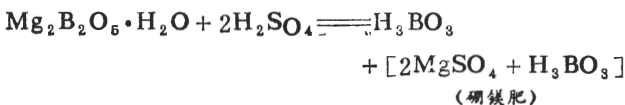
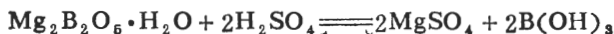
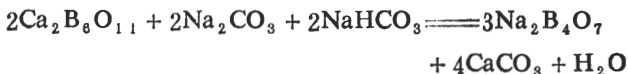
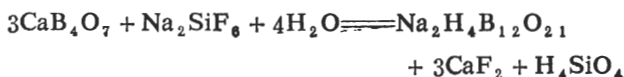
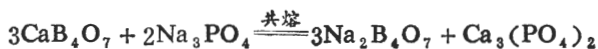
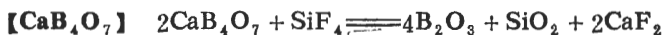
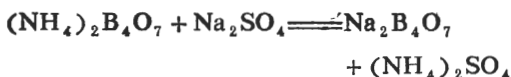
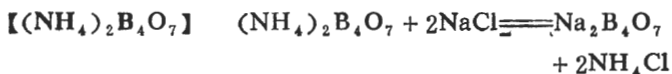
(在浓溶液中进行)

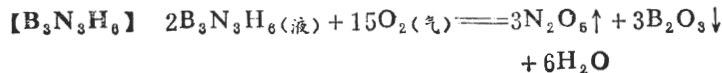
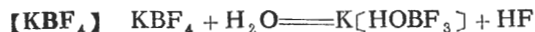
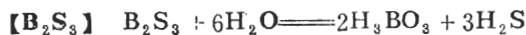
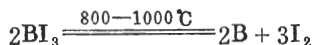
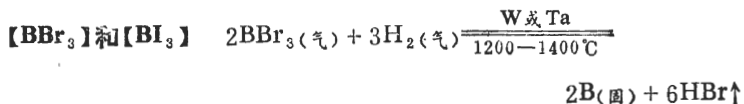
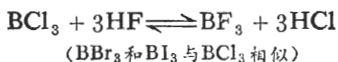
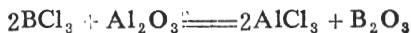
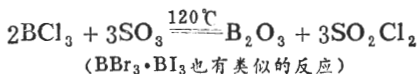
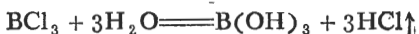
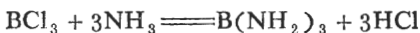
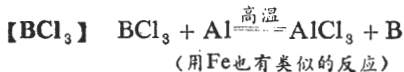
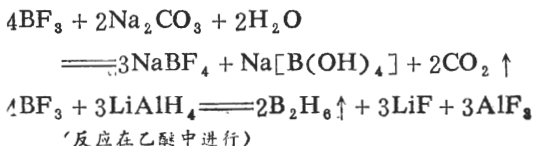


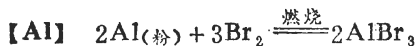
(过硼酸钠)



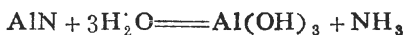
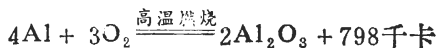




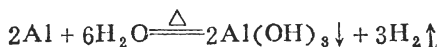
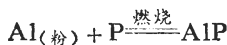


5.2 铝 $3s^2 3p^1$ Al=26.9815

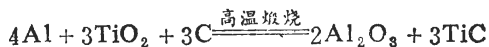
(卤素元素均有类似的反应)



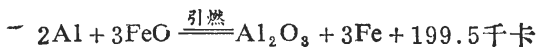
(反应较慢)



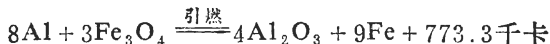
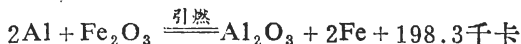
(去掉 Al_2O_3 以后的 Al)



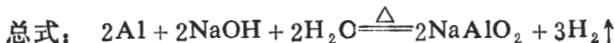
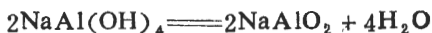
注: 铝热剂焊接钢轨的主要化学反应方程式:



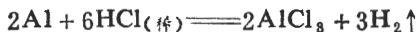
(主要发生的反应)



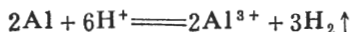
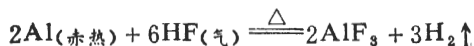
(要求 FeO 含量达 60%, Fe_2O_3 和 Fe_3O_4 少量, S 和 P 含量在 0.05% 以下)



(即Al与稀NaOH溶液反应)



(浓HCl与Al反应很慢, 加HgCl₂溶液时能促进反应。在HCl气流内加热Al, 也可以得到AlCl₃)

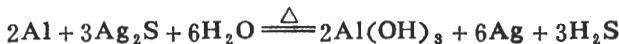


注: Al在常温时与H₂S不发生反应。

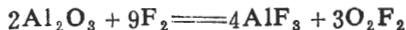
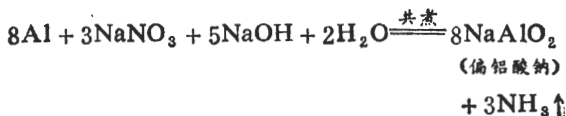


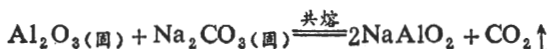
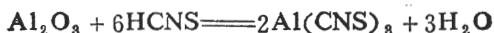
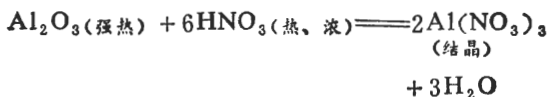
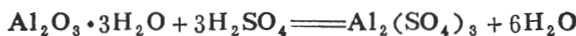
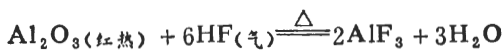
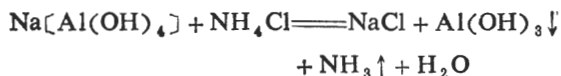
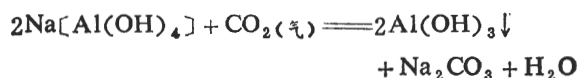
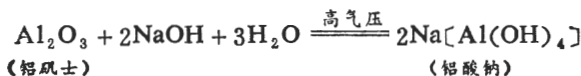
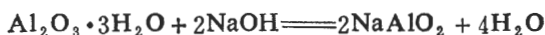
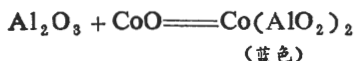
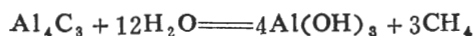
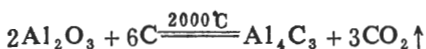
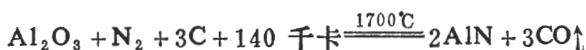
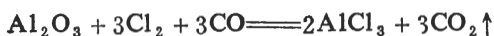
(Al在常温下与浓H₂SO₄不起反应, 成“钝态”。)

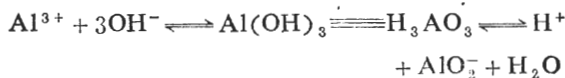
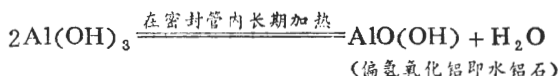
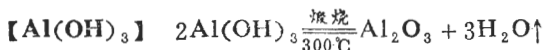
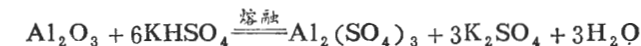
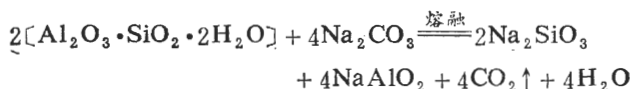
注: 冷的HNO₃不管浓、稀都对Al无作用, 因生成Al₂O₃保护层, 加热时发生猛烈反应。成“钝态”的铝不再与稀H₂SO₄、稀HCl作用。Al跟HNO₃的反应, 同Zn跟HNO₃的反应, 其反应产物由HNO₃的浓度而定的, 详细情况, 请参看Zn。



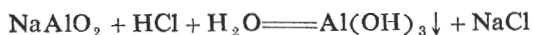
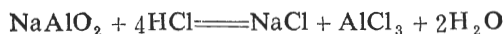
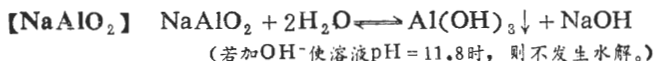
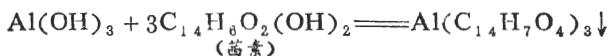
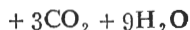
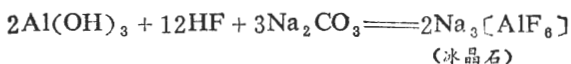
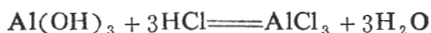
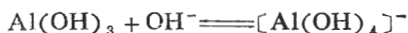
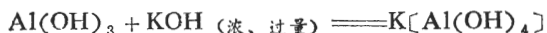
(Mg、Zn均能发生类似的反应)

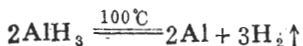
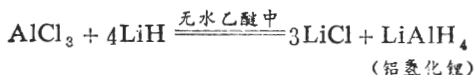
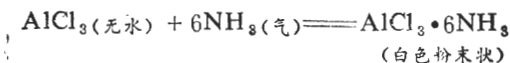
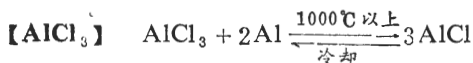
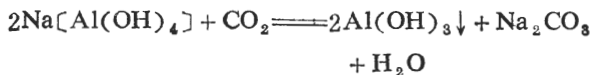
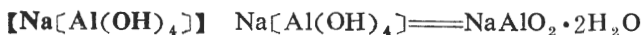
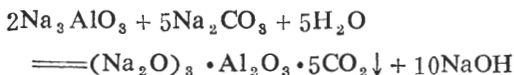
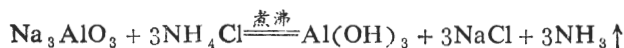
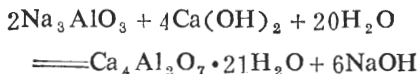
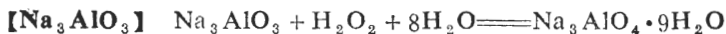
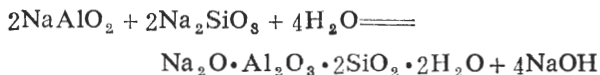
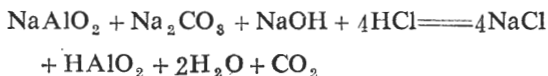
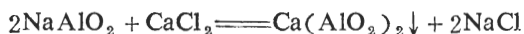
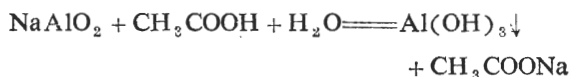


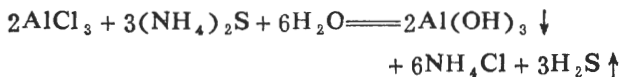
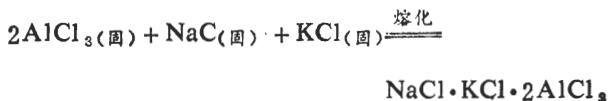
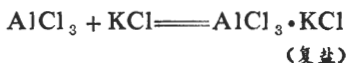
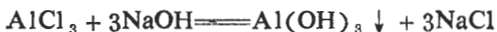
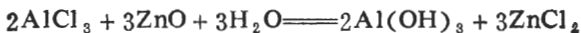
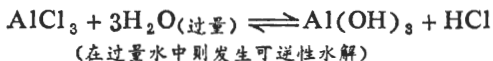
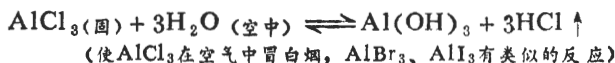




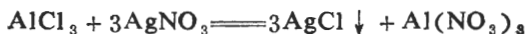
(加酸、加碱都能引起平衡移动, 促使 $\text{Al}(\text{OH})_3$ 沉淀溶解)



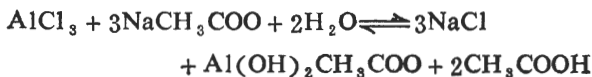
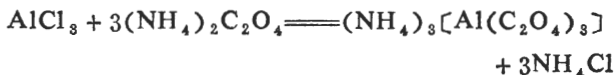
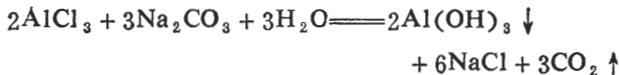
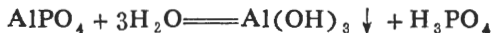
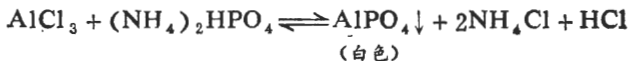


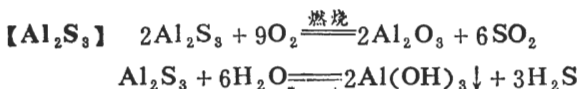
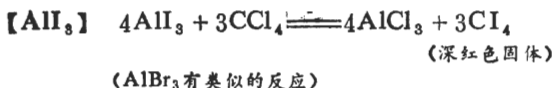
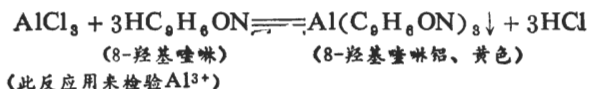


(AlCl_3 与 Na_2S 在溶液中的反应类似)

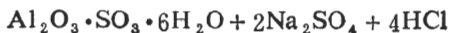
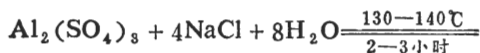
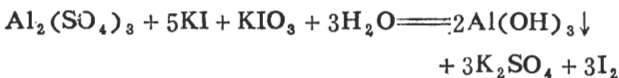
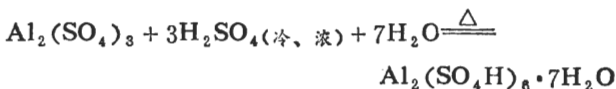
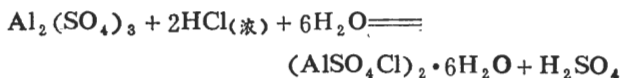
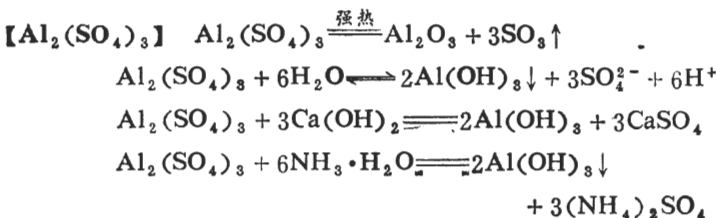
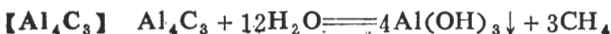


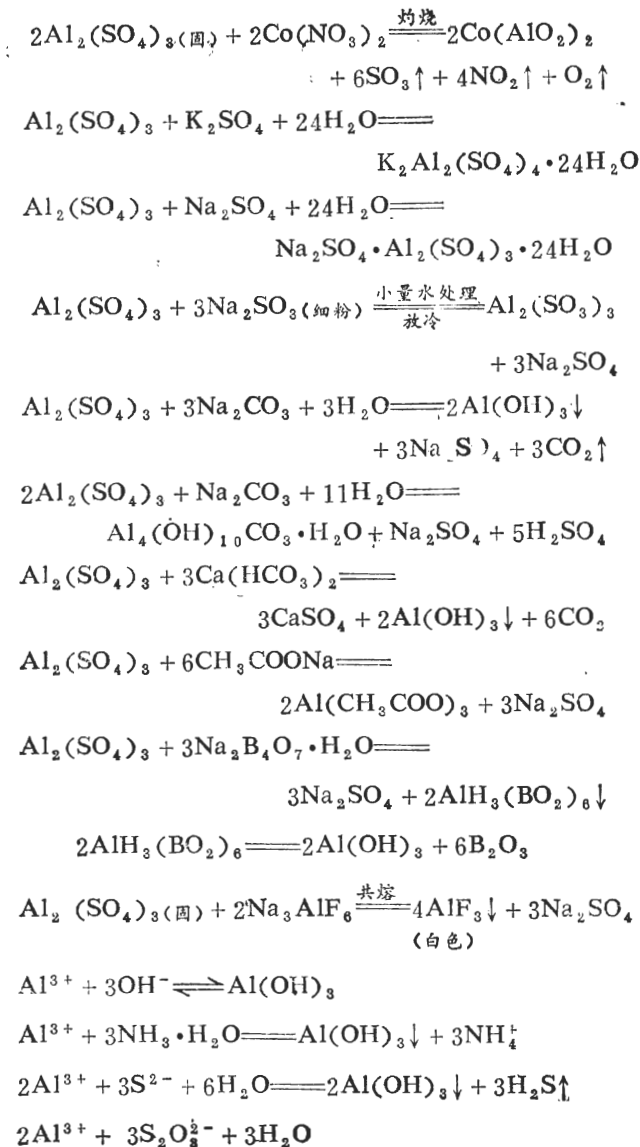
(AlBr_3 也有类似的反应)

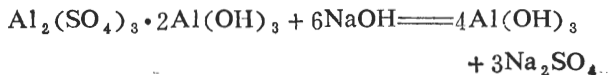
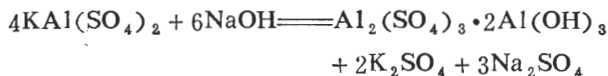
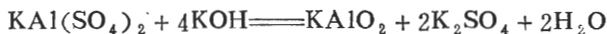
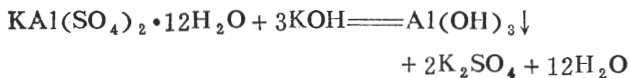
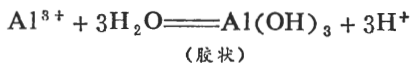
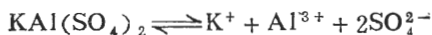
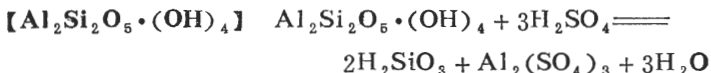
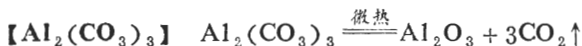
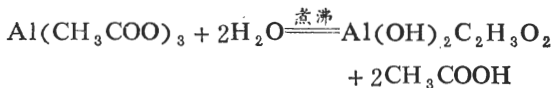
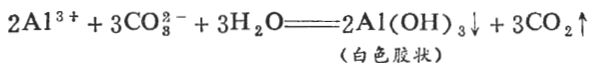
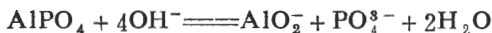
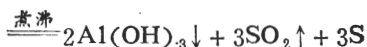


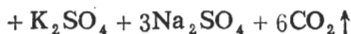
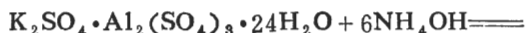
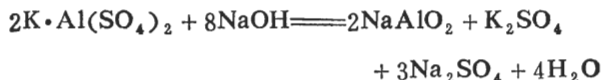
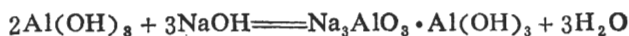


注：弱酸、弱碱所生成的盐，如果水解生成的酸和碱极弱，且是挥发性或溶解性很小的，则水解可进行到底。



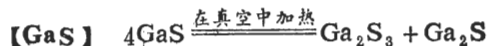
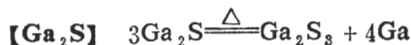
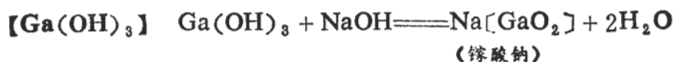
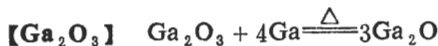
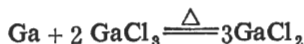
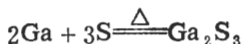
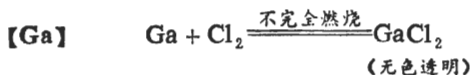


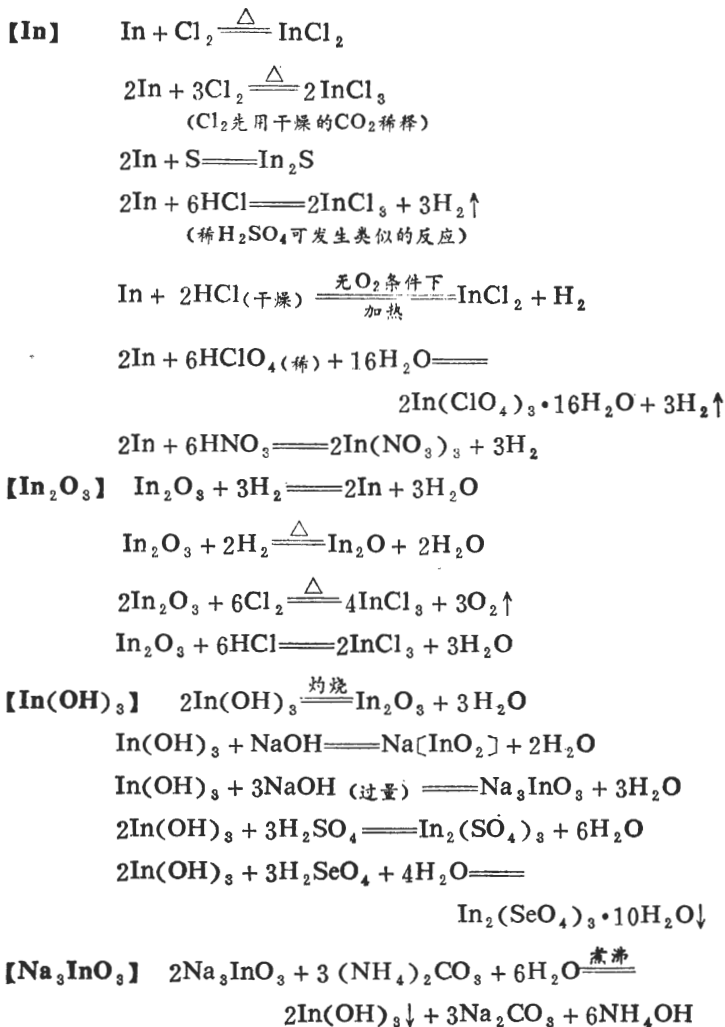


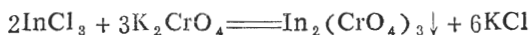
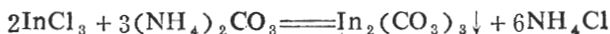
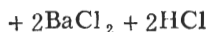
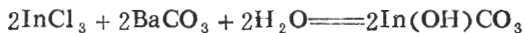
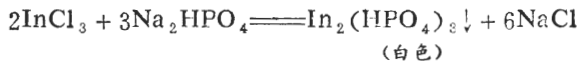
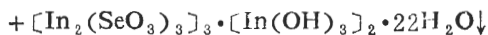
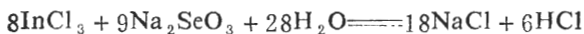
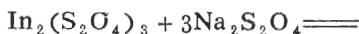
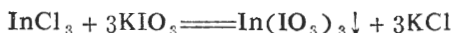
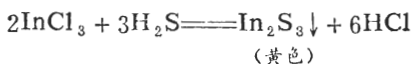
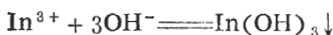
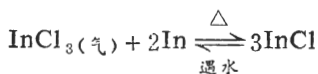
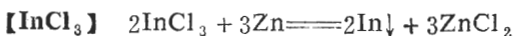
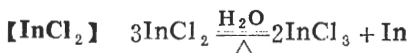
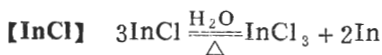
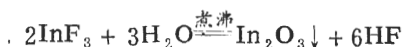
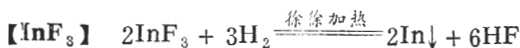


(泡沫灭火器内的反应)

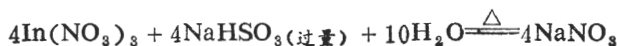
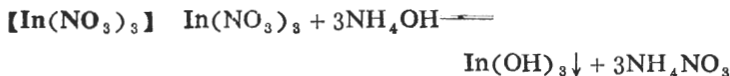
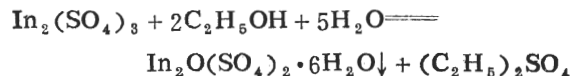
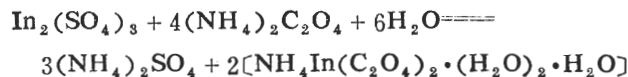
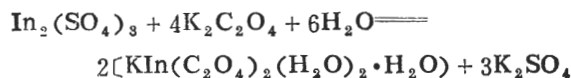
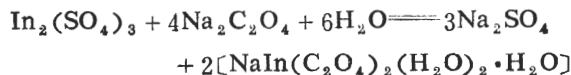
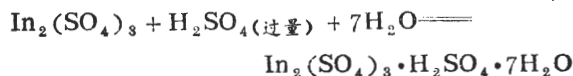
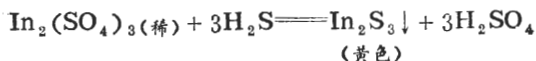
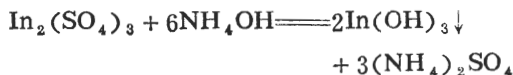
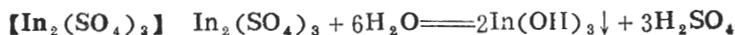
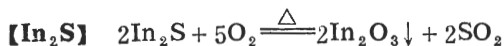
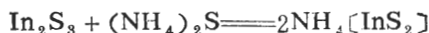
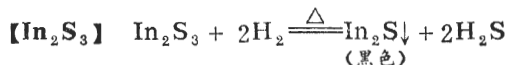
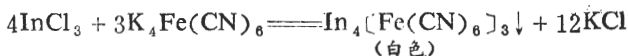
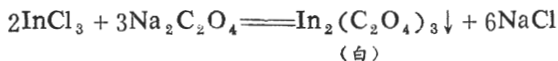
5.3 镓 $4s^2 4p^1$ Ga = 69.72

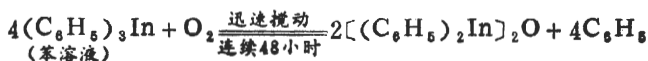
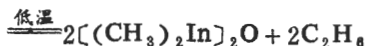
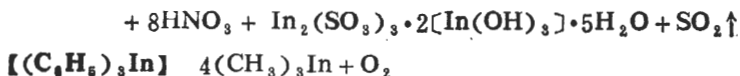


5.4 钢 $5s^2 5p^1$ In = 114.82


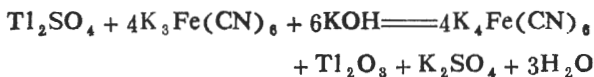
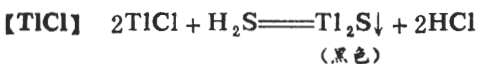
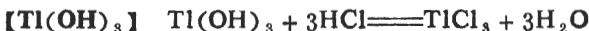
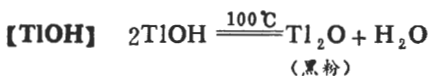
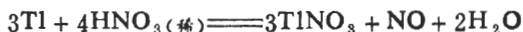
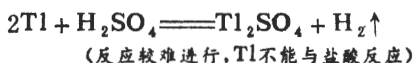
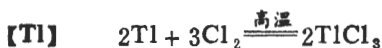


(黄色)



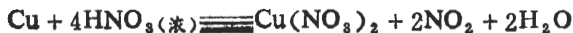
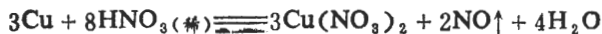
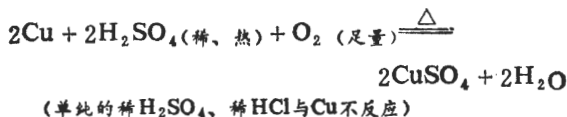
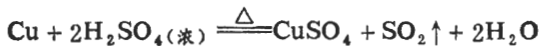
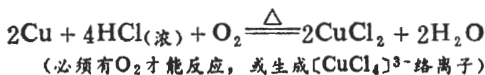
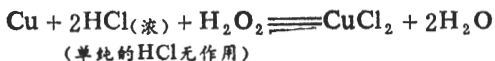
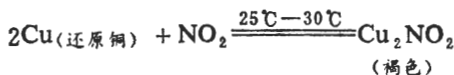
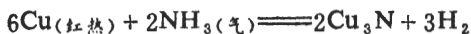
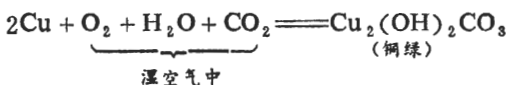
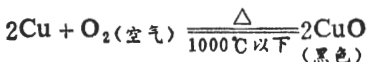
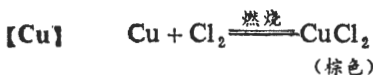


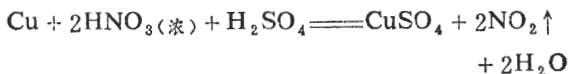
5.5 铊 $6s^2 6p^1$ $Tl = 204.37$



第六章 铜 族

6.1 铜 $3d^{10}4s^1$ $\text{Cu} = 63.546$

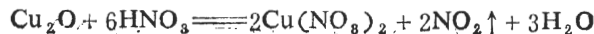
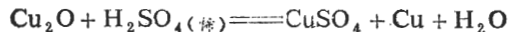
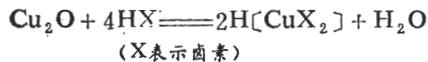
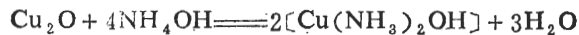
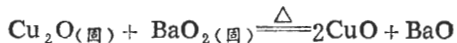
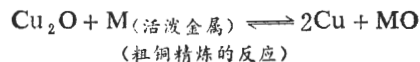
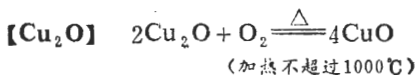
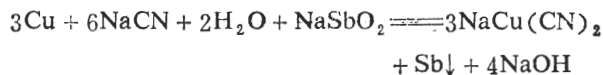
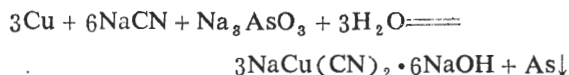
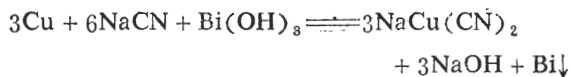
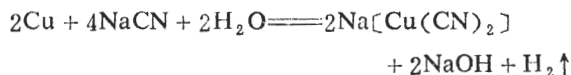
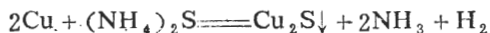


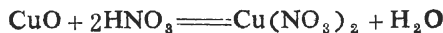
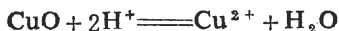
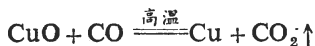
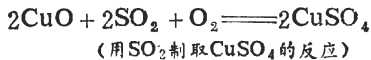
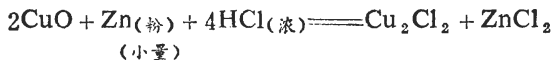
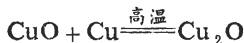
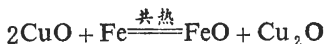
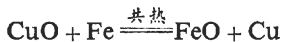
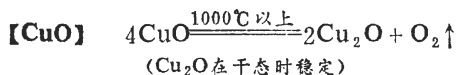
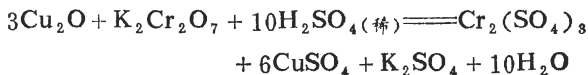
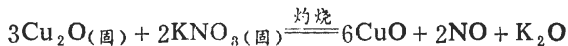
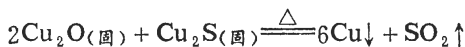
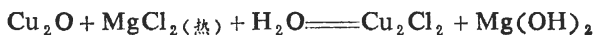


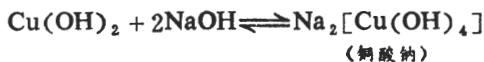
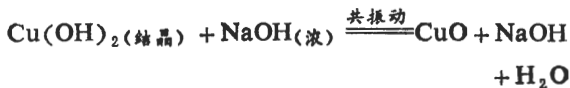
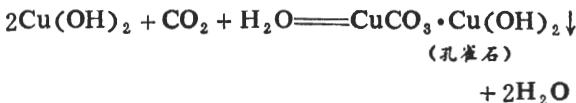
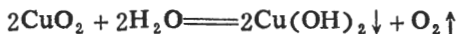
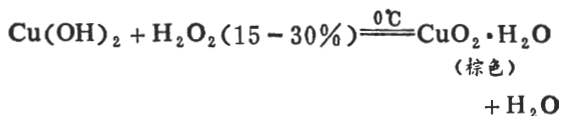
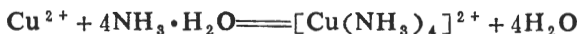
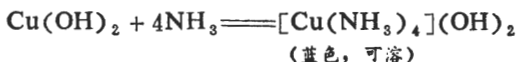
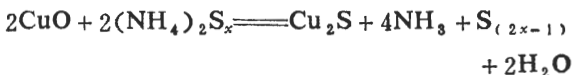
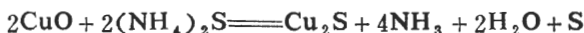
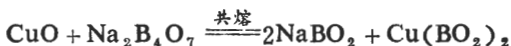
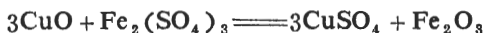
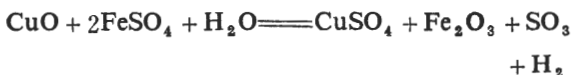
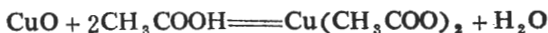
(实际得产物是 $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$)



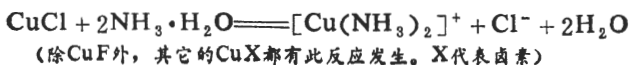
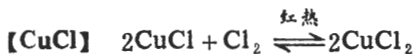
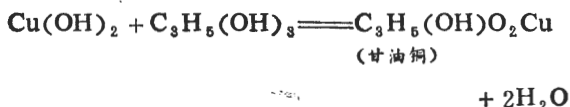
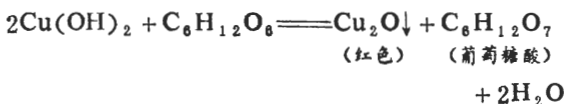
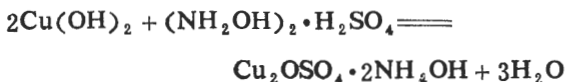
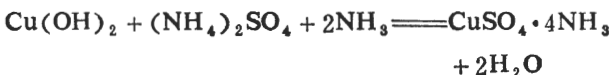
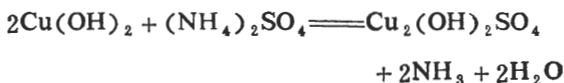
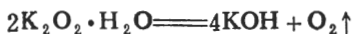
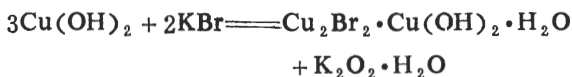
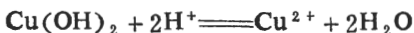
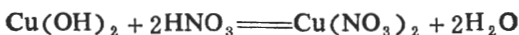
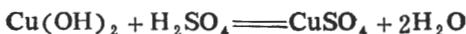
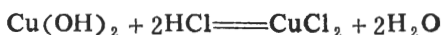
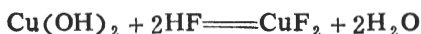
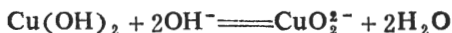
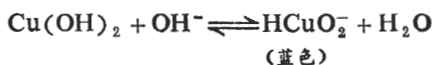
(无线电工业制印刷电路板用此反应)

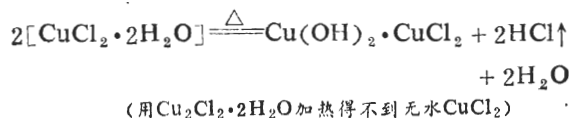
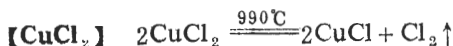
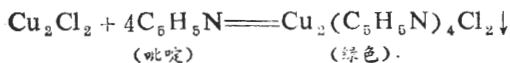
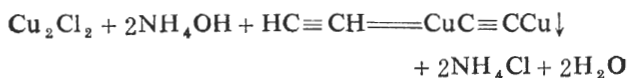
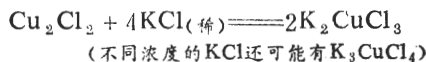
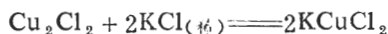
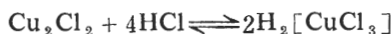
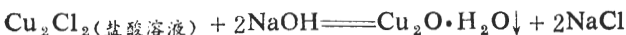
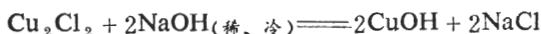
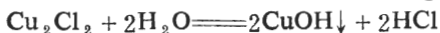
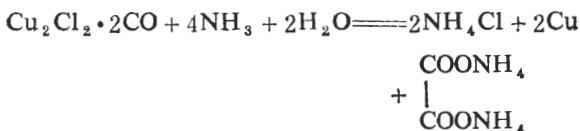
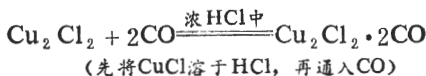
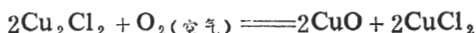
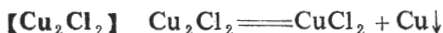
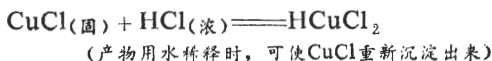


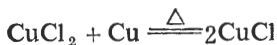
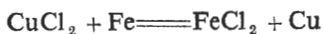




(碱金属氢氧化物均可)

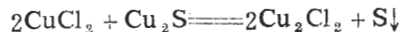
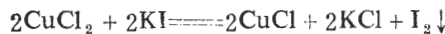
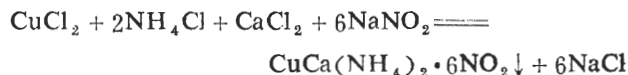
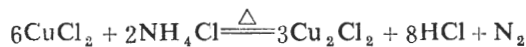
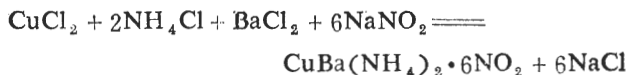
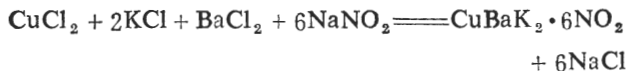
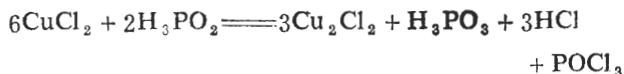
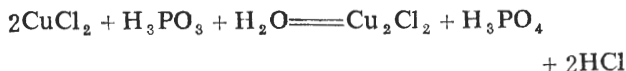
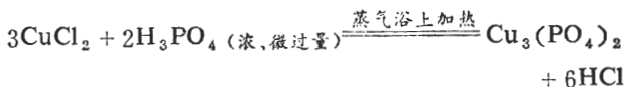
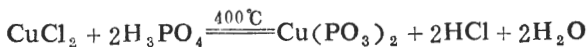
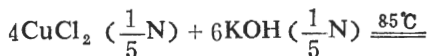


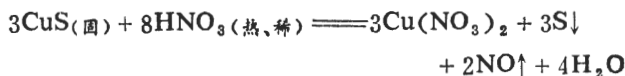
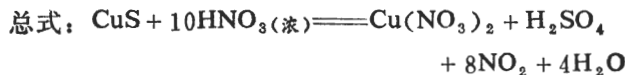
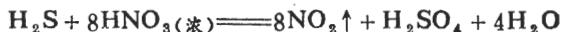
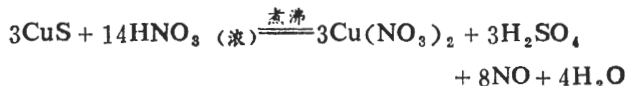
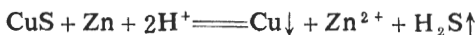
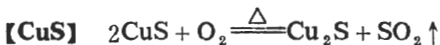
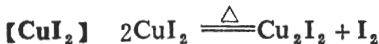
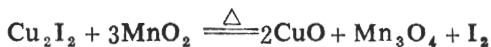
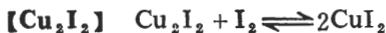
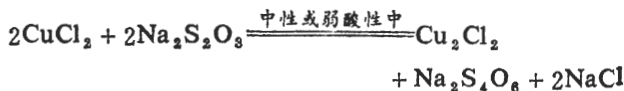




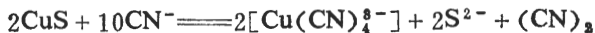
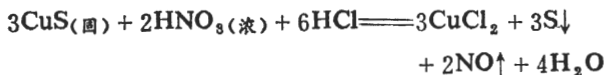
(白色结晶)

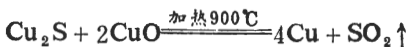
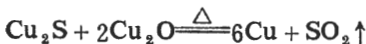
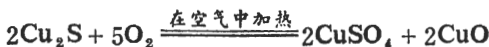
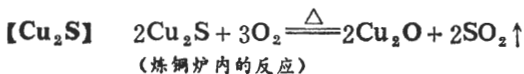
(CuCl_2 溶液先用盐酸酸化)



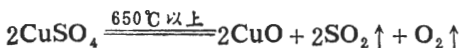
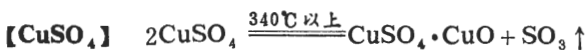
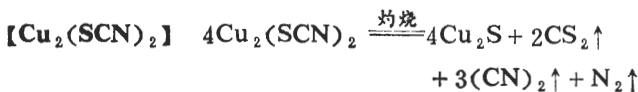
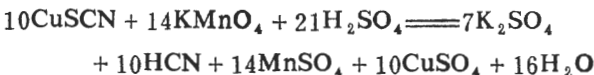
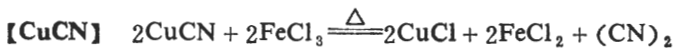
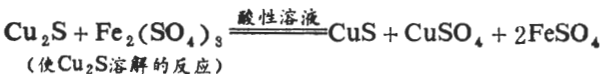
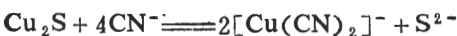
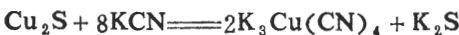
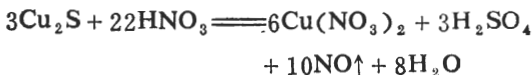


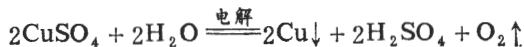
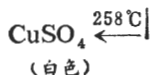
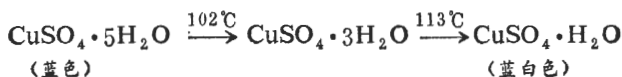
(这里的 HNO_3 , 其中只有 $\frac{1}{4}$ 作为氧化剂, $\frac{3}{4}$ 作为酸, 作为酸的部分也可以改用 HCl)





(反射炉内的反应)

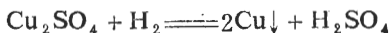
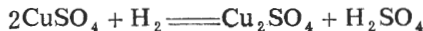
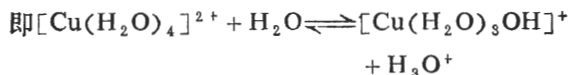




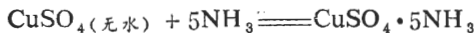
$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ 水解时溶液呈酸性;



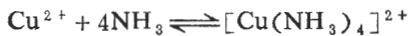
(故 CuSO_4 水解后溶液呈酸性)



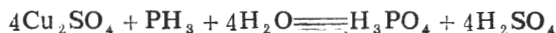
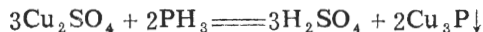
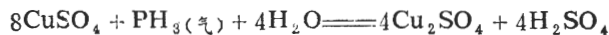
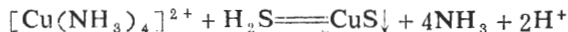
(蓝色结晶)

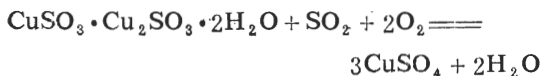
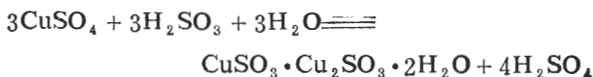
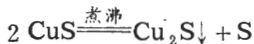
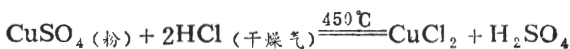
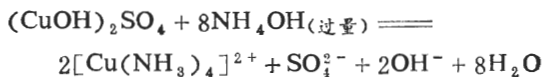
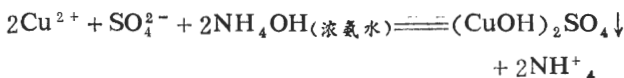
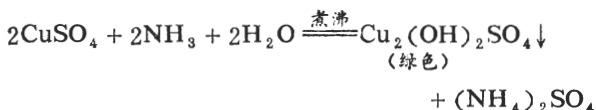
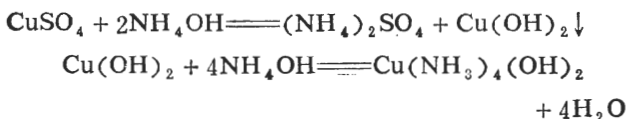
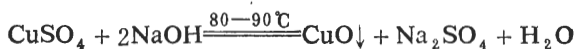
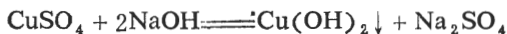
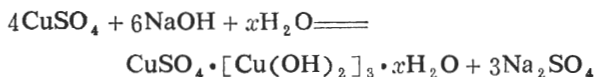
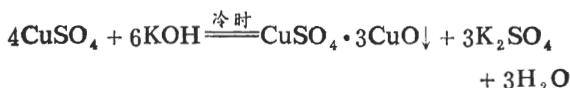
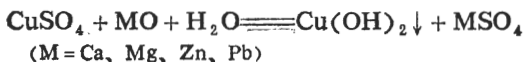
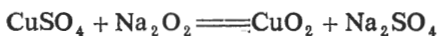


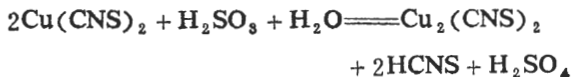
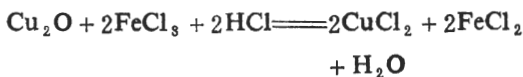
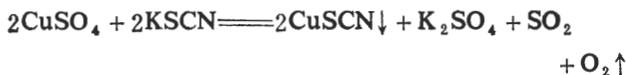
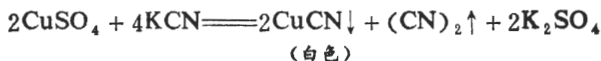
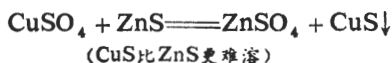
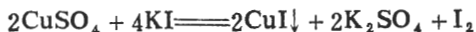
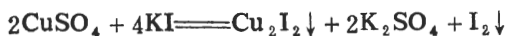
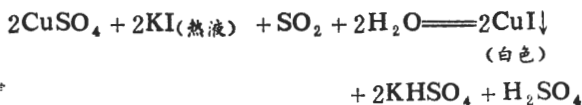
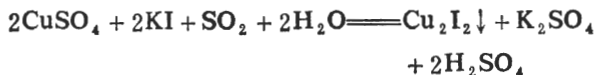
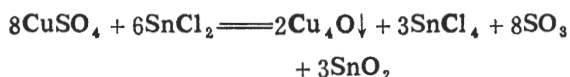
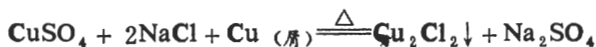
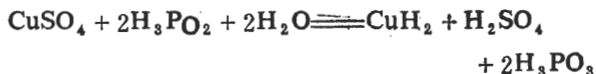
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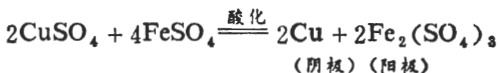
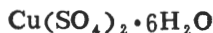
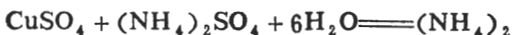
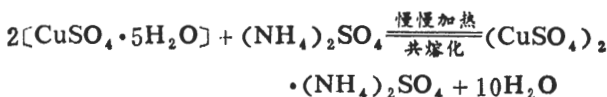
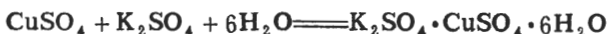
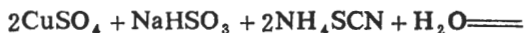
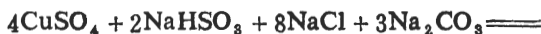
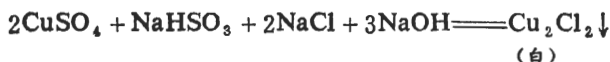


(深蓝色)

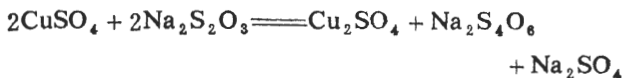
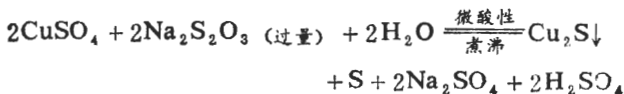
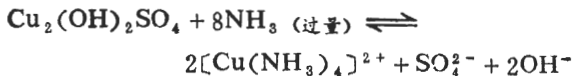
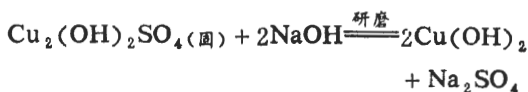
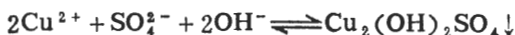
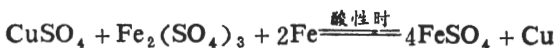


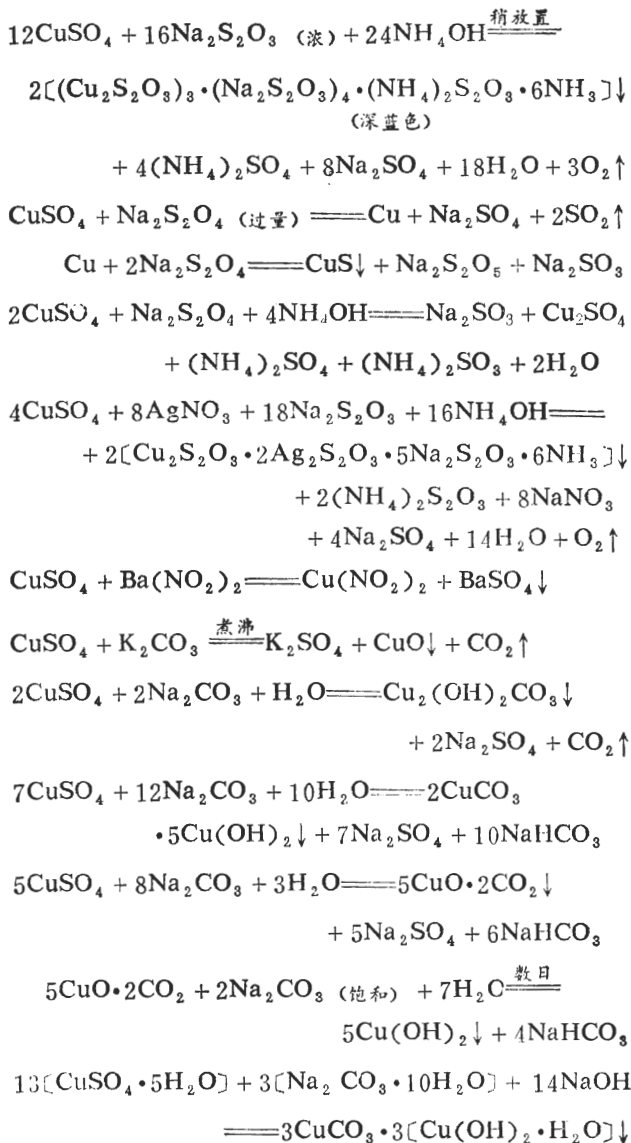


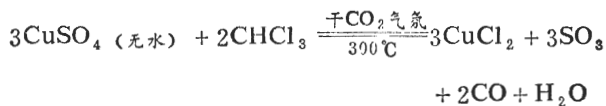
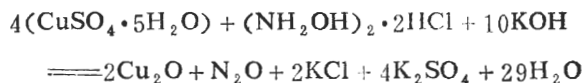
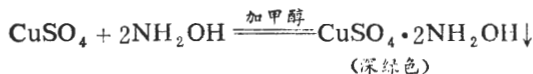
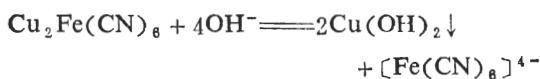
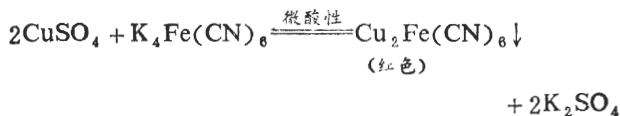
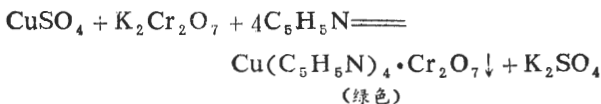
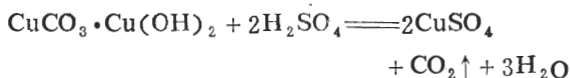
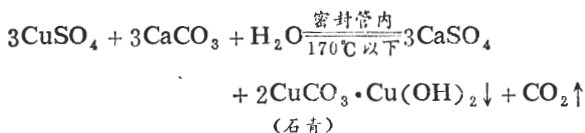
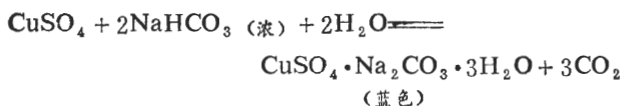
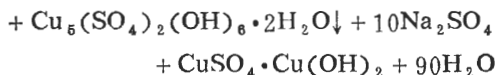




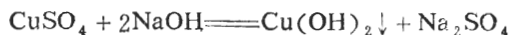
(在电解槽内的反应)

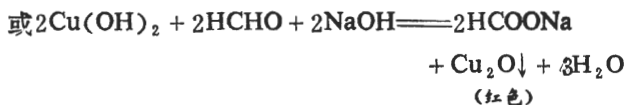
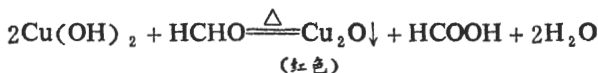




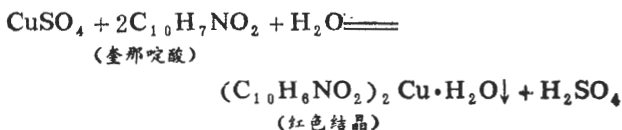
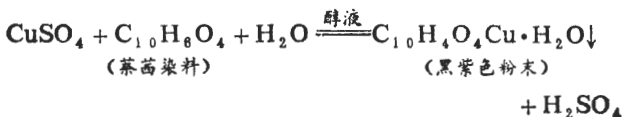
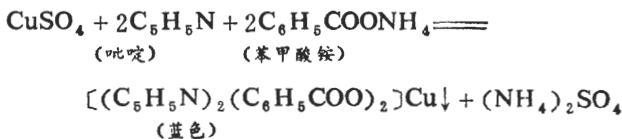
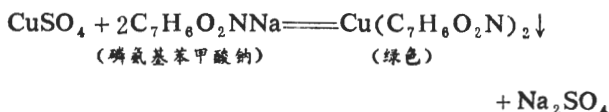
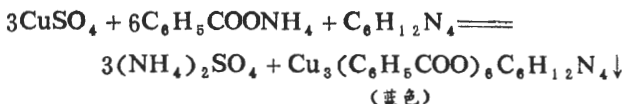
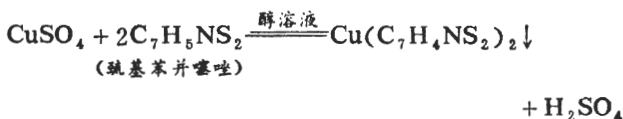
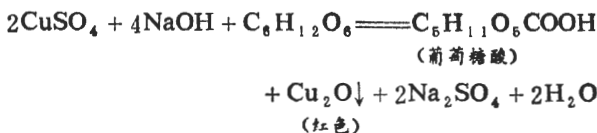


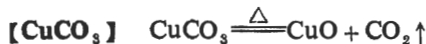
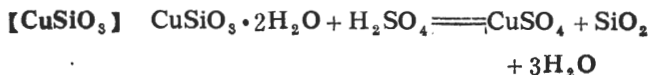
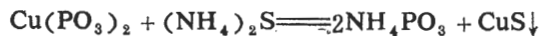
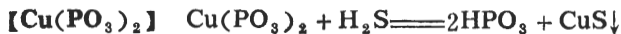
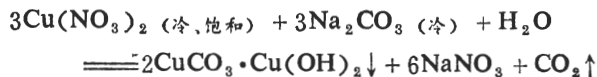
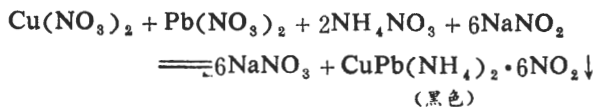
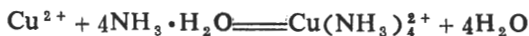
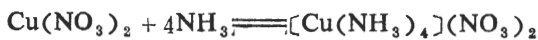
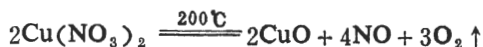
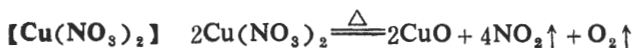
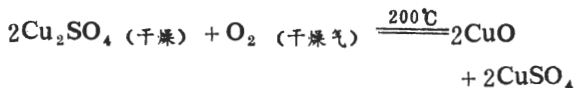
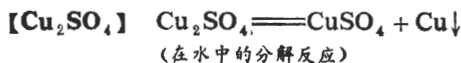
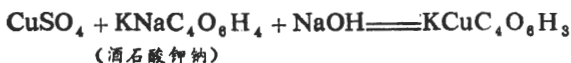
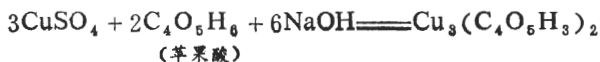
斐林溶液与甲醛的反应:

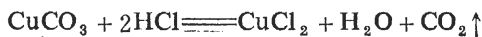




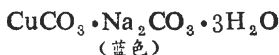
斐林溶液与葡萄糖反应:



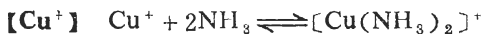
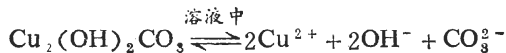
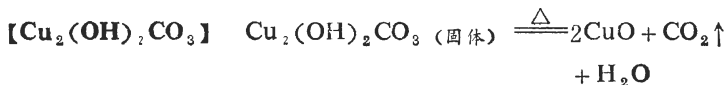
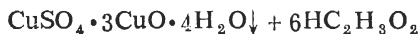
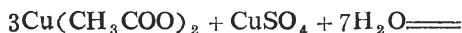
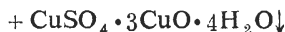
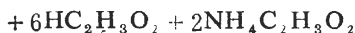
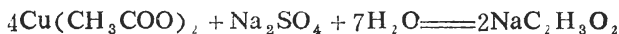




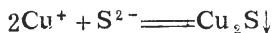
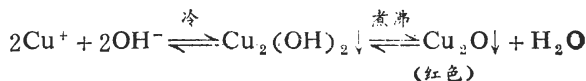
(HF、HBr均可发生类似的反应)

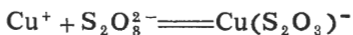
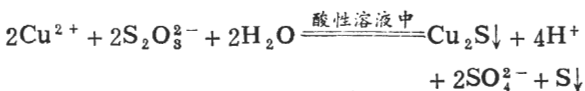
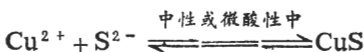
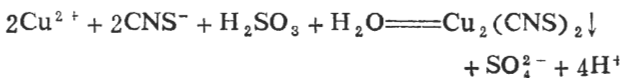
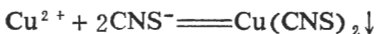
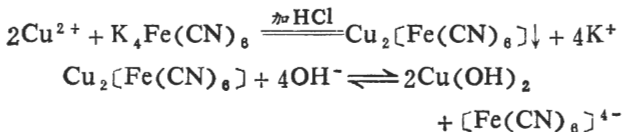
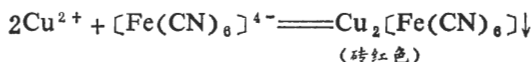
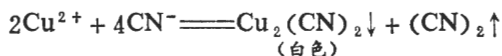
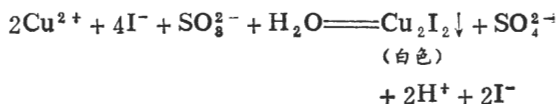
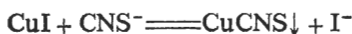
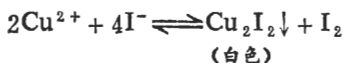
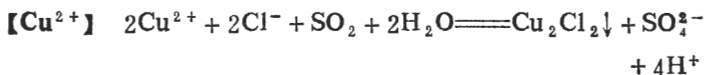


(淡蓝色)

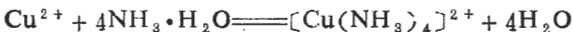
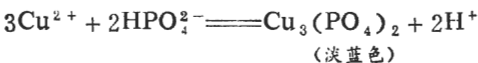


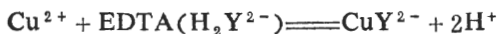
(红色)





(在过量的 $\text{S}_2\text{O}_3^{2-}$ 存在下)



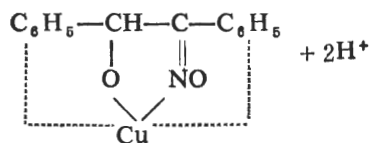


(白色)

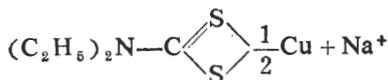
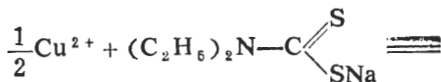
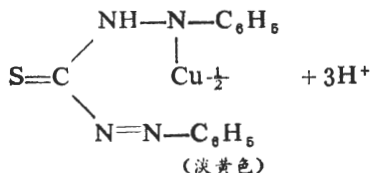
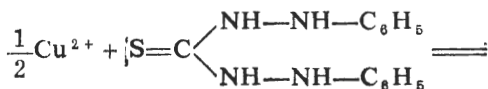
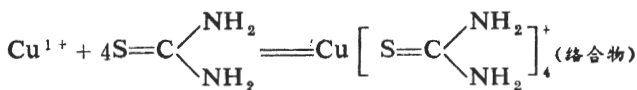
(EDTA系指乙二胺四乙酸盐)



(试铜灵)

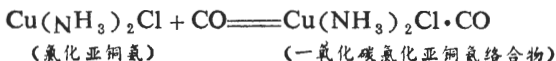
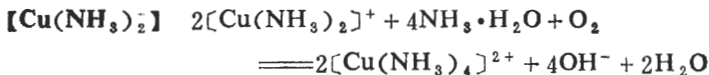
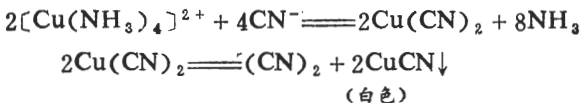
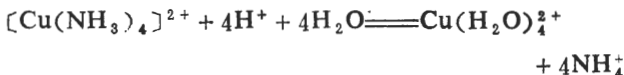
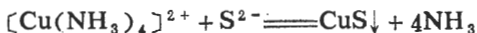
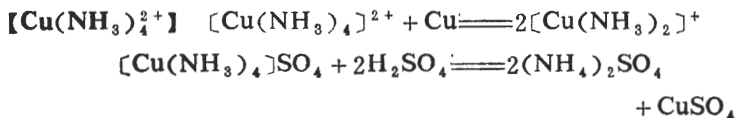
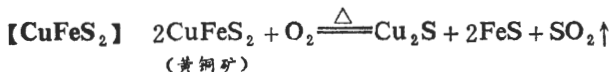
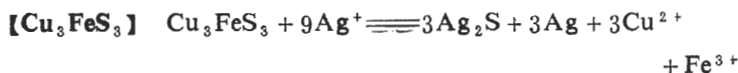
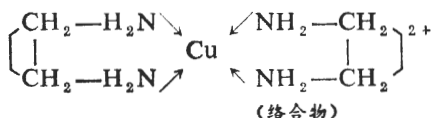
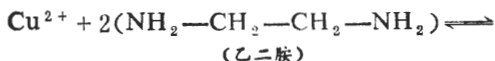
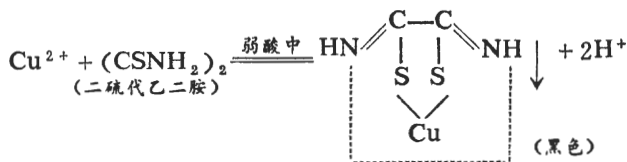
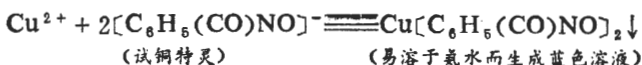


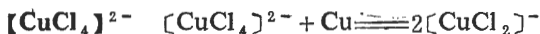
注：Cu²⁺与硫脲作用先将Cu²⁺变成Cu⁺然后Cu⁺再与硫脲发生反应，得稳定的络合物：



(棕色络合物)

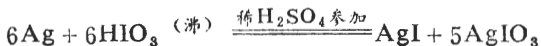
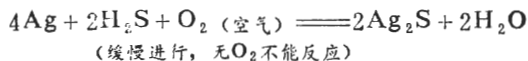
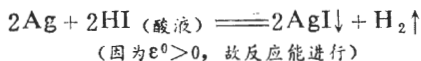
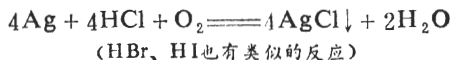
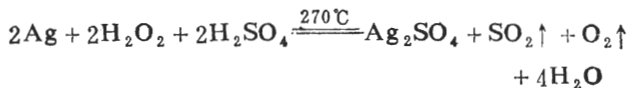
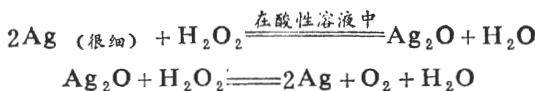
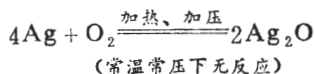
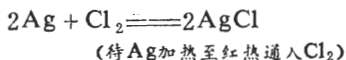
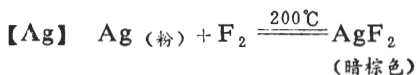
〔(乙氨基二硫代甲酸(铜试剂又叫D、D、T、C))〕

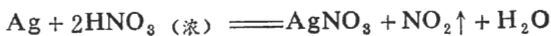
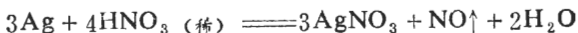
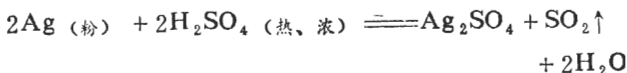




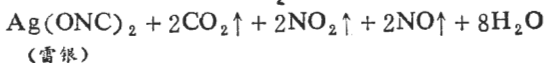
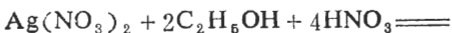
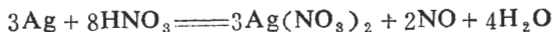
(因为 $\epsilon^0 > 0$, 反应可以进行。 ϵ^0 表示氧化还原反应中原电池的电动势。如果 $\epsilon^0 > 0$, 电极反应可以按指定方向自发地进行, 如果 $\epsilon^0 < 0$, 电极反应就不能按指定方向自发地进行, 而是按相反方向进行。)

6.2 银 $4d^{10} 5s^1$ $\text{Ag} \rightleftharpoons 107.868$

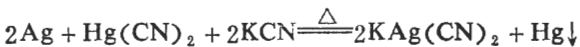
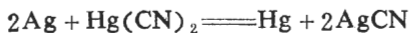
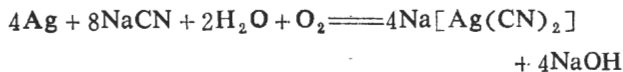
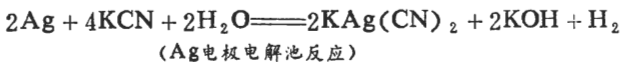
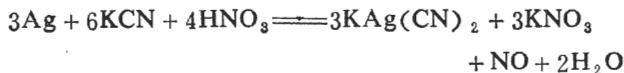
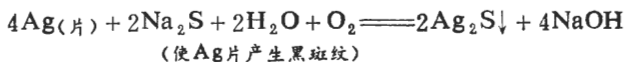
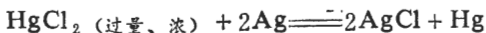
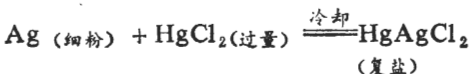


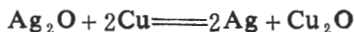
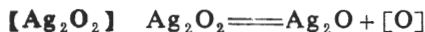
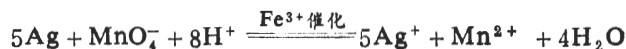
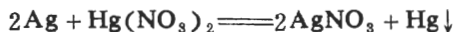
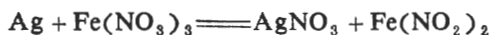
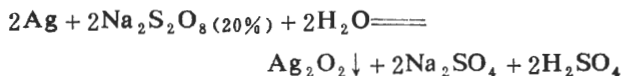


雷银制法:

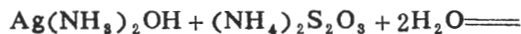
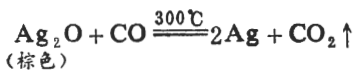
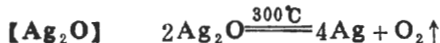
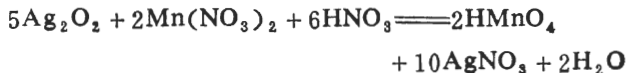


(有AgCl薄片沉积在Ag片上)





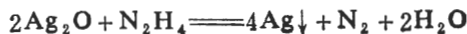
(铁蓄电池内的反应)



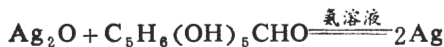
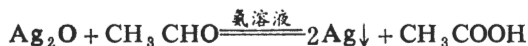
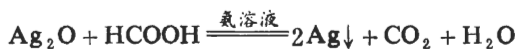
(白色)



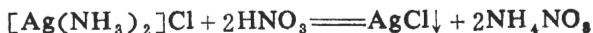
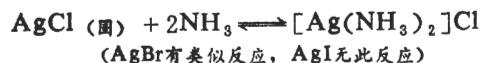
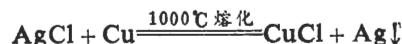
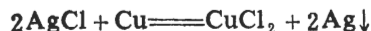
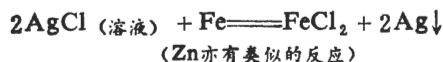
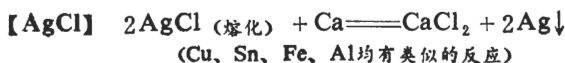
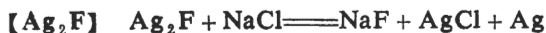
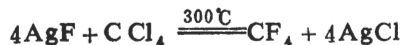
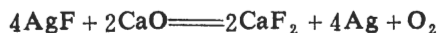
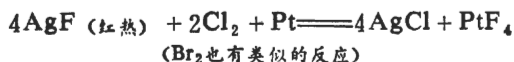
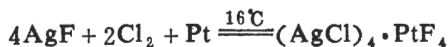
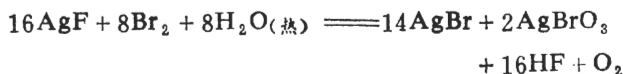
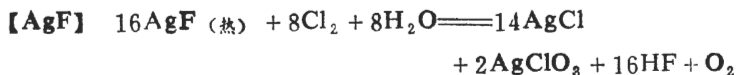
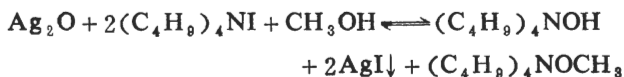
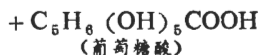
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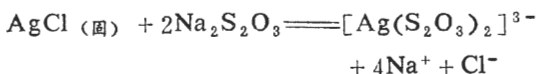
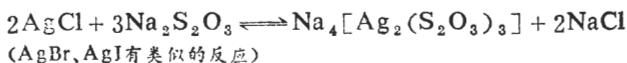
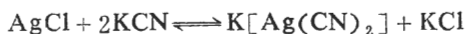
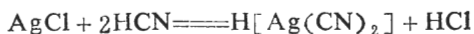
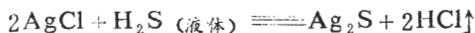
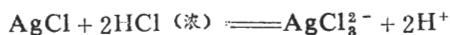
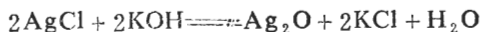
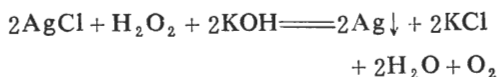
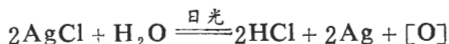


(灰)

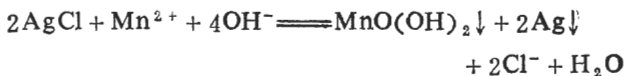
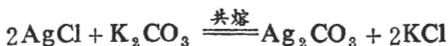
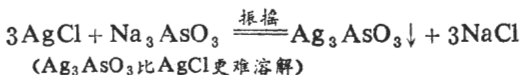
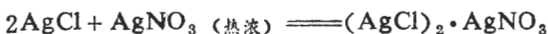
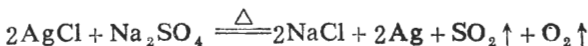
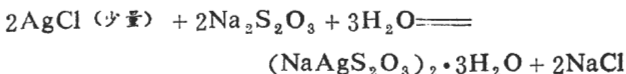


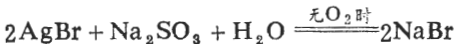
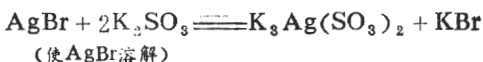
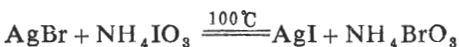
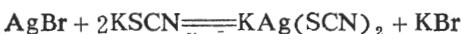
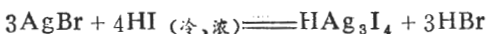
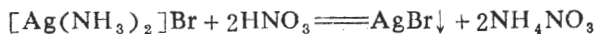
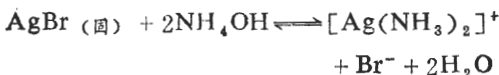
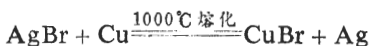
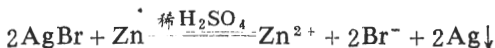
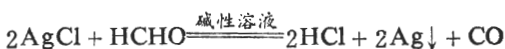
(葡萄糖)



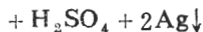


(使AgCl沉淀溶解)

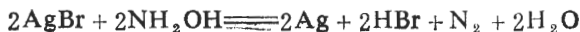
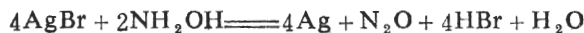
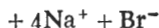


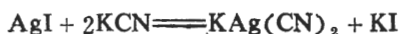
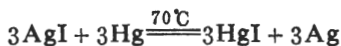
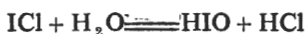
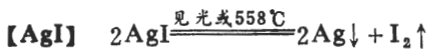


(自动催化)

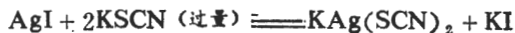


(照相术定影原理)

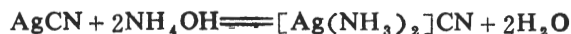




(使AgI溶解)



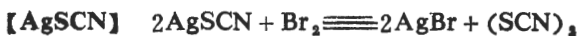
+ 2NaI



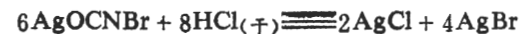
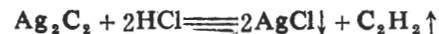
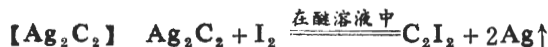
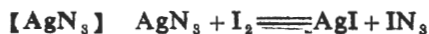
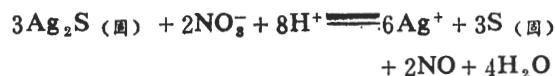
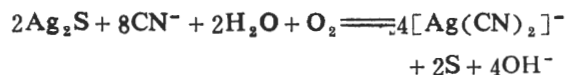
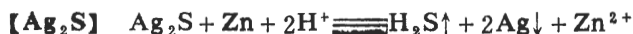
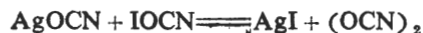
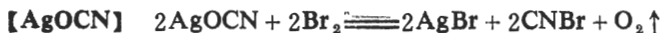
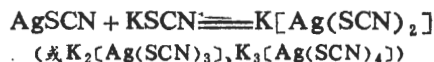
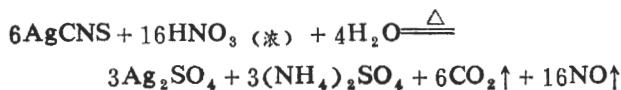
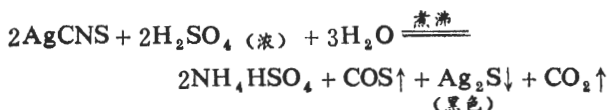
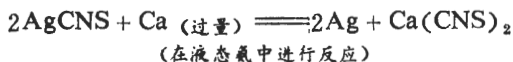
+ AgCN↓



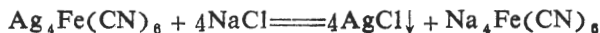
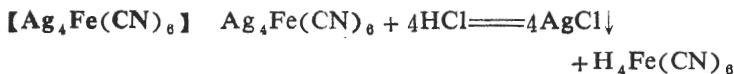
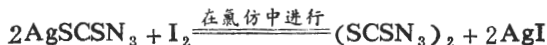
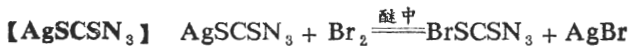
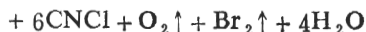
(白色)



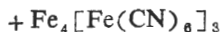
(反应在乙醚中进行)



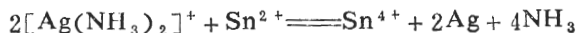
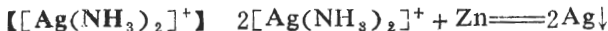
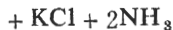
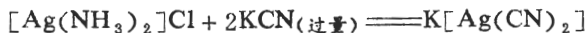
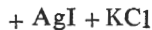
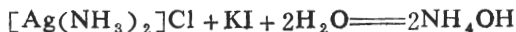
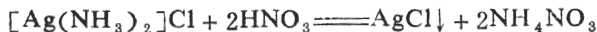
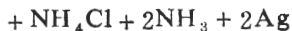
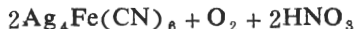
(溴氰酸银)

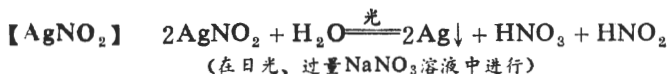
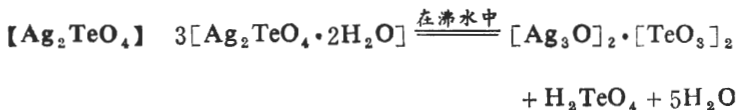
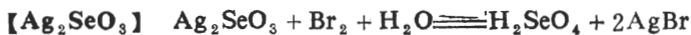
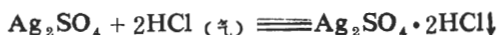
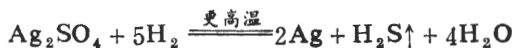
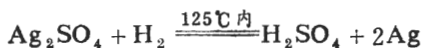
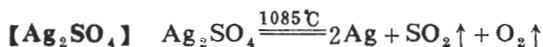
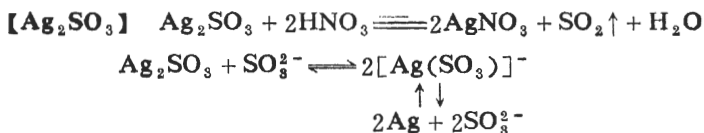
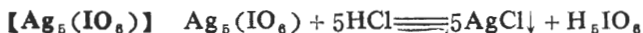
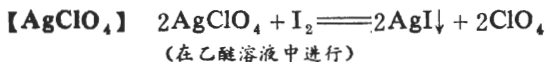
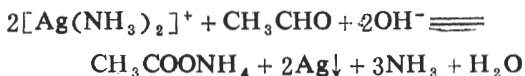


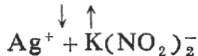
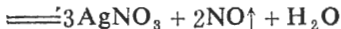
(亚铁氰化银)



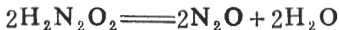
(普鲁士蓝)





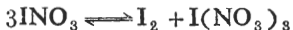
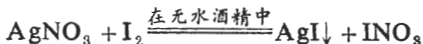
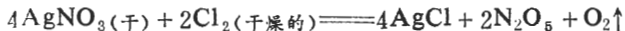
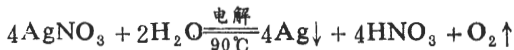


【 $\text{Ag}_2\text{N}_2\text{O}_2$ 】(次硝酸银)



【 AgNO_3 】 $2\text{AgNO}_3 \xrightarrow{440^\circ\text{C}} 2\text{Ag} + 2\text{NO}_2\uparrow + \text{O}_2\uparrow$

(有微量有机物时见光即分解)



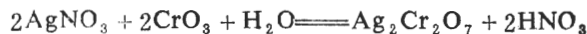
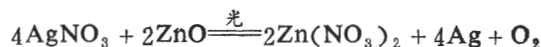
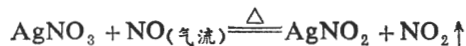
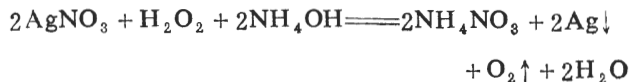
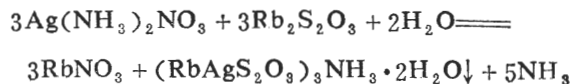
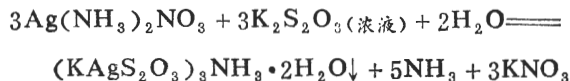
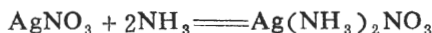
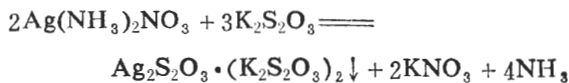
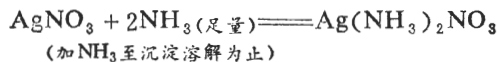
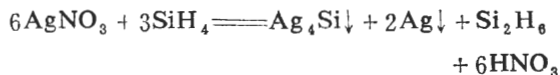
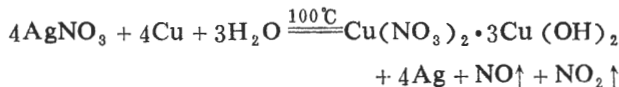
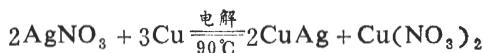
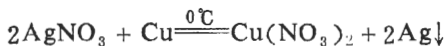
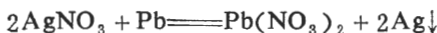
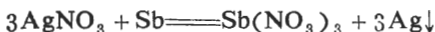
(棕)

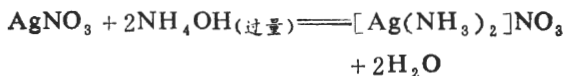
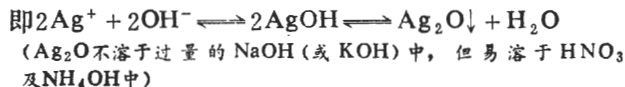
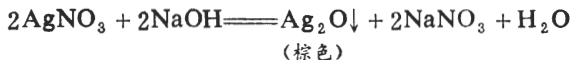
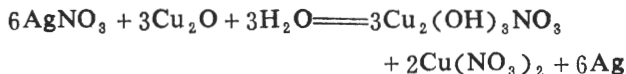
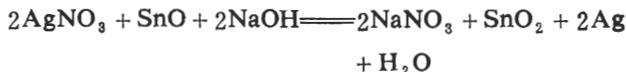
(AgNO_3 的苯甲腈溶液和硫的二硫化碳溶液的反应)



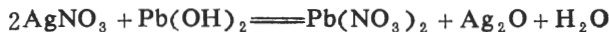
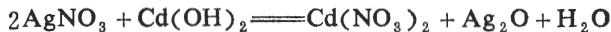
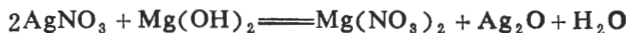
(此反应有时还放出 NO_2)







(少量 NH_4OH 则产生 Ag_2O 沉淀)



(白色)



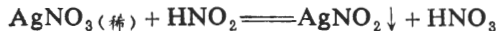
(淡黄色)

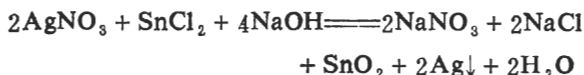
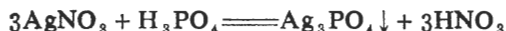
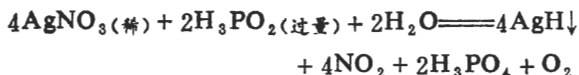


(黄色)

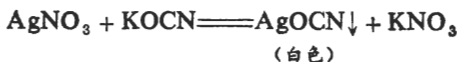
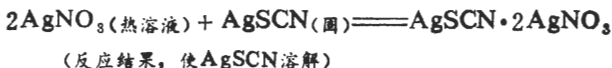
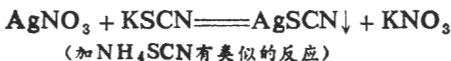
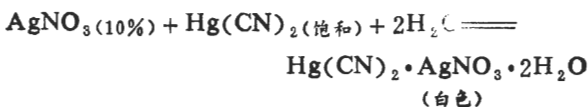
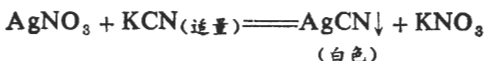
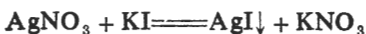
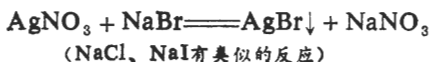
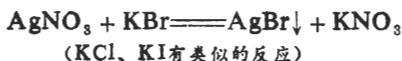
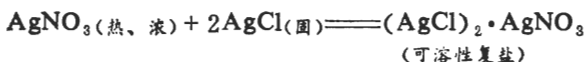
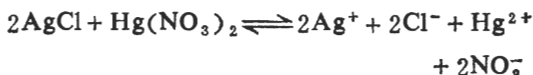


(黑色)

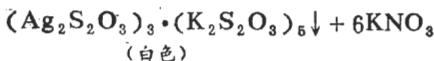
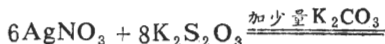
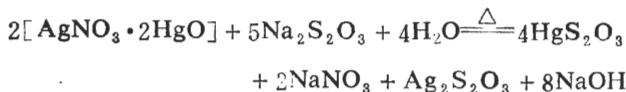
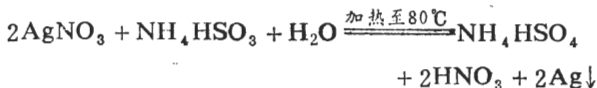
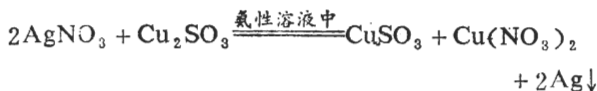
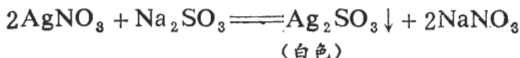
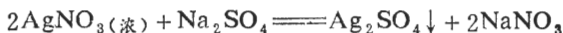
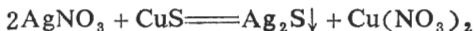
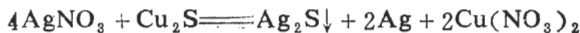
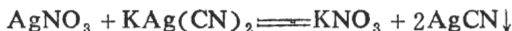
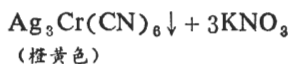
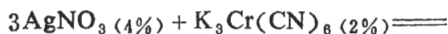


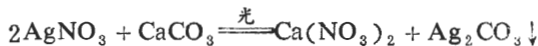
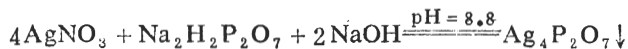
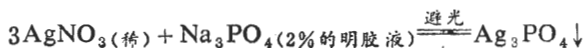
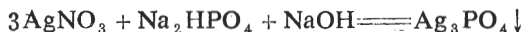
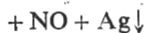
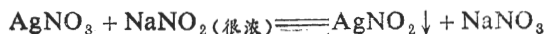
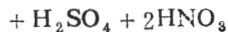
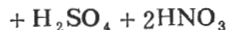
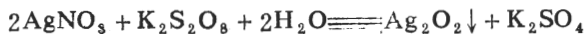
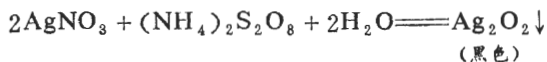


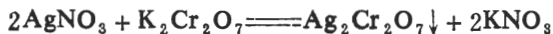
注：用熔化的 AgNO_3 作 HgCl_2 之冻点测定其反应为：



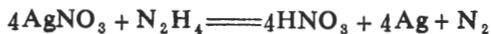
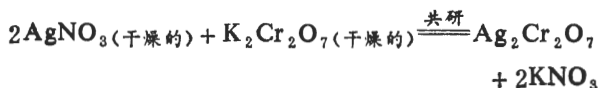
(AgOCN 溶于 HNO_3 和 NH_4OH)



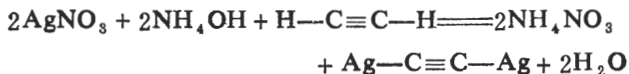
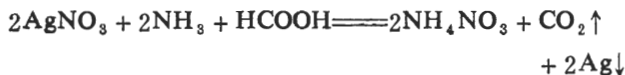
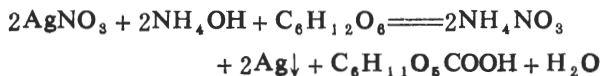
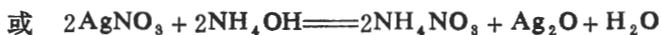
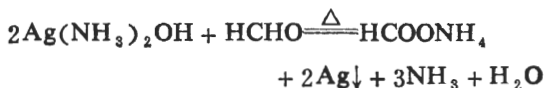
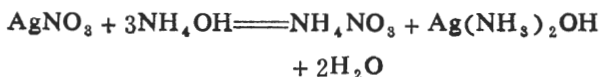




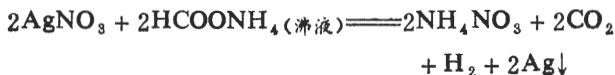
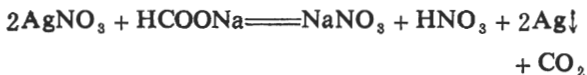
(在明胶溶液中进行反应)

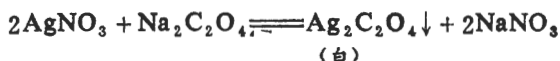


(银镜反应)

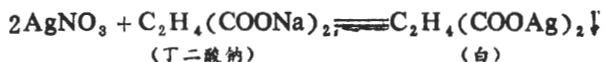


(甲酸钠)





(白)

 (Ag₂C₂O₄易溶于HNO₃或NH₄OH中)


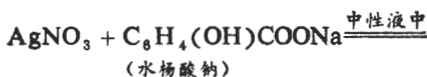
(丁二酸钠)

(白)

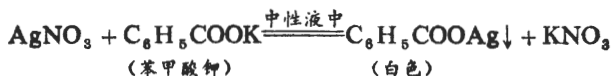
 + 2NaNO₃


(柠檬酸钠)

(白色)

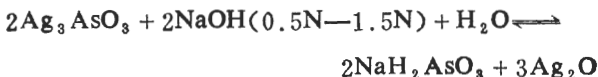
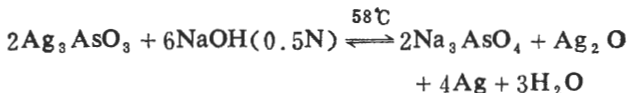
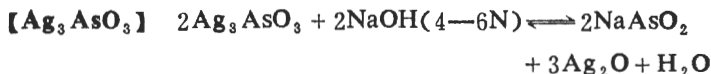
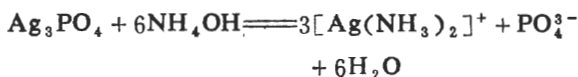
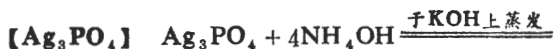


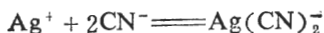
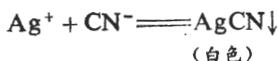
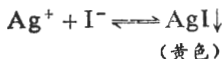
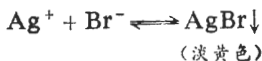
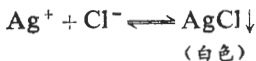
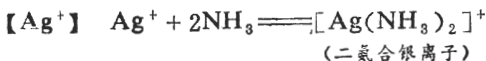
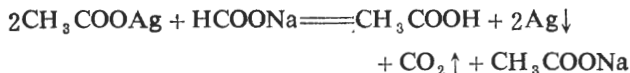
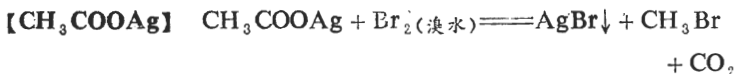
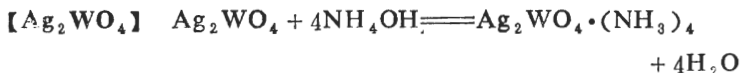
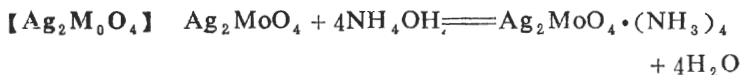
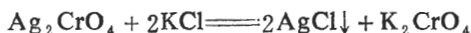
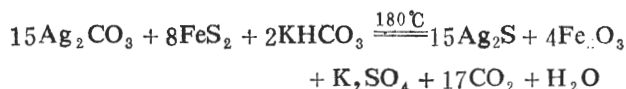
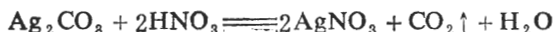
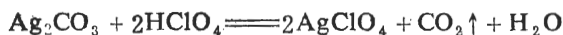
(水杨酸钠)

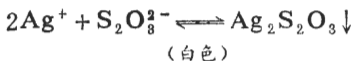
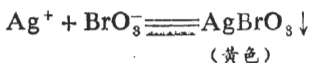
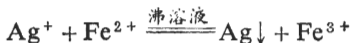
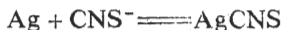


(苯甲酸钾)

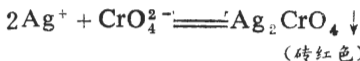
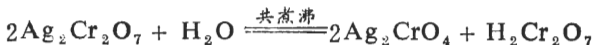
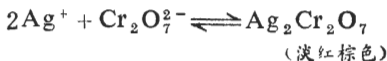
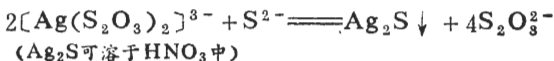
(白色)



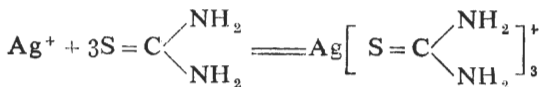
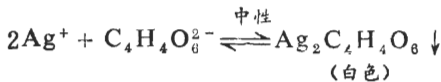


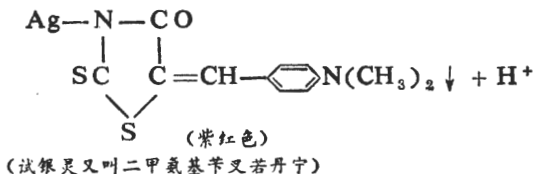
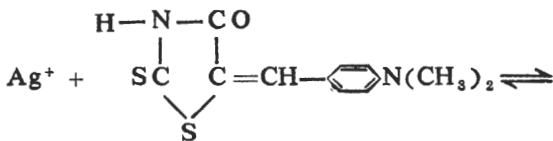
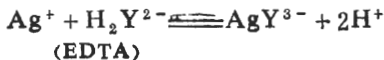


(在过量的 $\text{S}_2\text{O}_3^{2-}$ 中进行的反应)

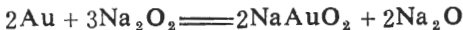
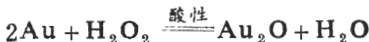
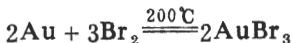
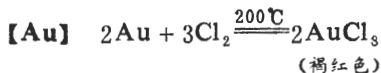


(Ag_2CrO_4 沉淀可溶于 HNO_3 及 NH_4OH 中)

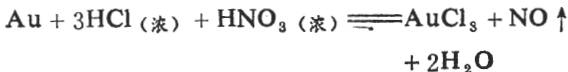
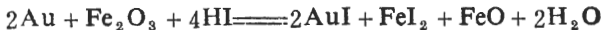




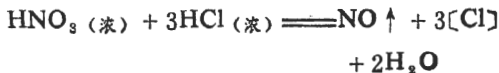
6.3 金 $5d^{10}6s^1$ $\text{Au} = 196.9665$

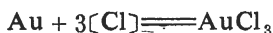


(偏金酸钾)

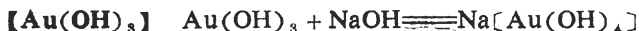
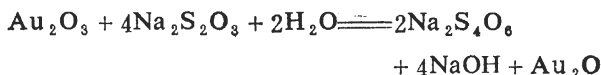
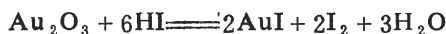
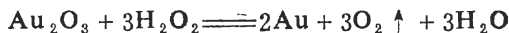
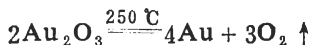
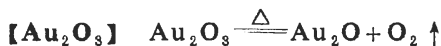
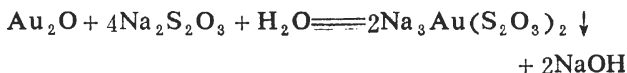
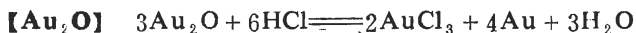
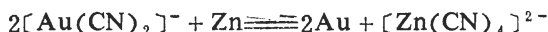
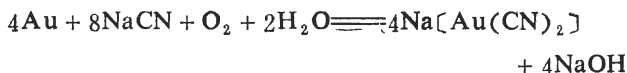
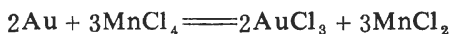
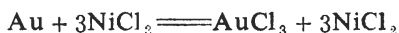
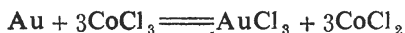
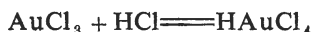
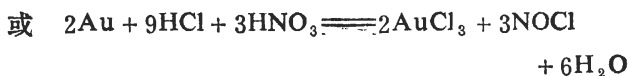
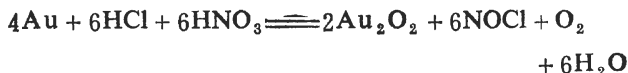


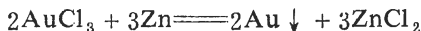
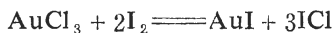
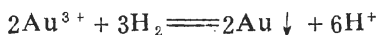
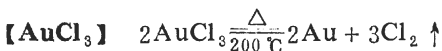
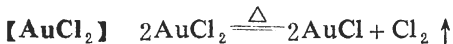
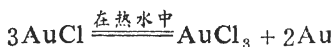
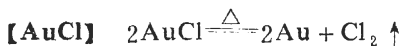
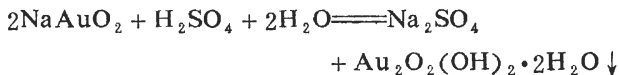
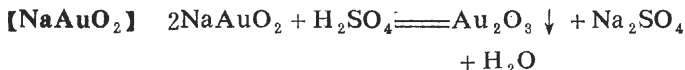
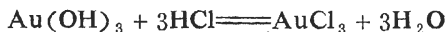
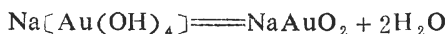
分步反应为:



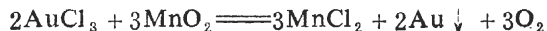
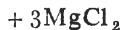
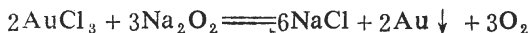
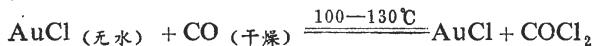
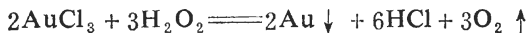


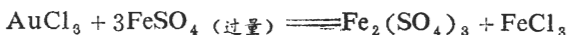
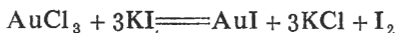
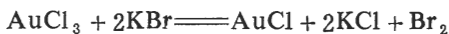
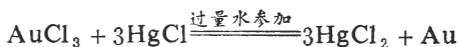
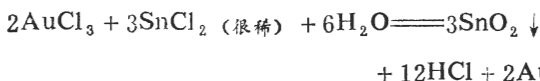
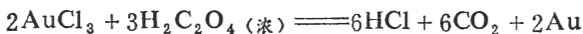
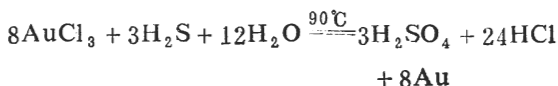
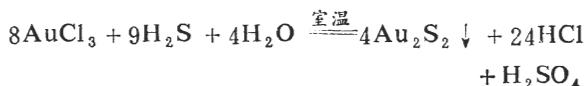
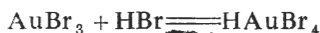
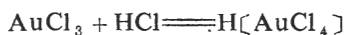
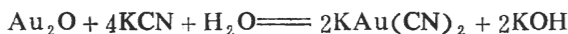
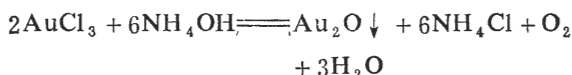
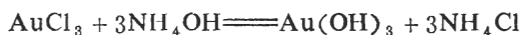
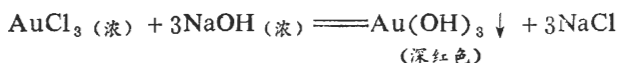
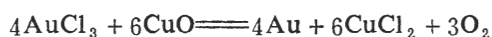
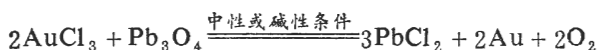
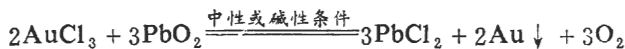
金在王水中不完全溶解时，则有中间产物：

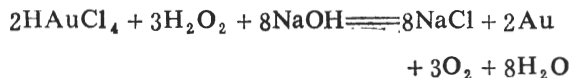
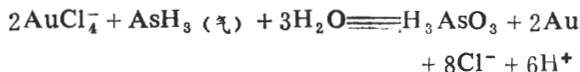
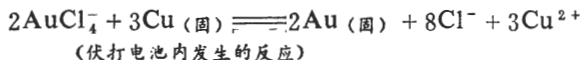
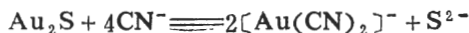
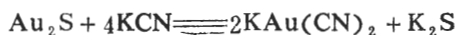
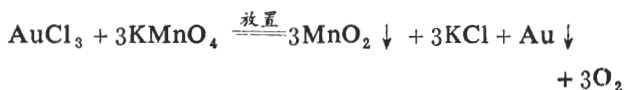
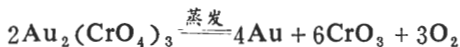
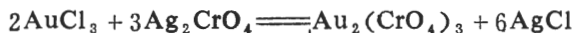
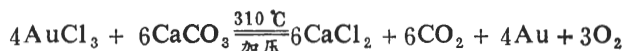
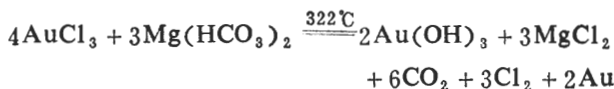
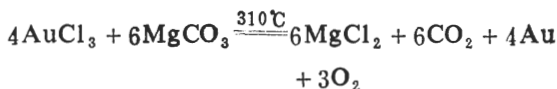
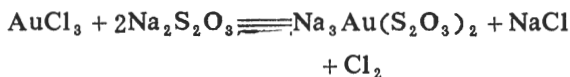


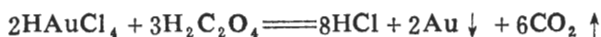


(氧三氯络金酸)

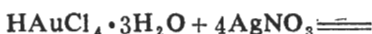




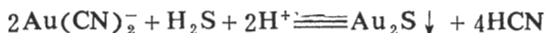
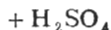
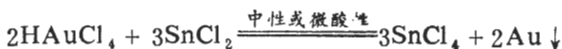
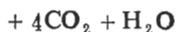


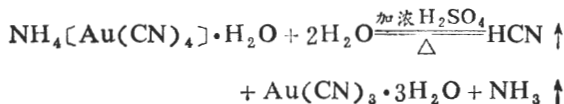
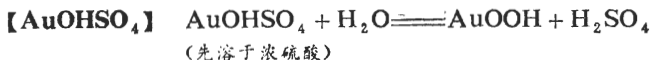
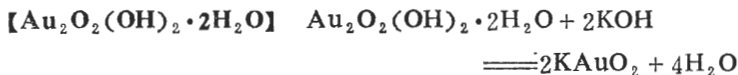
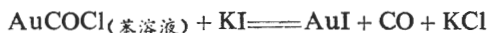
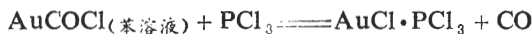
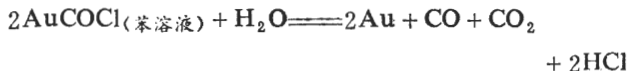
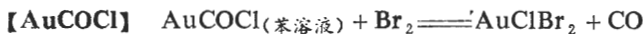
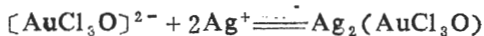


(HAuBr_4 有类似的反应)



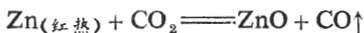
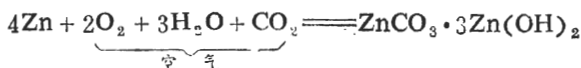
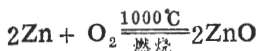
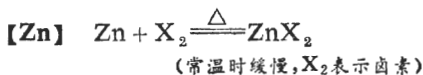
(棕色)



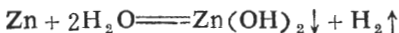


第七章 锌分族

7.1 锌 $3d^{10}4s^2$ $Zn = 65.37$



注: Zn不能和 H_2O 起反应,因生成不溶于水的 $Zn(OH)_2$,阻止反应继续进行,当有碱存在时, $Zn(OH)_2$ 可溶于碱而使Zn继续与 H_2O 反应。

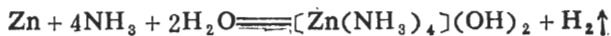




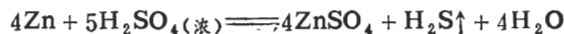
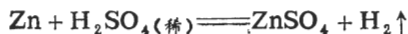
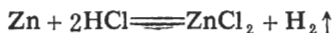
(Al有类似的反应)



(Zn溶于强碱的反应)

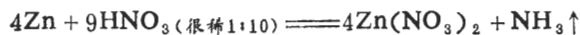
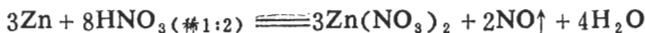


(Al不能发生类似的反应)



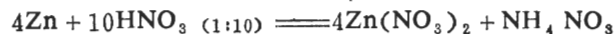
+ 3H₂O

注: Zn与HNO₃反应随反应温度和 HNO₃ 浓度的不同而有不同的产物:

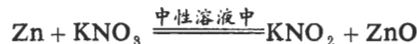
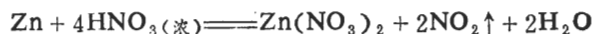


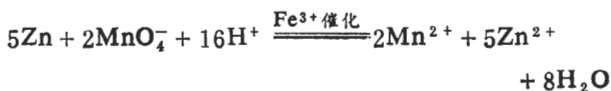
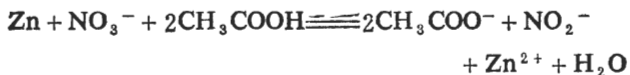
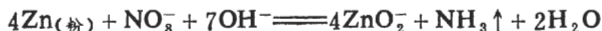
+ 3H₂O

(生成的NH₃可继续被氧化成NH₄NO₃)

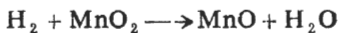
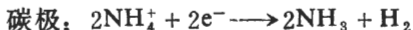


+ 3H₂O

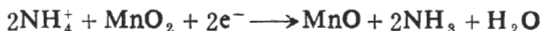




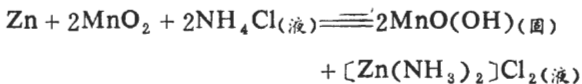
注：干电池使用时的电极反应：



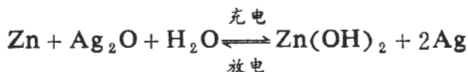
碳极总反应：



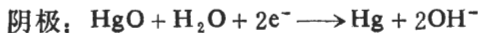
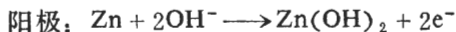
净电池反应：



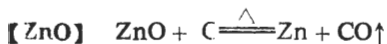
注：银锌蓄电池内的净反应：

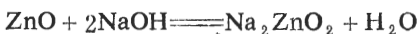
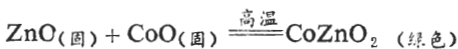
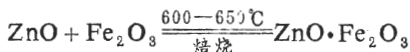


注：罗宾—马洛瑞电池反应：

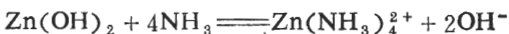
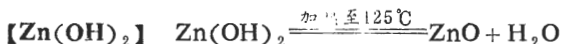


净电池反应：

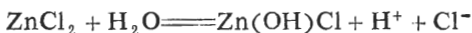
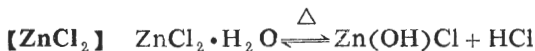
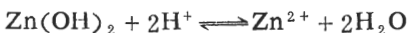
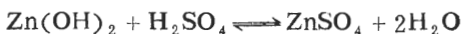
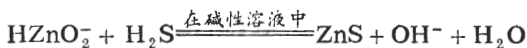
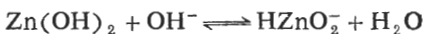
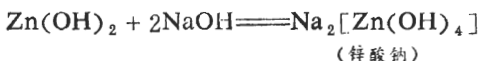
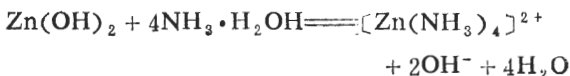
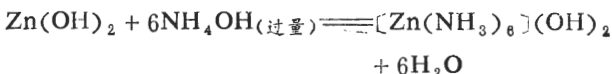




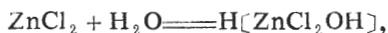
(加稀 H_2SO_4 有类似的反应)



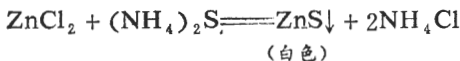
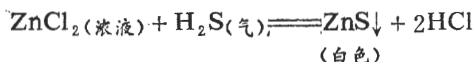
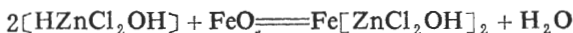
(Al(OH)_3 无此反应)



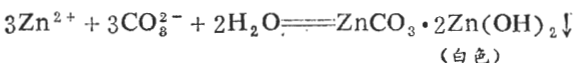
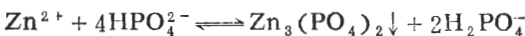
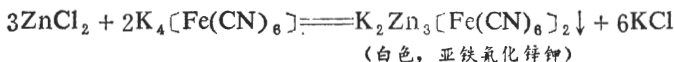
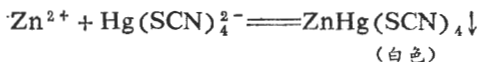
注: ZnCl_2 的浓溶液可形成络合酸, 有酸性:



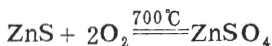
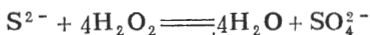
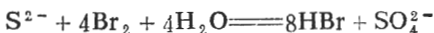
此络合酸能溶解金属氧化物，如焊接时用 ZnCl_2 去氧化物。



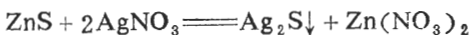
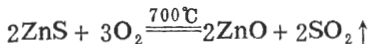
(锌盐的检验方法之一)



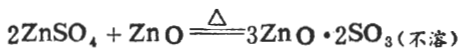
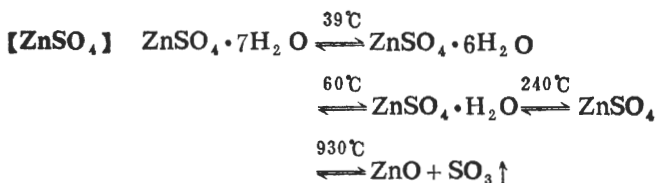
注：ZnS难溶于水，能溶于 H_2O_2 和溴水：



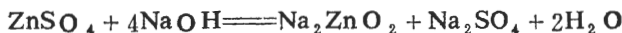
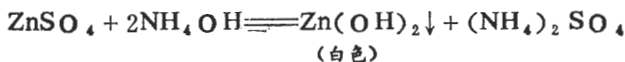
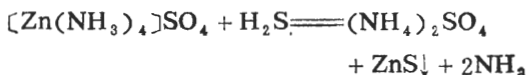
(温度在低度赤热下发生的主要反应)



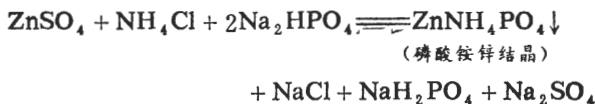
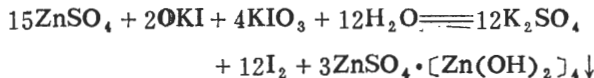
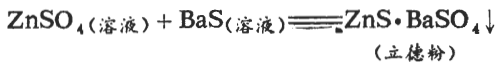
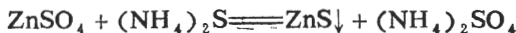
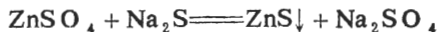
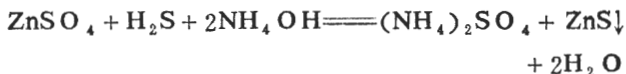
(PH_3 极毒，故 Zn_3P_2 能作杀鼠剂)

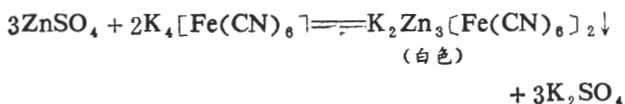
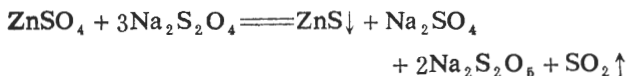
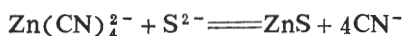
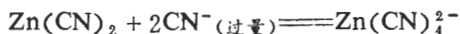
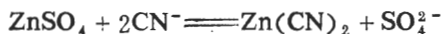


注: ZnSO_4 溶液加浓氨水起初有沉淀, 若继续加氨水沉淀则溶解:

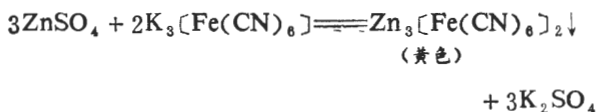
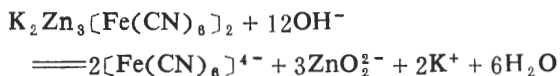


(反应在酸性溶液中进行)

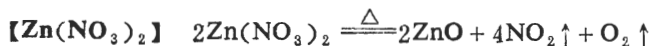
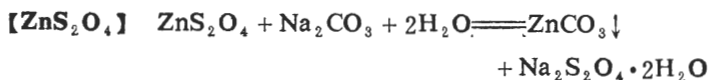
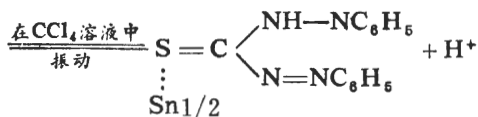
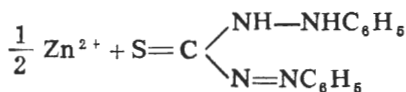
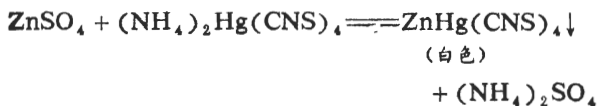


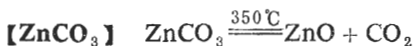
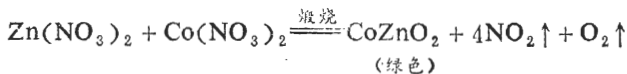


($\text{K}_2\text{Zn}_3[\text{Fe}(\text{CN})_6]_2$ 不溶于酸, 溶于碱)

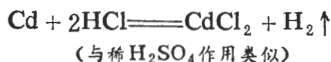


(产物中的沉淀溶于HCl和 NH_4OH)



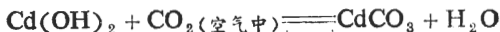
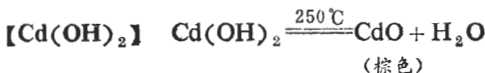
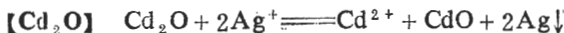
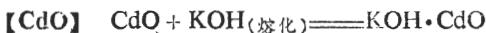


7.2 镉 $4d^{10}5s^2$ $\text{Cd} = 112.40$

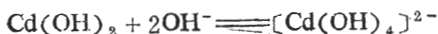
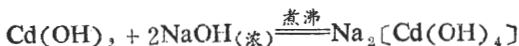


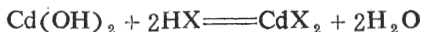
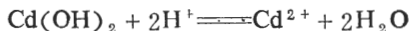
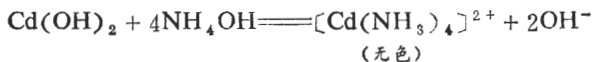
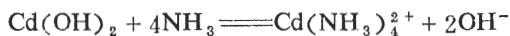
注: Cd和稀 HNO_3 的反应与Zn相似。

Cd与 H_2 、 N_2 不反应。与碱也不起反应。

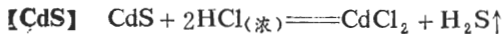
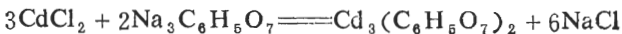
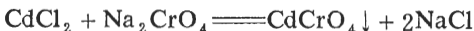
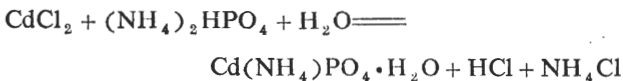
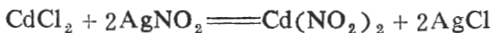
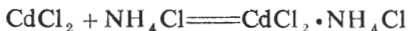
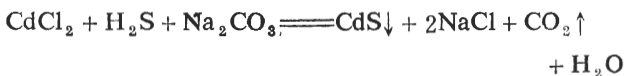
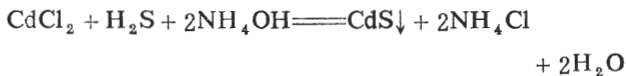
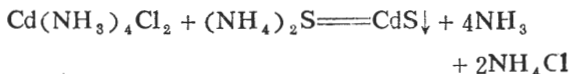
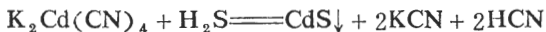
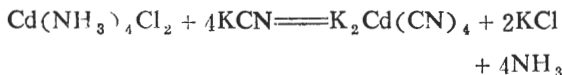
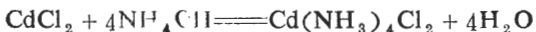
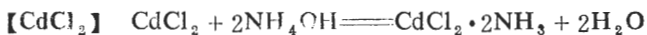
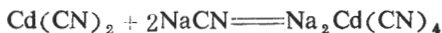
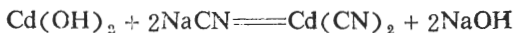


注: Cd(OH)_2 具有两性,但酸性很弱。

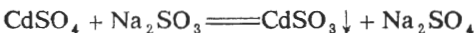
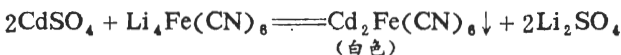
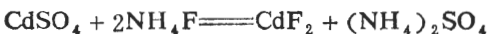
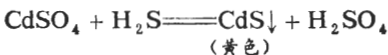
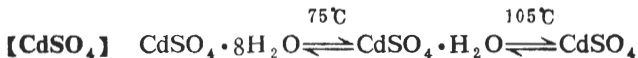
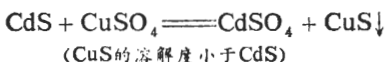
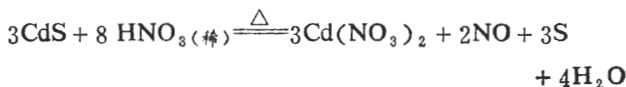




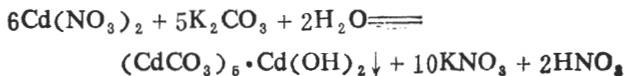
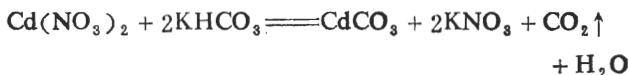
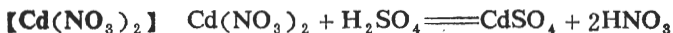
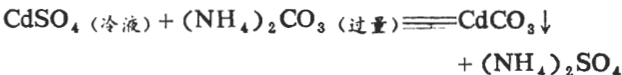
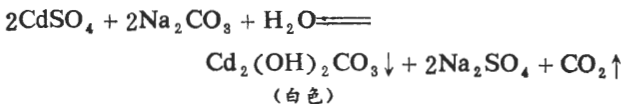
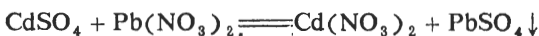
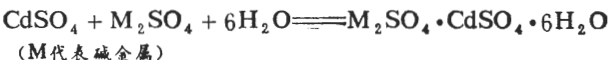
(X = Cl, Br, I)

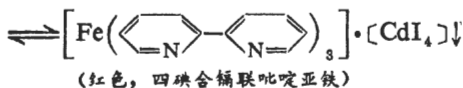
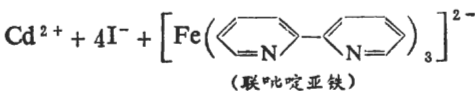
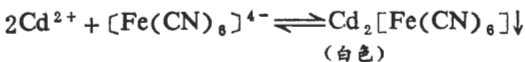
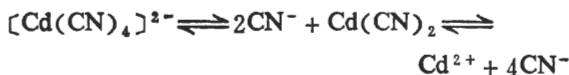
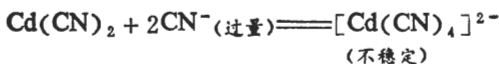
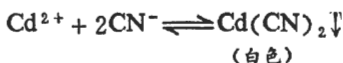
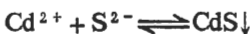
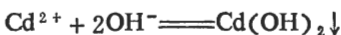
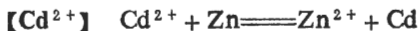
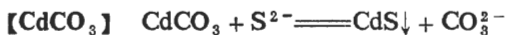
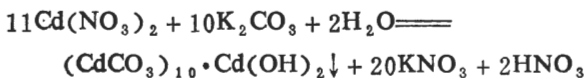


(CdS不溶于稀HCl)

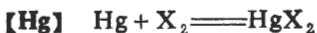


注: CdSO_4 与碱金属硫酸盐(M_2SO_4)形成复盐:

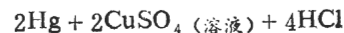
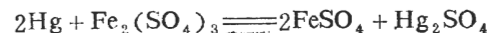
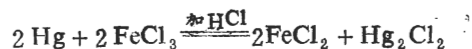
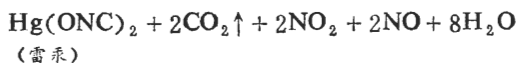
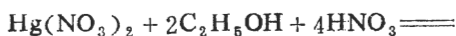
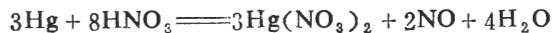
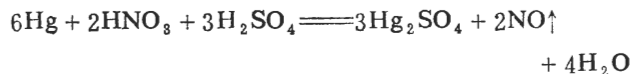
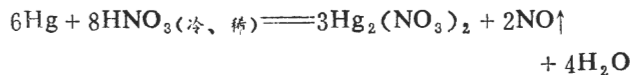
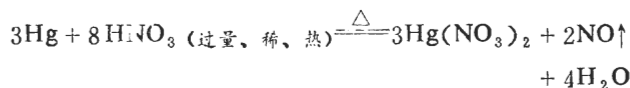
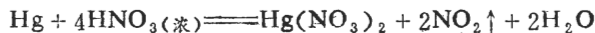
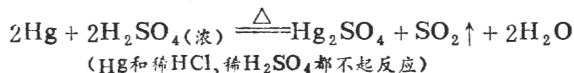
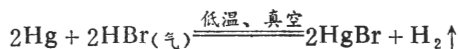
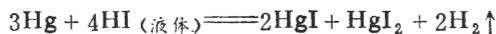
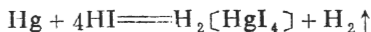
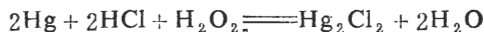
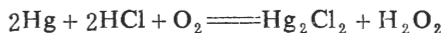
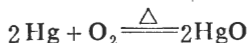
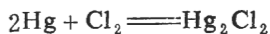


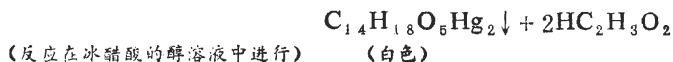
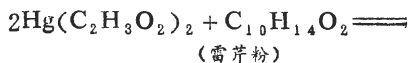
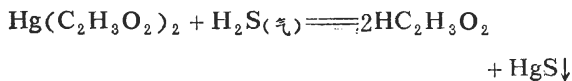
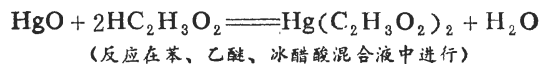
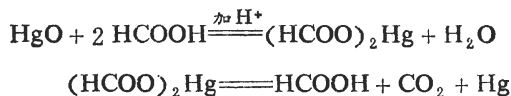
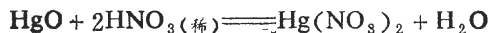
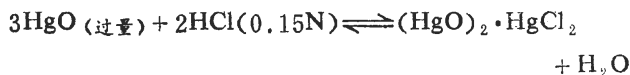
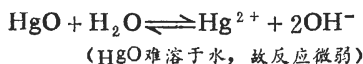
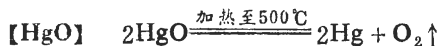
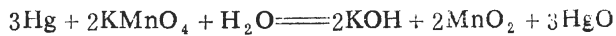
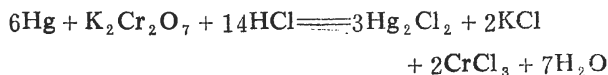
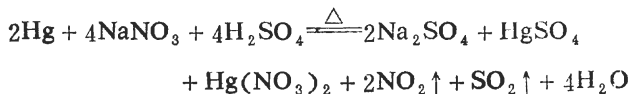
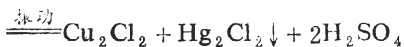


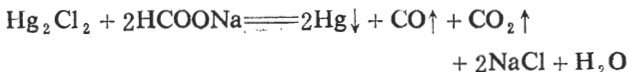
7.3 汞 $5d^{10}6s^2$ $\text{Hg} = 200.59$



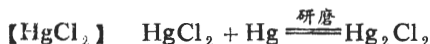
(X代表卤素元素)



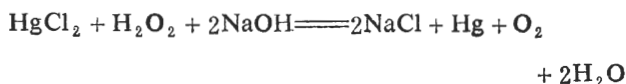
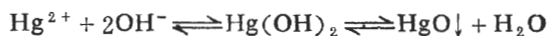
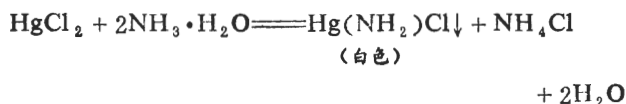
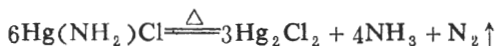
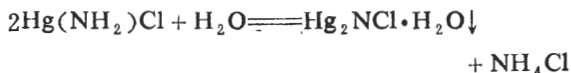
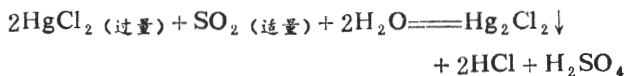
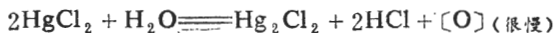




注: Hg_2Cl_2 不溶于水、 HCl 和冷稀 HNO_3 , 可溶于热稀 HNO_3 及王水中。

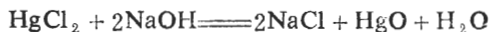


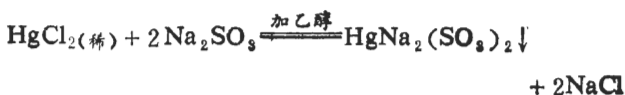
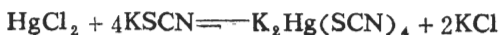
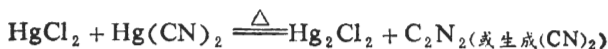
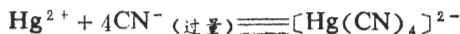
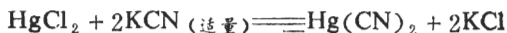
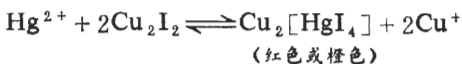
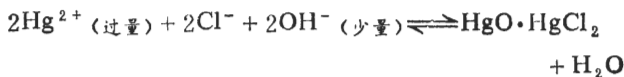
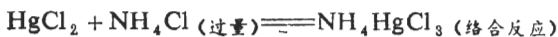
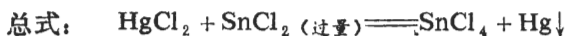
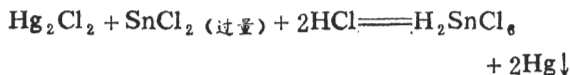
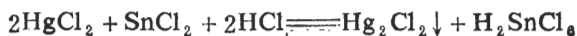
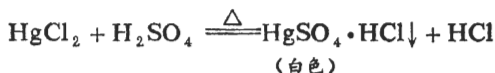
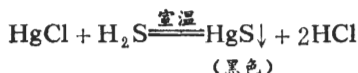
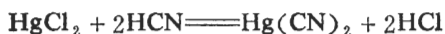
注: 当 HgCl_2 的水溶液暴露在空气中, 发生以下反应:

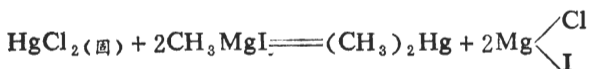
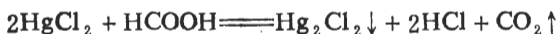
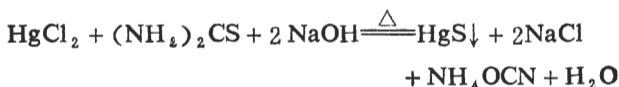
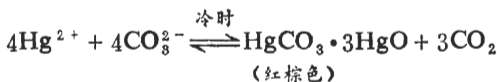
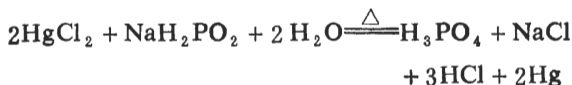
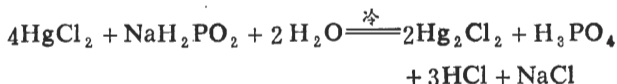
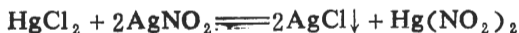


(HgBr 有类似的反应)

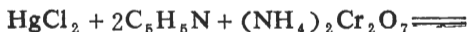
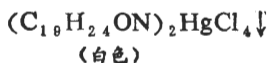
注: HgCl_2 与 NaOH 和甘油的作用如下:



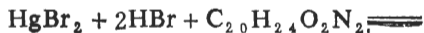
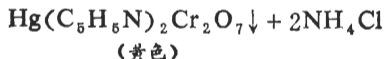




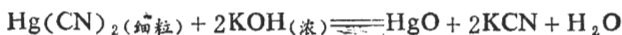
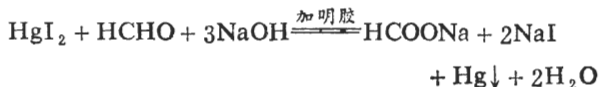
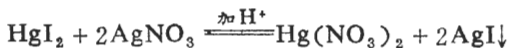
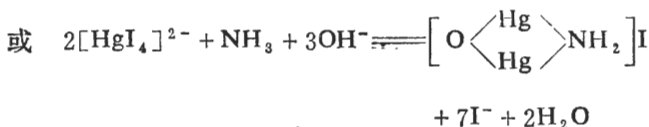
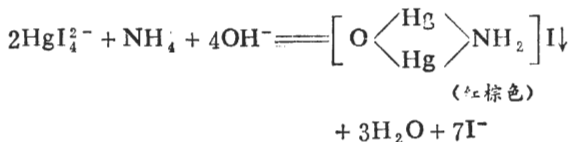
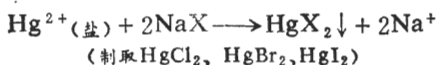
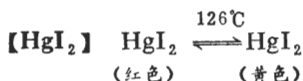
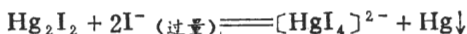
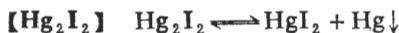
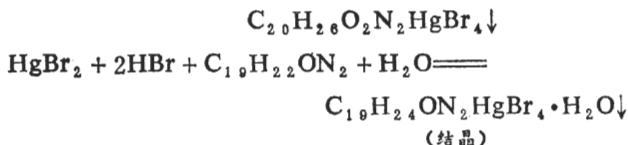
(盐酸桂酰麻黄碱)

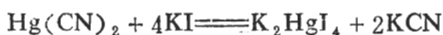
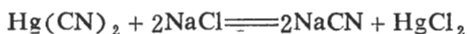
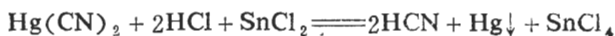
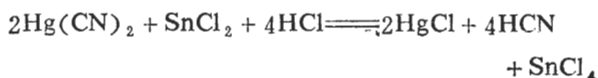
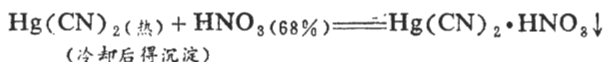
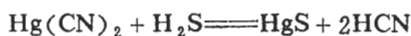


(吡啶)

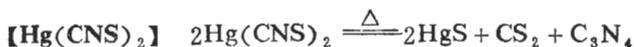
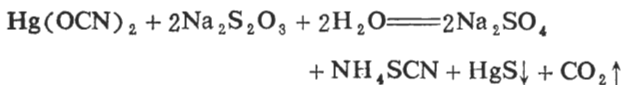
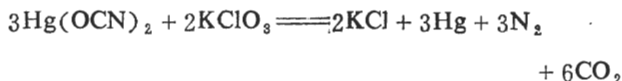
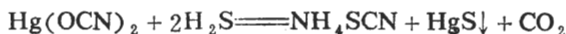
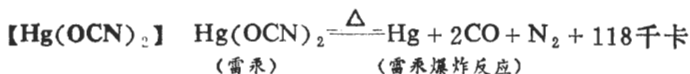
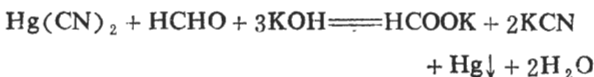
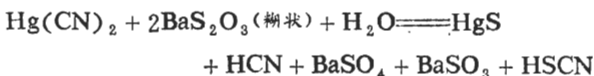
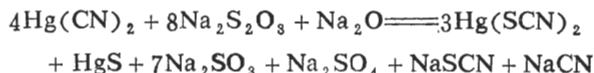
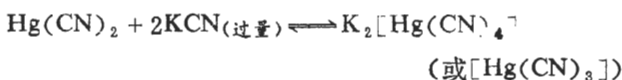


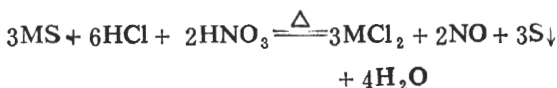
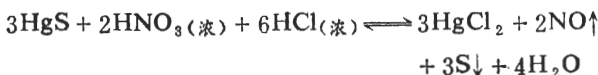
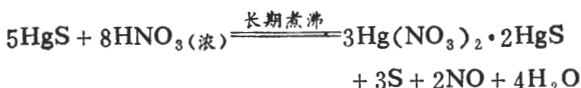
(噻啉)



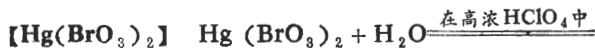
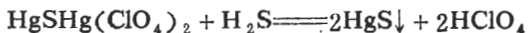
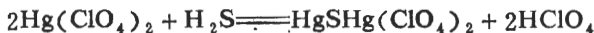
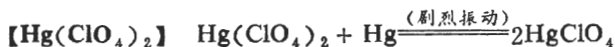
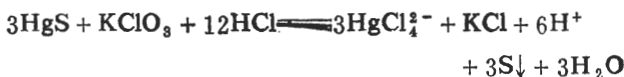
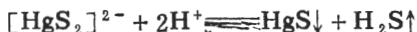
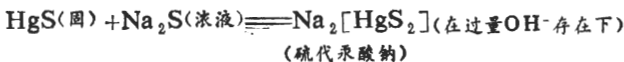
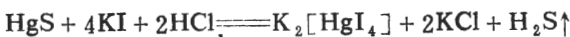


(反应较难进行)

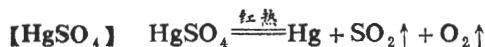


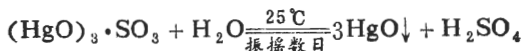
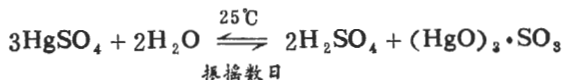
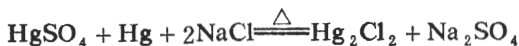
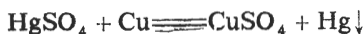


(MS 表示不溶于水的金属硫化物)

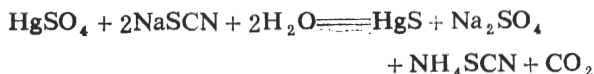
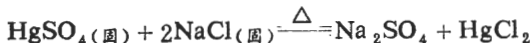
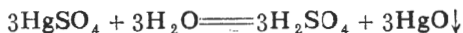


(溴酸羟基汞)

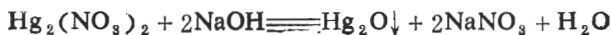
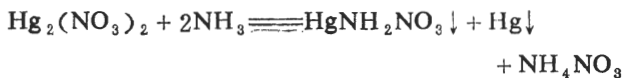
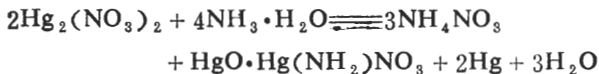
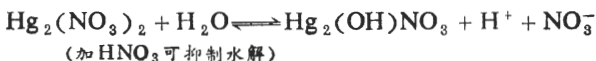
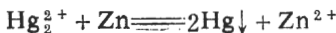


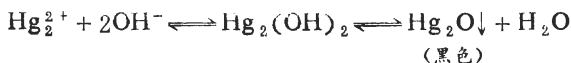


总式:



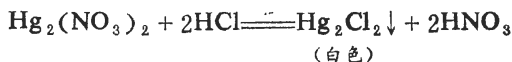
注: 在电位顺序表中, Hg 以前的金属能将亚汞盐中的汞沉淀出来。



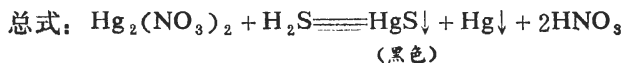
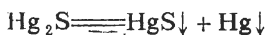


(黑色)

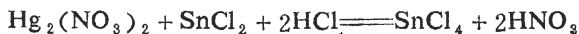
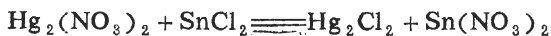
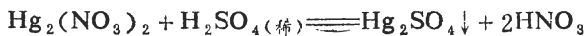
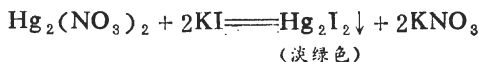
(Hg_2O 不溶于水及碱,但溶于 HNO_3 。 Hg_2O 易分解为 HgO 及 Hg)



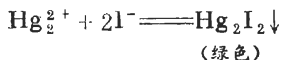
(白色)



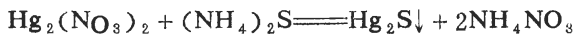
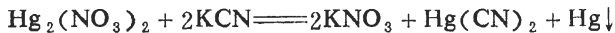
(黑色)

+ 2 $\text{Hg}\downarrow$ 

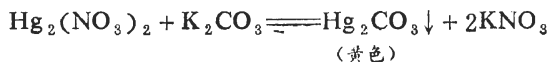
(淡绿色)

(加 KCl 、 KBr 有类似的反应)

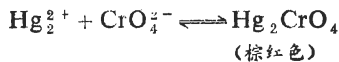
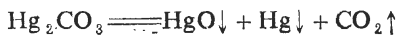
(绿色)



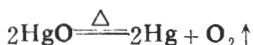
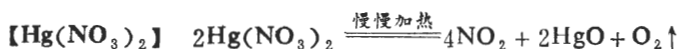
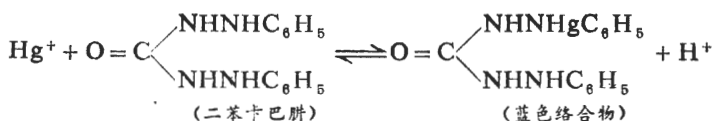
(Hg_2S 不溶于水、 HNO_3 、碱金属氢氧化物及硫化铵。但溶于王水及碱金属多硫化物中)



(黄色)



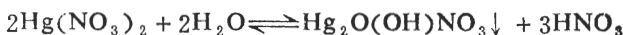
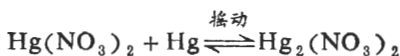
(棕红色)



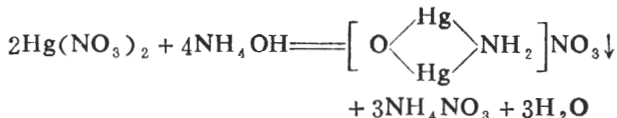
(Sn、Pb等均可发生类似的反应)



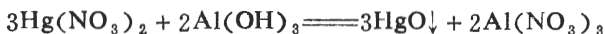
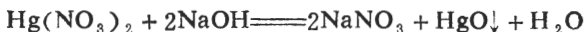
(使铜片产生灰色斑点)



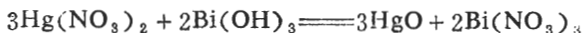
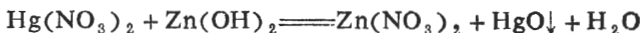
(所以配制 $\text{Hg(NO}_3)_2$ 溶液时, 应加 HNO_3 防止水解产生沉淀)



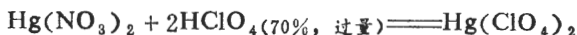
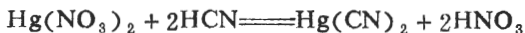
(沉淀溶解于过量的氨水和 NH_4Cl 中)



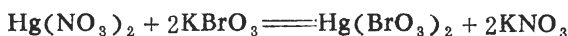
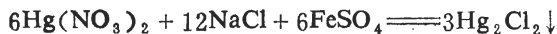
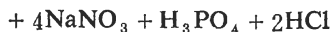
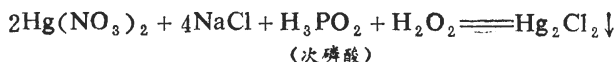
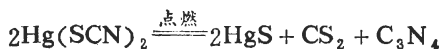
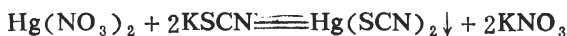
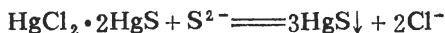
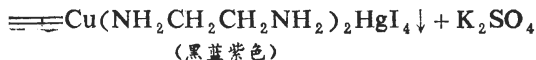
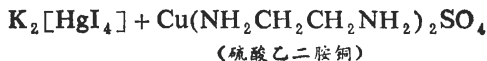
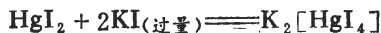
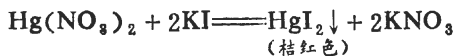
+ $3\text{H}_2\text{O}$



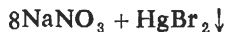
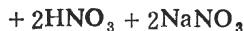
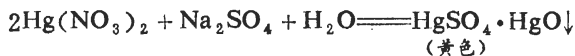
+ $3\text{H}_2\text{O}$



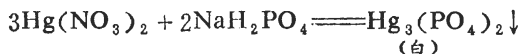
+ 2HNO_3

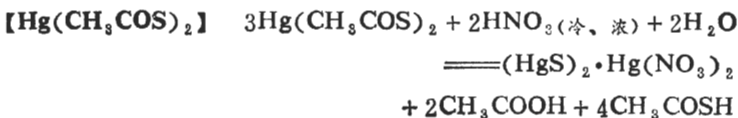
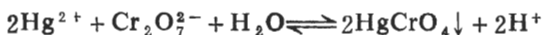
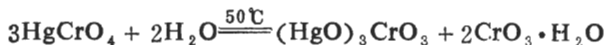
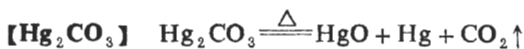
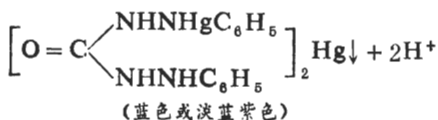
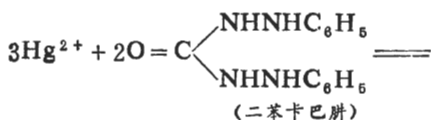
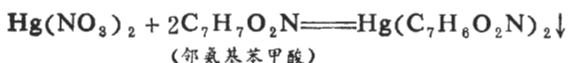
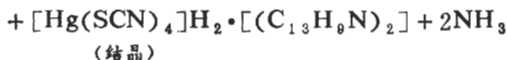
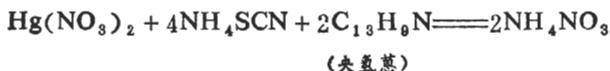
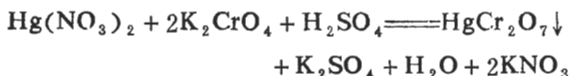


(在 HNO_3 存在下进行反应)



(在 HNO_3 存在下进行反应)

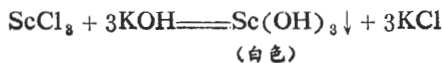
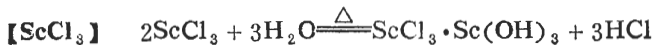
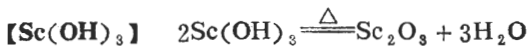
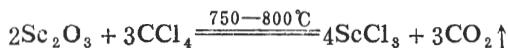
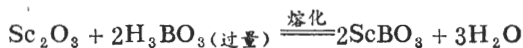
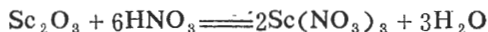
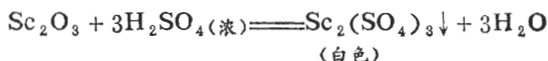
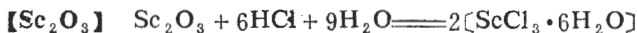


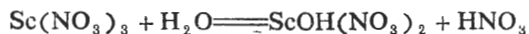
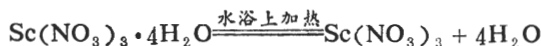
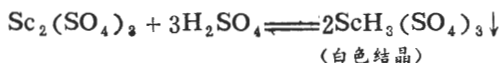
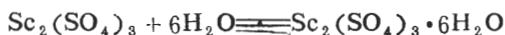
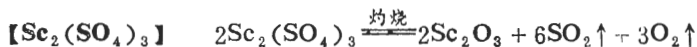
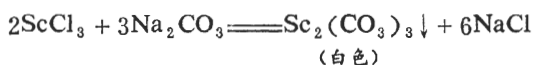
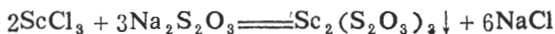
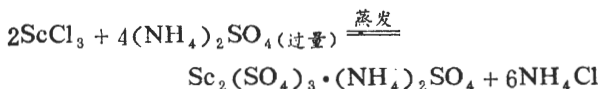
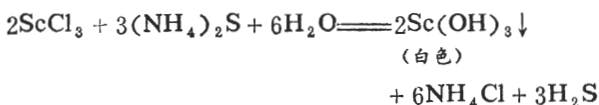
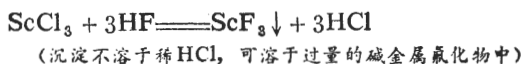
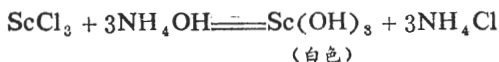
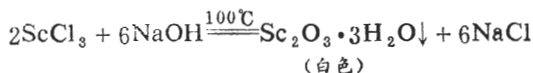


第八章 钪 分 族

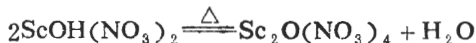
8. 1 钪 $3d^1 4s^2$ Sc = 44.9559

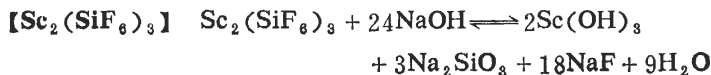
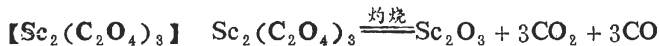
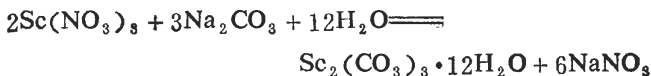
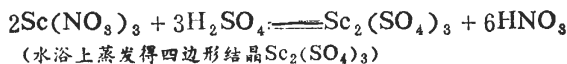
钪是第一稀土系(包括钪、钇、镧及镧系中15个元素)中的代表元素,对于稀土元素的单质应用较少,因为它们的化学性质较活泼,如它们在空气中很快被氧化,能与水作用放出 H_2 ,易与酸作用,是强还原剂,所以,不论是它们的存在及应用,都是以化合物形式出现。



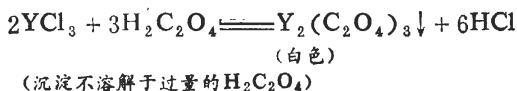
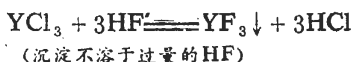
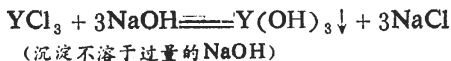
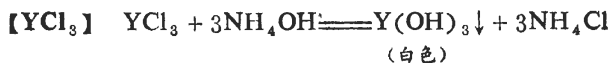


(在100℃真空情况加热16小时)

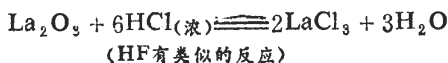
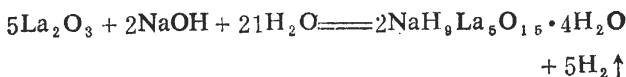
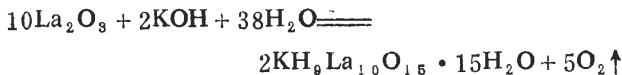
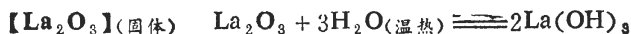


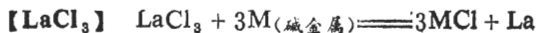
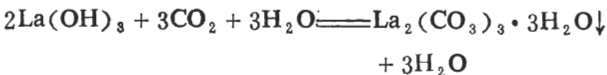
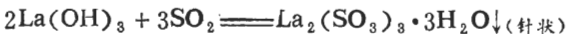
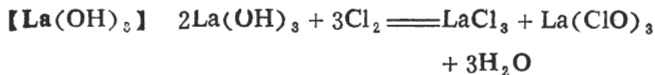
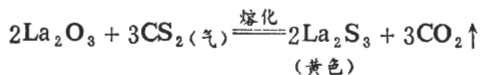
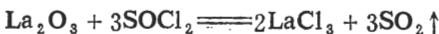
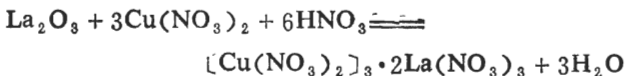
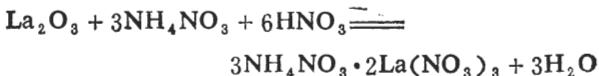
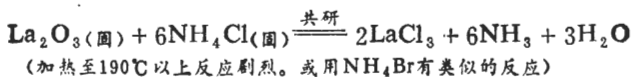
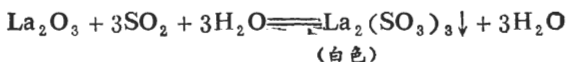
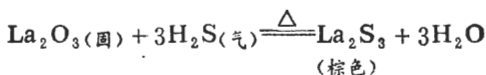
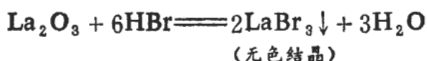


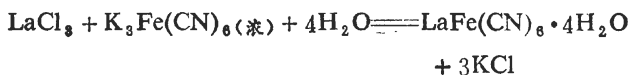
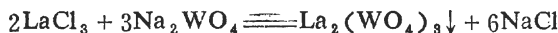
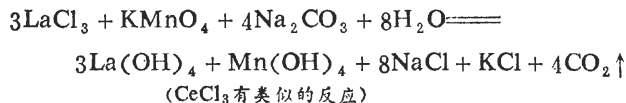
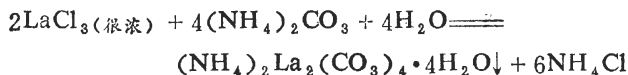
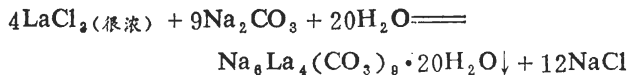
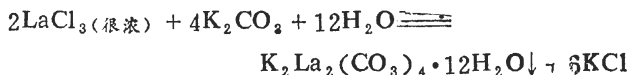
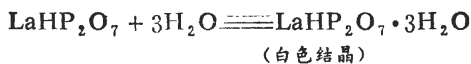
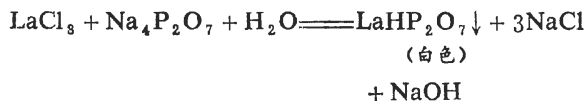
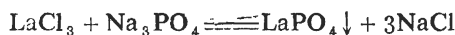
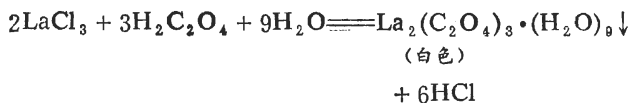
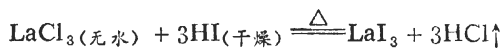
8.2 钇 $4d^1 5s^2 \quad Y = 88.9059$



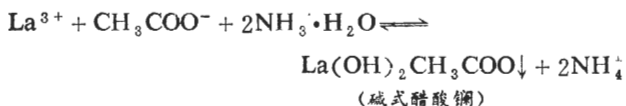
8.3 镧 $5d^1 6s^2 \quad \text{La} = 138.9055$





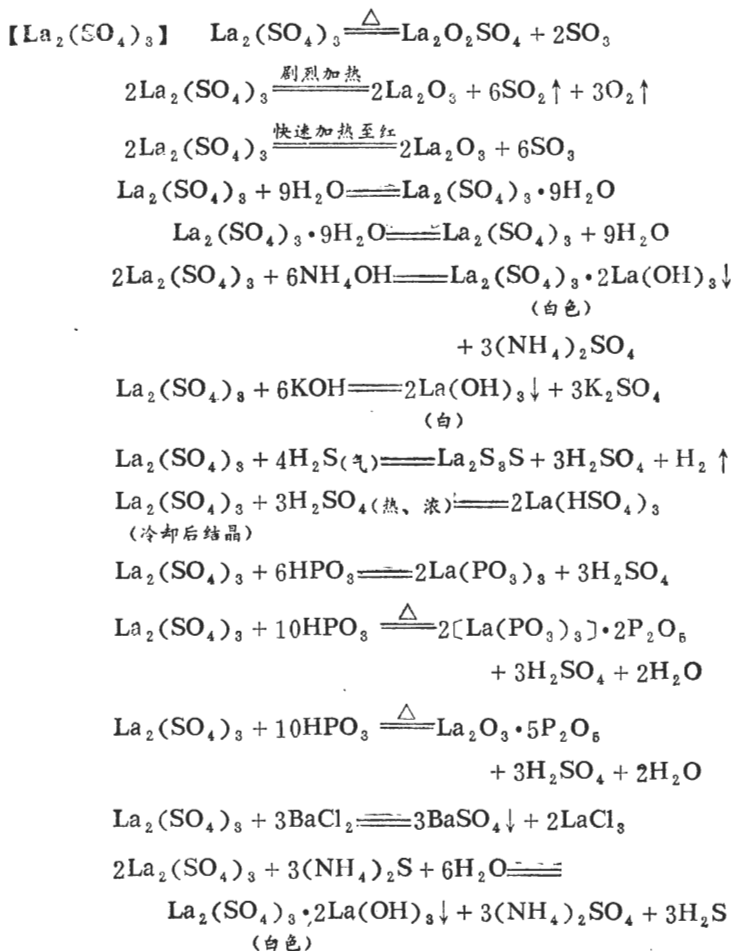


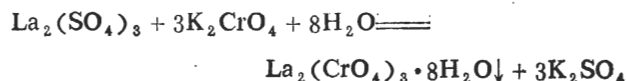
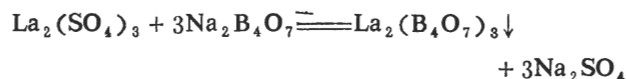
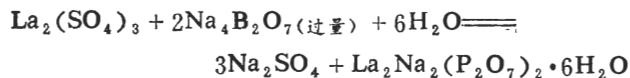
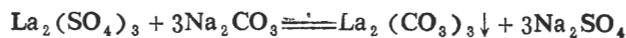
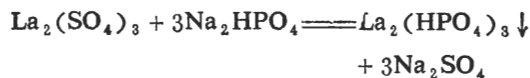
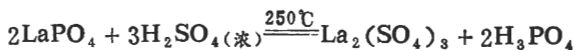
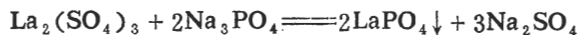
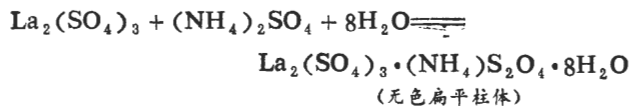
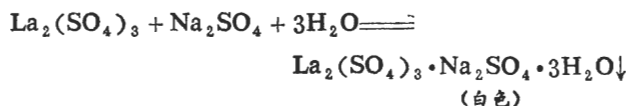
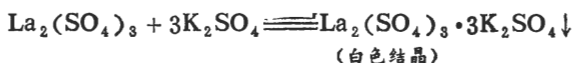
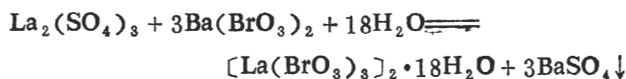
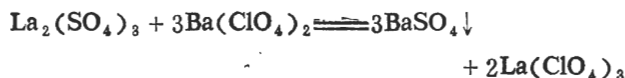
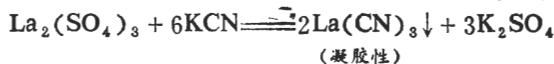
注：\text{La}^{3+} 的鉴定反应：

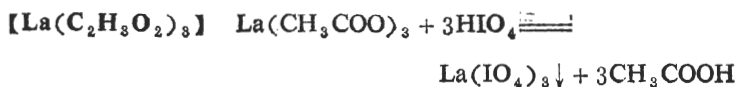
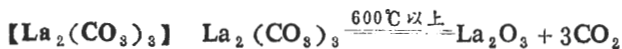
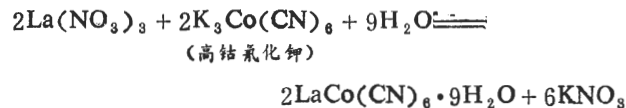
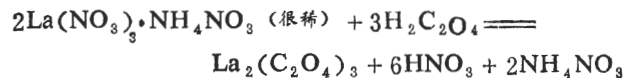
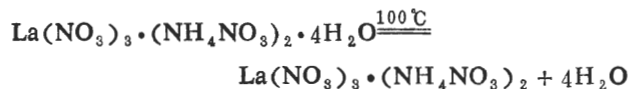
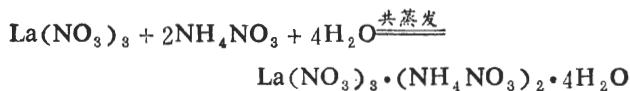
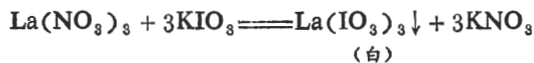
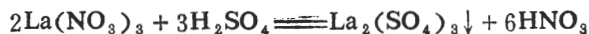
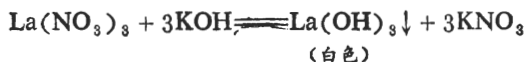
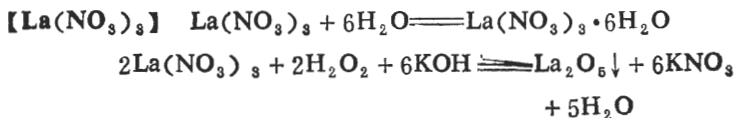
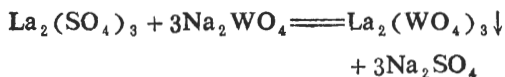
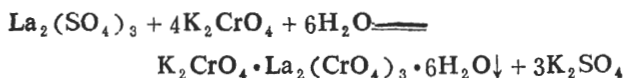


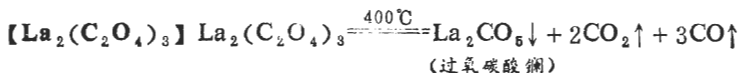
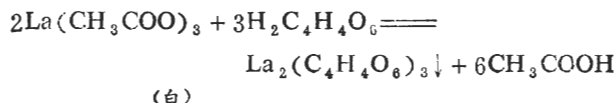
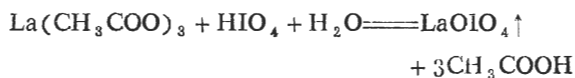
(碱式醋酸铜能吸附 I_2 而显蓝色。此反应亦可用未检验 CH_3COO^- 。

但 SO_4^{2-} 、 PO_4^{3-} 、 F^- 及 BO_2^- 有干扰，可用 Ba^{2+} 沉淀除去。

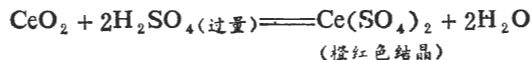
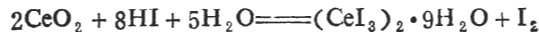
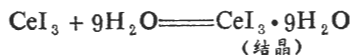
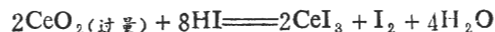
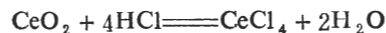
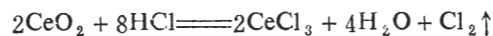
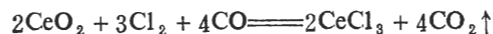
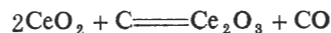
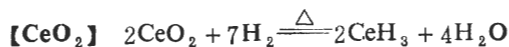
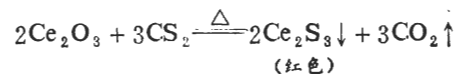
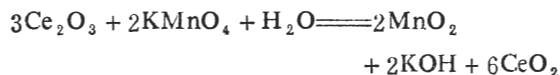
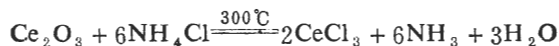
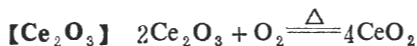


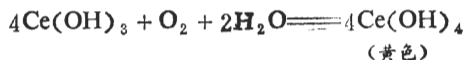
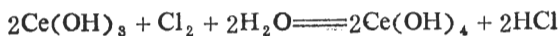
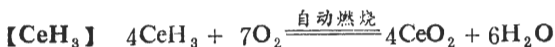
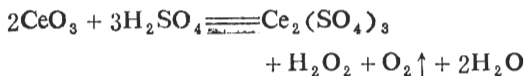
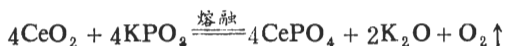
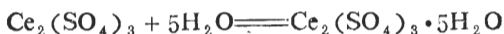
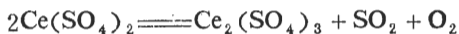
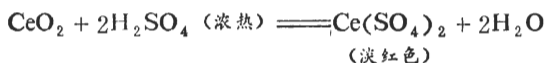
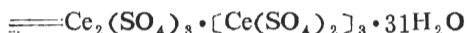
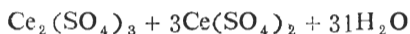
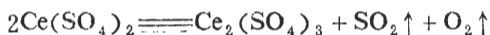


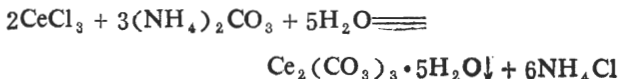
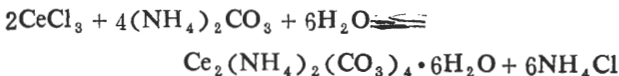
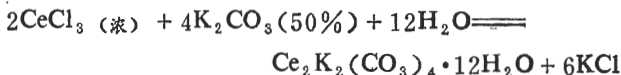
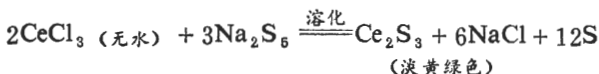
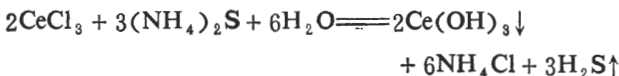
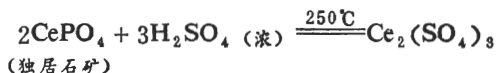
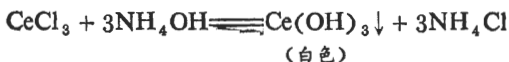
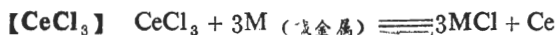
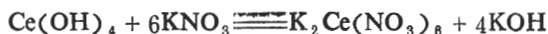
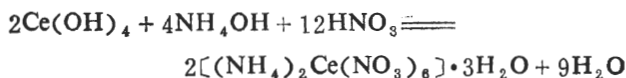
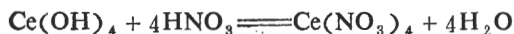
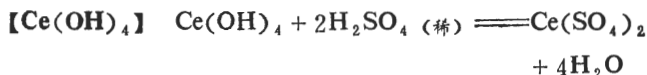
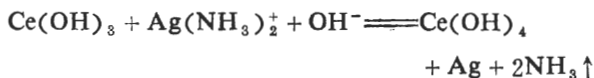


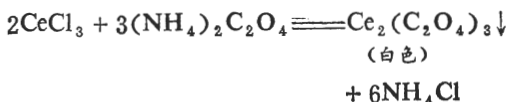
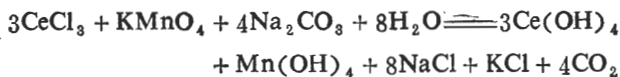


8.4 铈 $4f^15d^16s^2$ $\text{Ce} = 740.13$

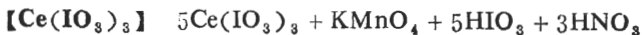
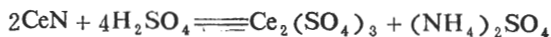
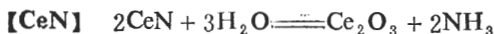
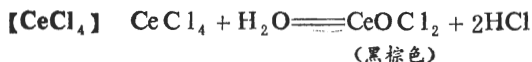
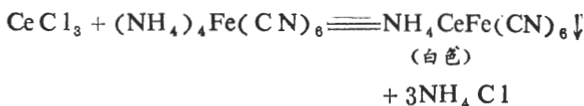
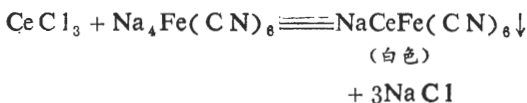
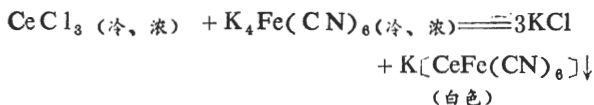
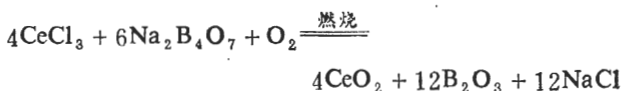
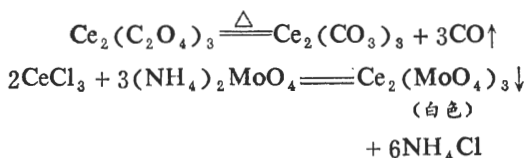
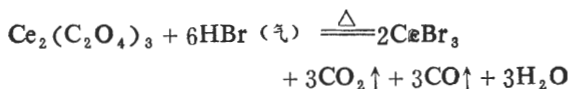


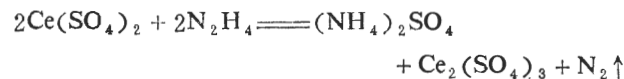
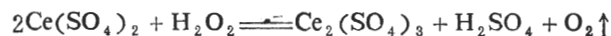
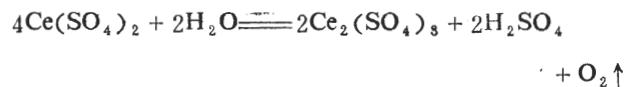
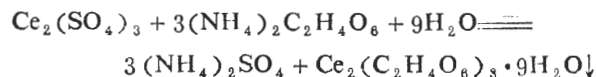
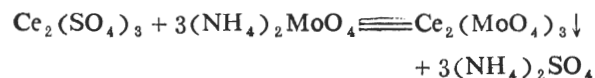
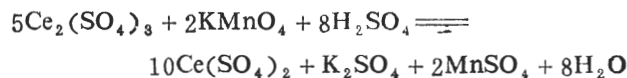
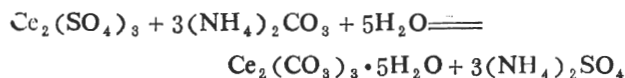
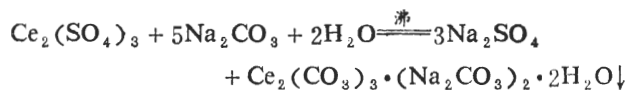
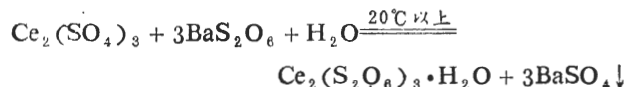
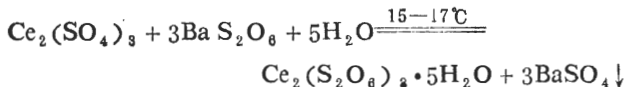
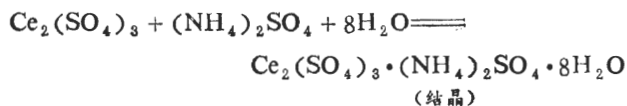
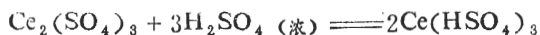


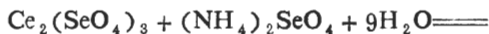
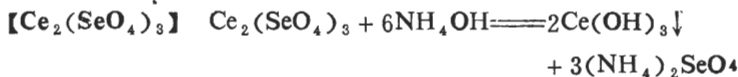
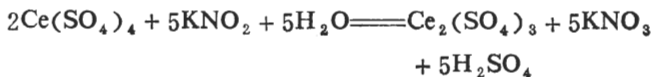
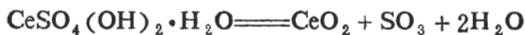
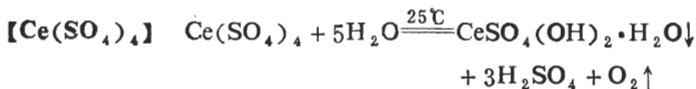
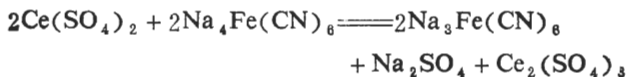
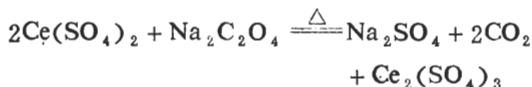
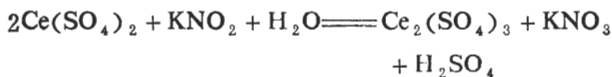
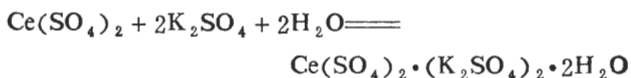
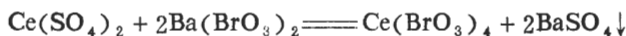
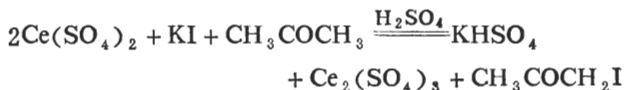
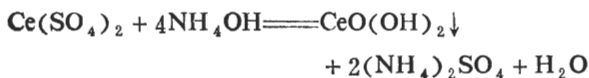


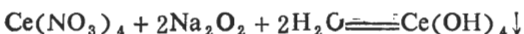
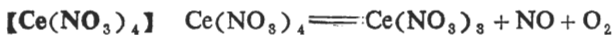
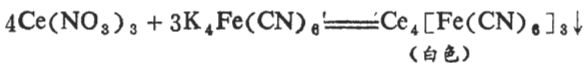
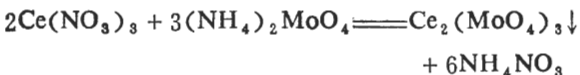
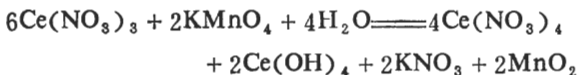
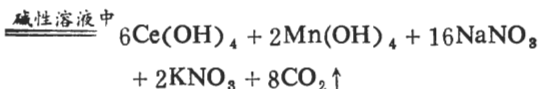
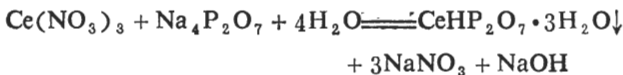
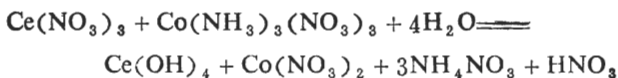
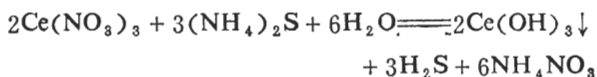
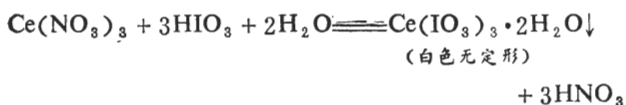
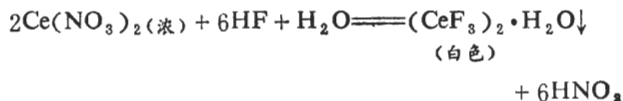


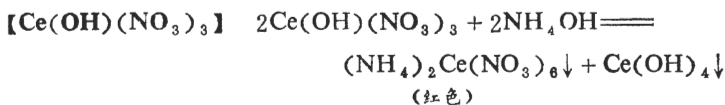
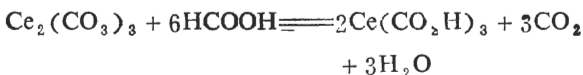
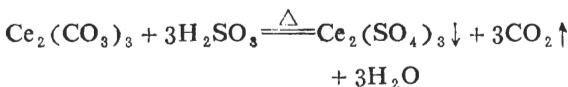
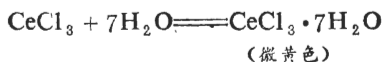
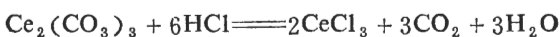
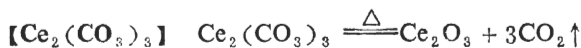
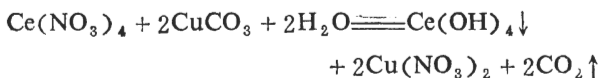
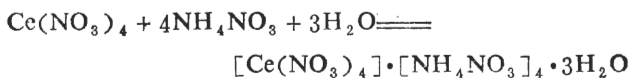
(与 $\text{H}_2\text{C}_2\text{O}_4$ 有类似的反应)











注：1. 铈盐与 $\text{Na}_2\text{S}_2\text{O}_3$ 溶液不发生沉淀；

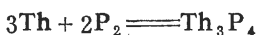
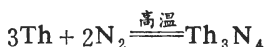
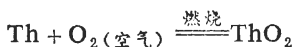
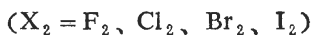
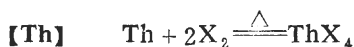
2. 铈盐与 K_2SO_4 的饱和溶液作用，有白色 $\text{Ce}(\text{SO}_3)_3 \cdot 3\text{K}_2\text{SO}_4$ 沉淀生成；

3. 铈盐与 H_2O_2 作用，生成黄色的 $\text{Ce}(\text{OH})_3\text{O} \cdot \text{OH}$ 或 $\text{CeO}_3 \cdot 2\text{H}_2\text{O}$ 沉淀；

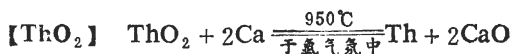
4. 铈盐与 $(\text{NH}_4)_2\text{CO}_3$ 溶液作用，生成白色的 $\text{Ce}_2(\text{CO}_3)_3$ 沉淀；

5. 铈盐与 NH_4F 作用时，生成 CeF_3 白色沉淀；

6. 铈盐与 KIO_3 溶液作用时，生成白色的 $\text{Ce}(\text{IO}_3)_3$ 沉淀。

8.5 钍 $6d^2 7s^2$ Th = 232.0381

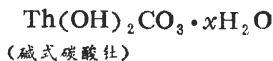
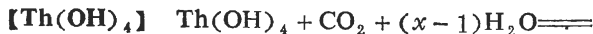
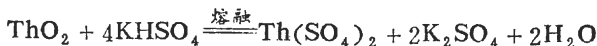
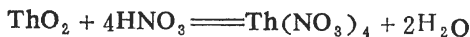
注: HX、稀 H_2SO_4 与Th作用, 放出氢气。浓 HNO_3 使Th钝化, Th易溶于浓的HCl和王水。Th和强碱无作用。



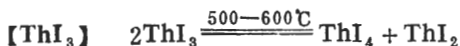
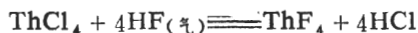
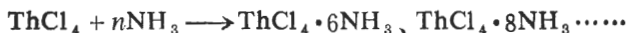
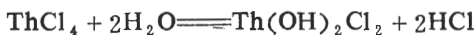
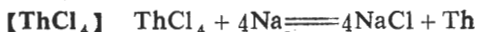
(用于制取Th)



注: ThO_2 是一种很稳定的物质, 不溶于水、稀酸和稀碱。



($\text{Th}(\text{OH})_4$ 不溶于碱)



注：1. 钍盐与 NH_3 、 $(\text{NH}_4)_2\text{S}$ 、 NaOH 等作用时，均有白色 $(\text{Th}(\text{OH})_4$ 或 $\text{ThO}_2 \cdot n\text{H}_2\text{O})$ 沉淀生成；

2. 钍盐与 Na_2CO_3 或 $(\text{NH}_4)_2\text{CO}_3$ 溶液作用时，有白色碱式碳酸钍沉淀生成；

3. 钍盐与草酸或草酸铵溶液作用时，有白色结晶 $\text{Th}(\text{C}_2\text{O}_4)_2 \cdot (\text{H}_2\text{O})$ 生成；

4. 钍盐与 K_2SO_4 饱和溶液作用时，生成白色络盐沉淀 $\text{K}_4\text{Th}(\text{SO}_4)_4 \cdot 2\text{H}_2\text{O}$ ；

5. H_2O_2 与钍作用，生成水合过氧化钍沉淀 $\text{ThO}_3 \cdot 3\text{H}_2\text{O}$ 、 $\text{Th}(\text{OH})_3\text{OH}$ 、 $\text{Th}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$

6. 钍盐与 KIO_3 溶液作用，生成白色沉淀 $\text{Th}(\text{IO}_3)_4$ ；

7. 钍盐与 $\text{Na}_2\text{S}_2\text{O}_3$ 溶液作用，生成 $\text{Th}(\text{S}_2\text{O}_3)_2$ ；

8. 钍盐与 $\text{K}_4\text{Fe}(\text{CN})_6$ 溶液作用，生成白色 $\text{Th}[\text{Fe}(\text{CN})_6]$ 沉淀。

8.6 铀 $5f^3 6d^1 7s^2 \quad U = 238.029$

铀是一种银白色的金属，相当软，比重很大（比重为18.7），在 1133°C 时熔化，化学性质活泼，在室温下会氧化，

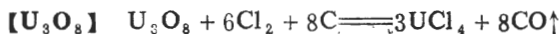
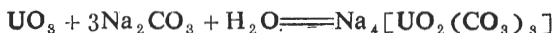
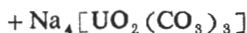
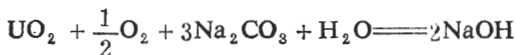
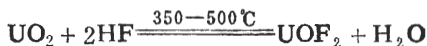
粉末铀有可燃性，块状铀可与沸水作用。



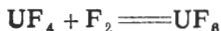
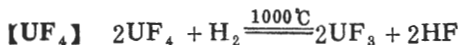
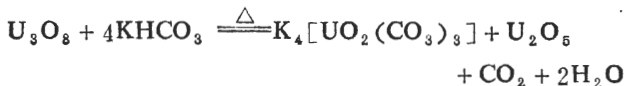
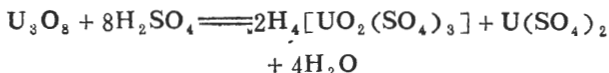
(U与Cl₂、Br₂、I₂反应时，需加热。加热时U还能与其他非金属反应。)

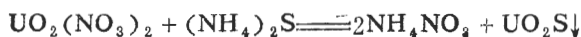
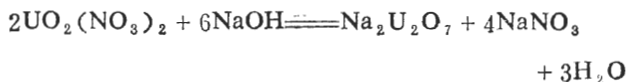
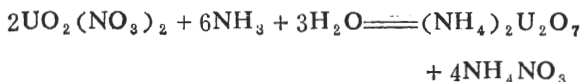
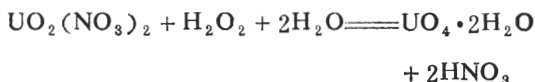
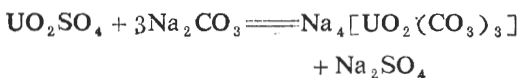
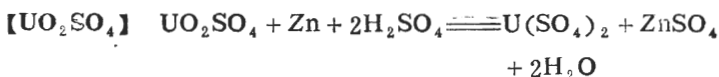
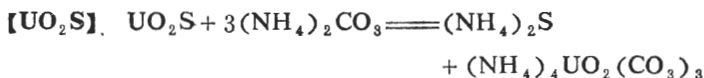
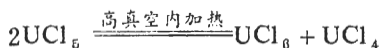
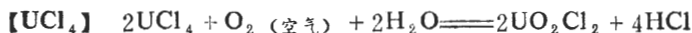
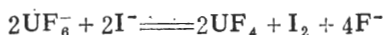
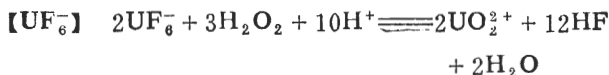
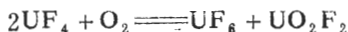


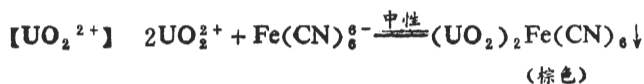
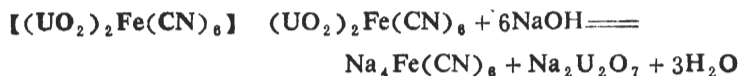
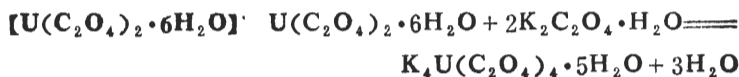
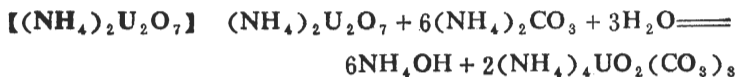
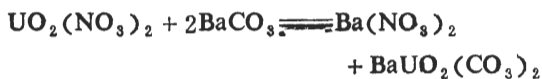
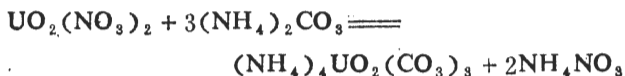
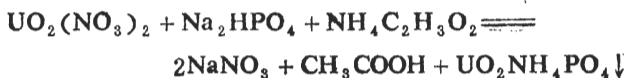
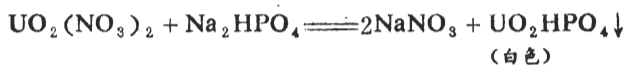
注：铀能溶于稀酸(稀H₂SO₄除外)，与强碱作用很微弱。铀是一种强还原剂，可以从许多金属的盐溶液中将它们置换出来如Sn、Cu、Ag、Hg等。



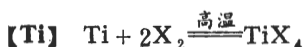
(暗绿色)



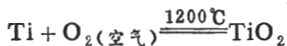
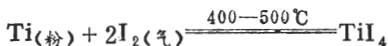




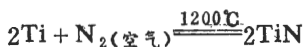
第九章 钛分族

9.1 钛 $3d^2 4s^2$ Ti = 47.90

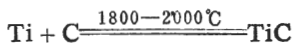
(Ti与F₂反应为150℃, 与Cl₂反应为300℃才能进行)



(在纯氧气中需加热至600℃才能反应)

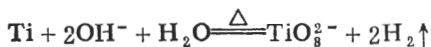


(在纯N₂中800℃就反应)



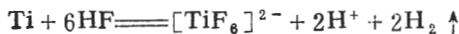
(黑色)

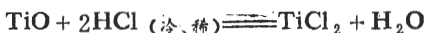
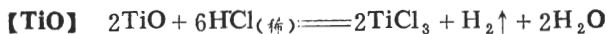
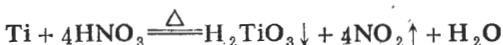
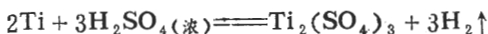
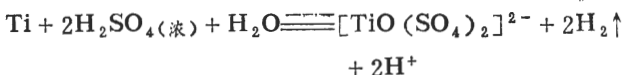
(TiC很硬, 熔点为3100℃)



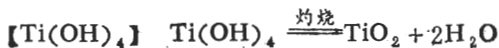
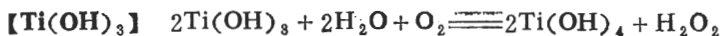
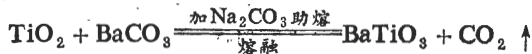
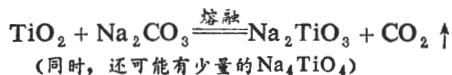
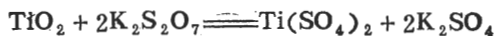
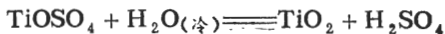
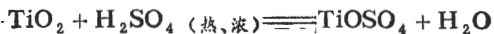
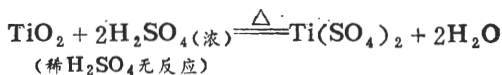
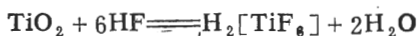
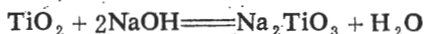
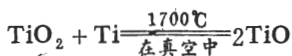
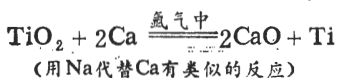
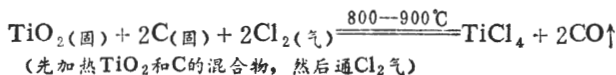
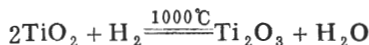
(中等程度的强碱浓的有反应, 稀的无反应)

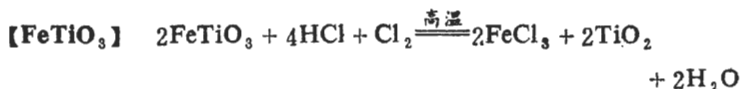
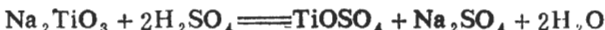
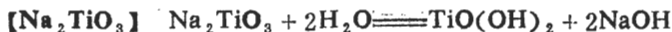
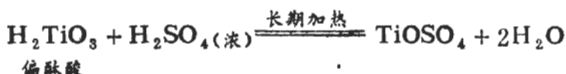
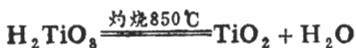
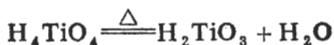
注: 稀HCl和稀H₂SO₄几乎不与Ti反应, 常温下也不和HNO₃反应。Ti易溶于HF和HCl的混合液中或溶于HF和H₂SO₄(或HNO₃)的混合酸中。



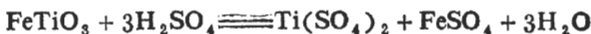


【TiO₂】 注：TiO₂是两性氧化物。

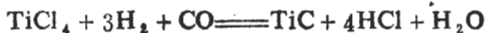
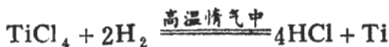
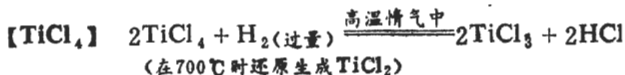
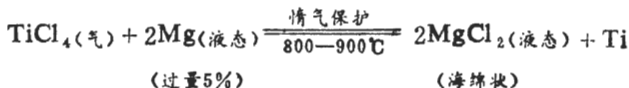
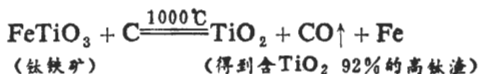


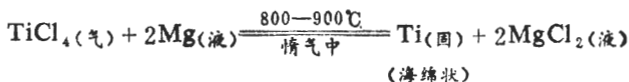
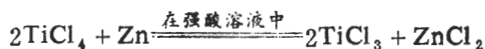
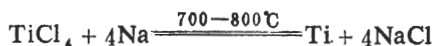


(温度控制在足以使 FeCl_3 挥发出来)

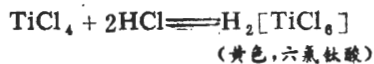
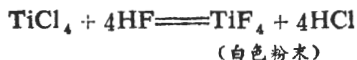
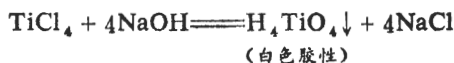
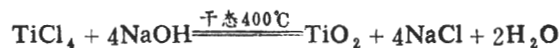
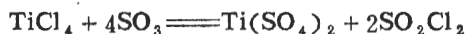
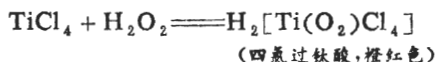
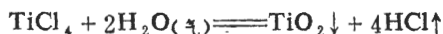
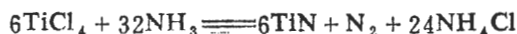


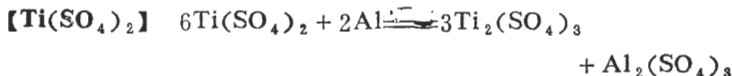
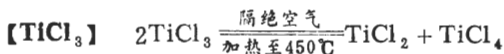
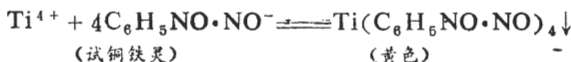
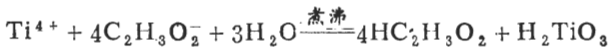
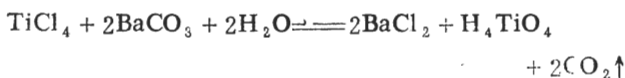
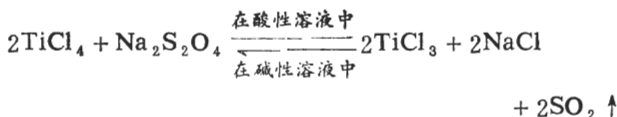
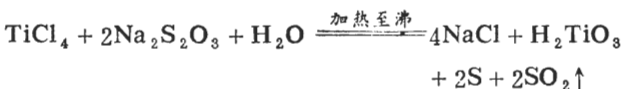
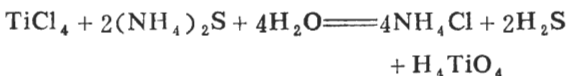
由钛铁矿提炼钛:



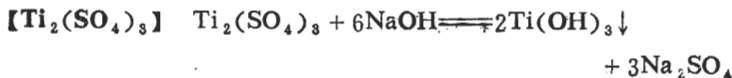
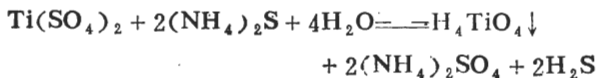
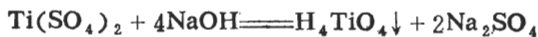
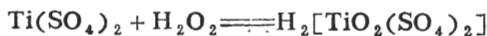


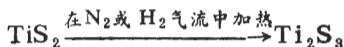
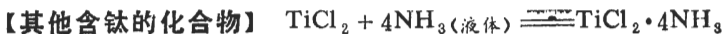
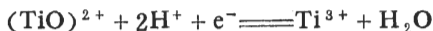
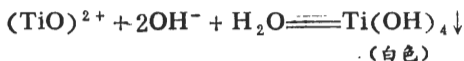
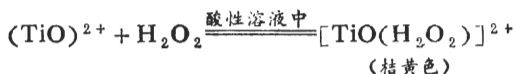
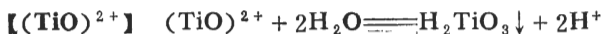
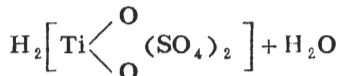
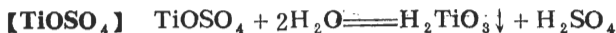
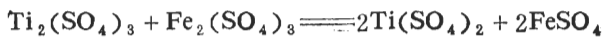
+ 122 千卡





(在 H_2SO_4 存在下进行反应)

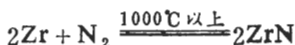
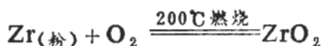
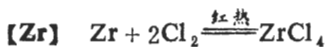




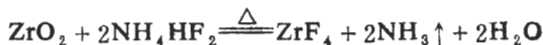
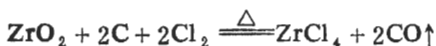
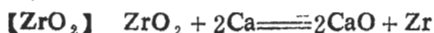
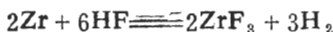
9.2 锆 $4d^2 5s^2$ Zr = 91.22

铪 $5d^2 6s^2$ Hf = 178.49

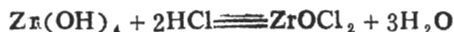
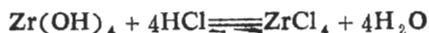
锆和铪在性质上非常相似，制取方法也相同，下面以Zr为代表列出其主要反应。

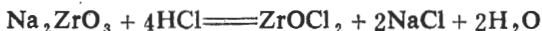


注：锆和铪都不与水、稀酸、碱起作用，但易溶于“王水”和HF。

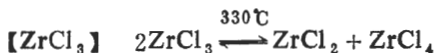
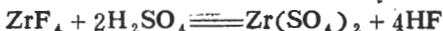
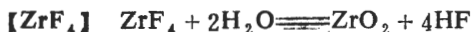


注：Zr(OH)₂具有两性、碱性大于酸性，但可与浓的强碱作用。

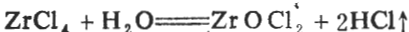
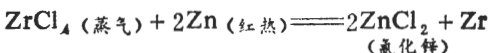
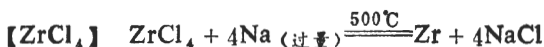




(CaZrO₃有类似的反应)

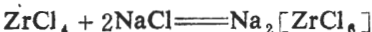
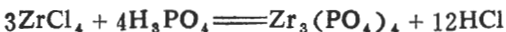
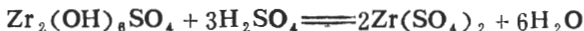
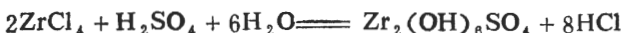


(无空气存在之下)

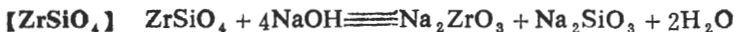
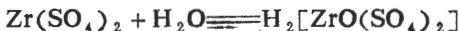
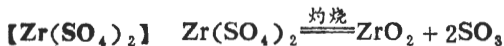


(或氯化锆)

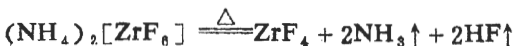
(在潮湿空气中ZrCl₄冒烟)



(Na₂[ZrCl₆]遇水分解)



【其他含锆的化合物】



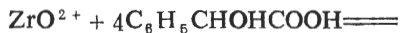
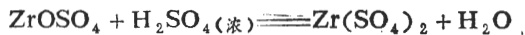


(六氟锆酸钾)

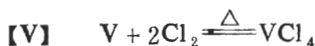


(白色胶状)

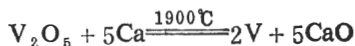
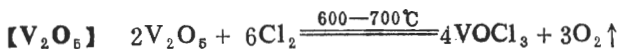
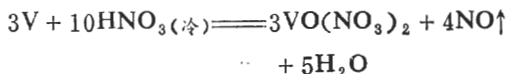
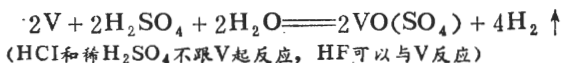
(ZrOBr有类似的反应)



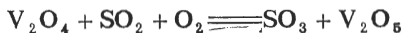
第十章 钒分族

10.1 钒 $3d^3 4s^2$ $V = 50.9414$ 

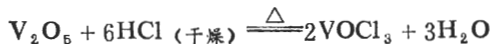
(还可以生成低价氧化物: VO 、 VO_2 、 V_2O_3 等)

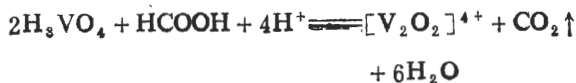
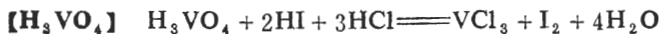
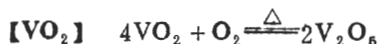
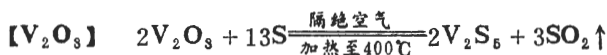
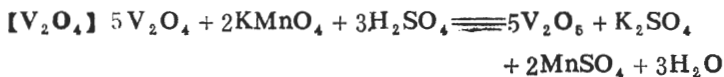
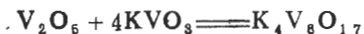
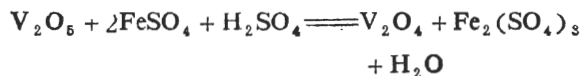
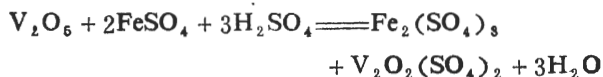
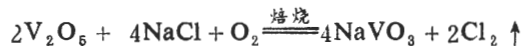
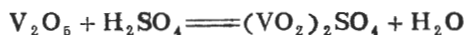
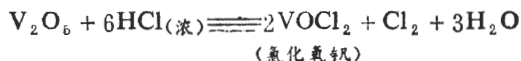


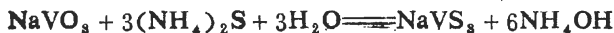
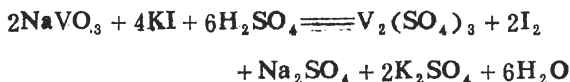
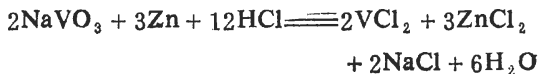
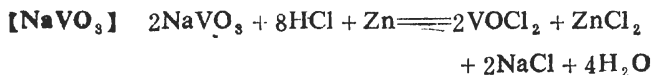
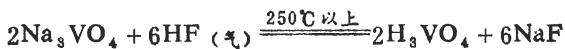
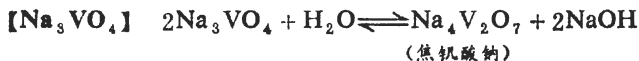
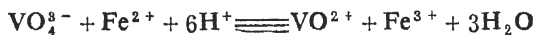
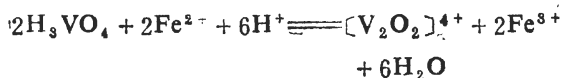
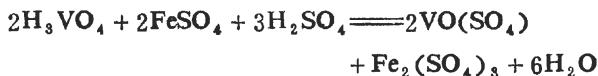
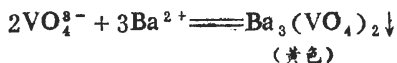
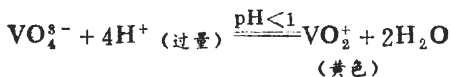
(工业上制 V)

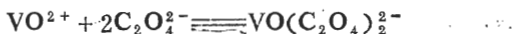
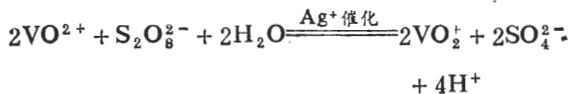
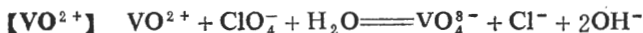
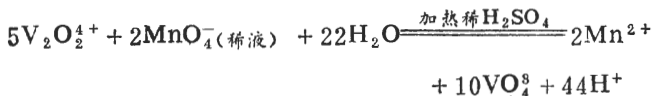
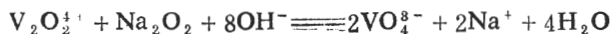
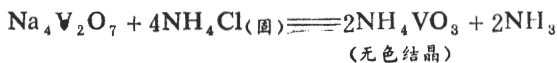
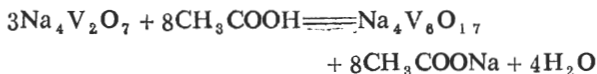
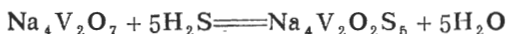
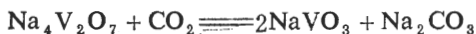
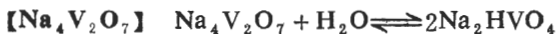
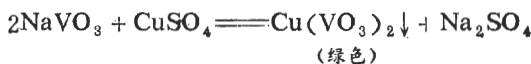


(偏钒酸钠)



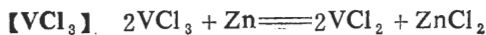
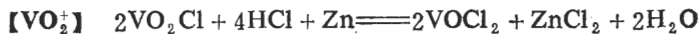








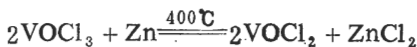
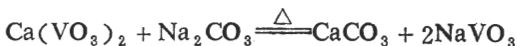
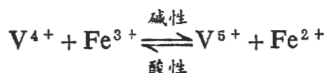
(Tart代表酒石酸根离子)

(VCl₄很不稳定)

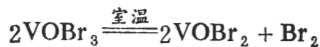
(二氯氧化钒)

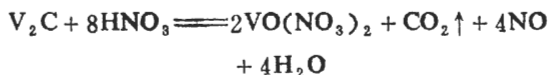


(棕黄色粉末)

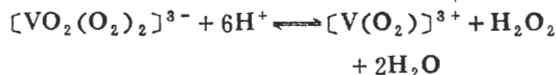
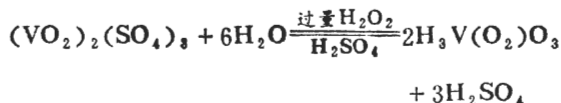
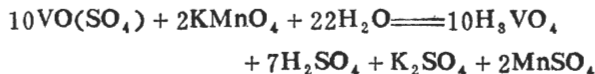


(反应在弹管内进行)



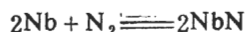
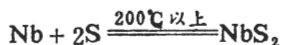
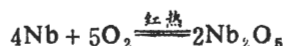
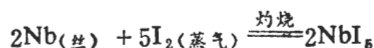
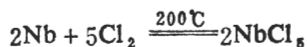


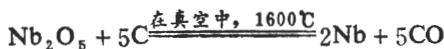
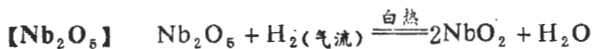
(硫酸钒氧基)



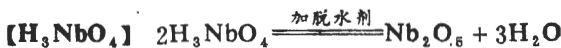
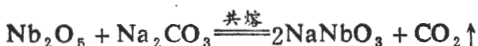
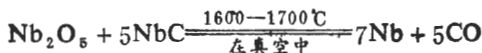
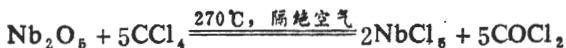
10.2 铌 $4d^4 5s^1$ Nb = 92.90604

【Nb】注：游离的Nb化学性质非常稳定，常温时不与空气、水、酸、碱等作用。易溶于 HNO_3 和 HF 的混合液中，但不溶于其他酸。在热浓碱中可起反应。

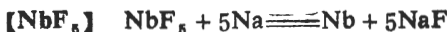
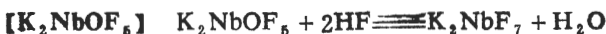
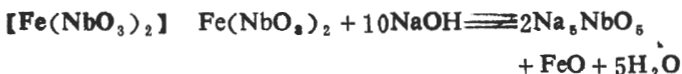
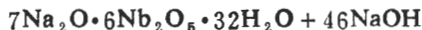




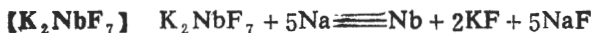
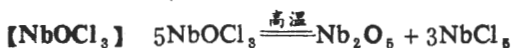
(Ta也有类似的反应)



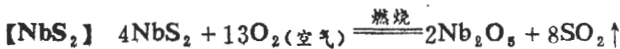
(用同样方法可制取Ta₂O₅)



(工业上制取Nb)



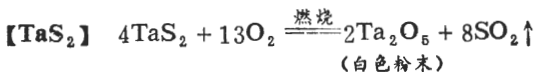
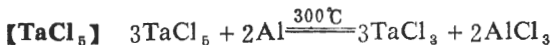
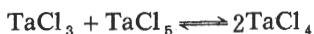
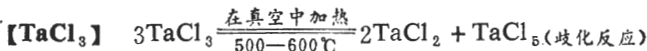
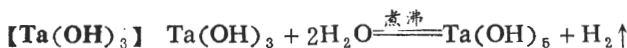
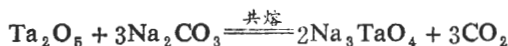
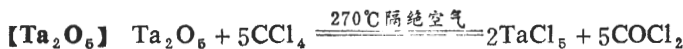
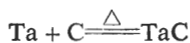
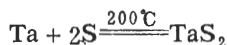
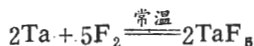
(K₂TaF₇有类似的反应)



(白粉末)

10.3 钽 $5d^3 6s^2$ $T_a = 180,9479$

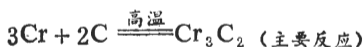
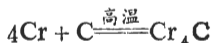
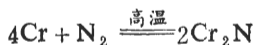
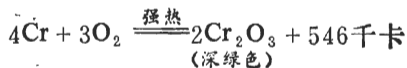
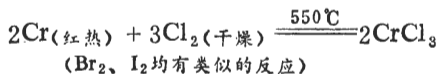
注：游离的Ta化学性质非常稳定，常温时不与空气、水、酸、碱等作用。钽能与HF慢慢作用，在150℃以上才与浓H₂SO₄反应。钽易溶于HNO₃和HF的混合液中，在其他酸中不溶解。热、浓碱可与它反应。

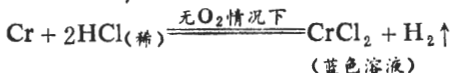


第十一章 铬分族

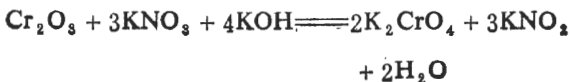
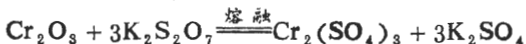
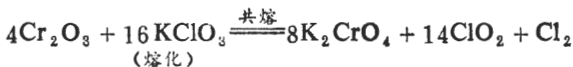
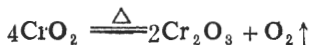
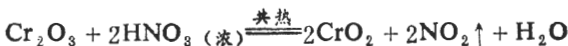
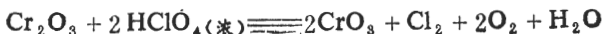
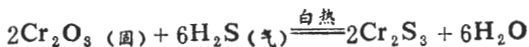
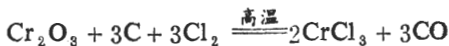
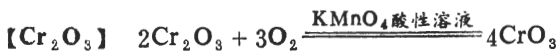
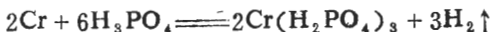
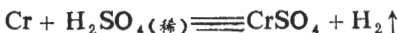
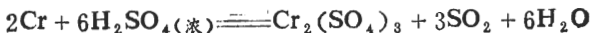
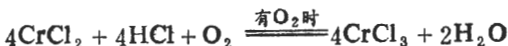
11.1 铬 $3d^5 4s^1$ Cr = 51.996

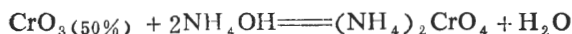
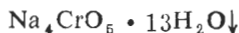
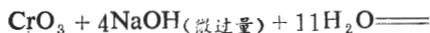
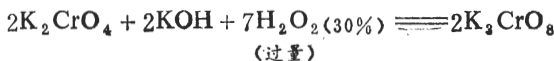
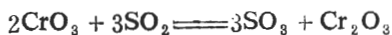
【Cr】 注：铬与冷的浓 HNO_3 、冷的稀 HNO_3 均无反应，成“钝态”，因生成 Cr_2O_3 保护层。成“钝态”后的铬不再与稀酸反应。高温时，铬能与卤素、S、 N_2 、C、Si、B等直接化合。



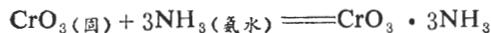


(HBr, HI均可发生类似的反应)

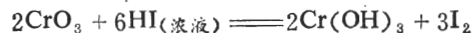
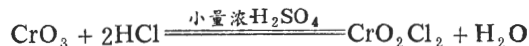
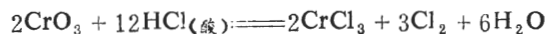




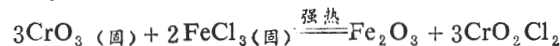
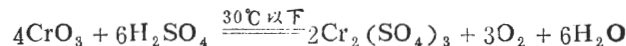
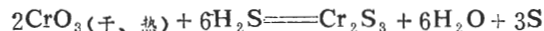
(冷却至0℃)



(棕色)

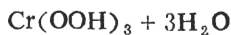
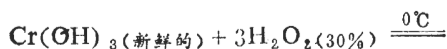
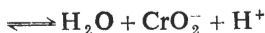
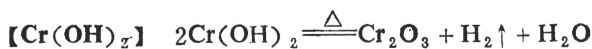
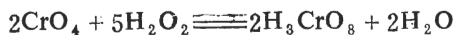
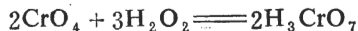
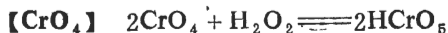
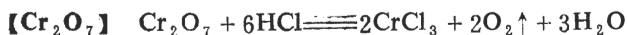


(使HI氧化)

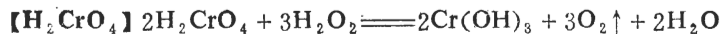
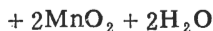
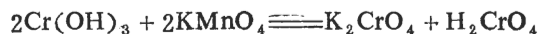
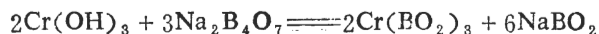
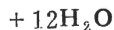
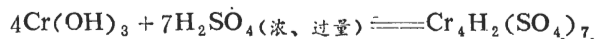
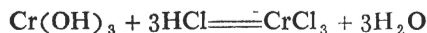
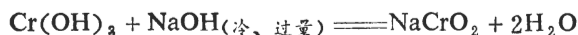


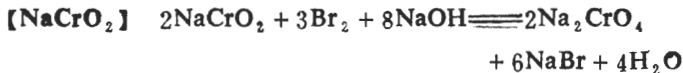
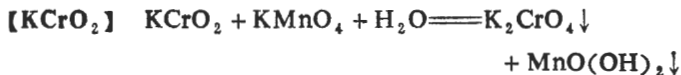
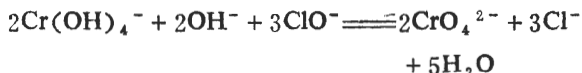
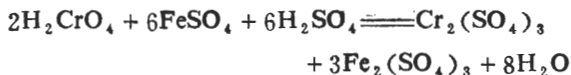
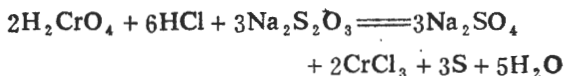
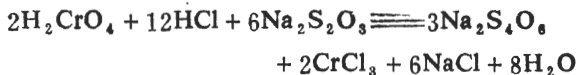
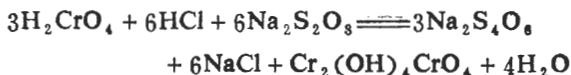
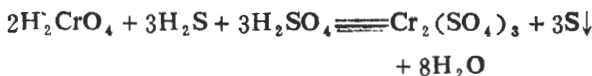
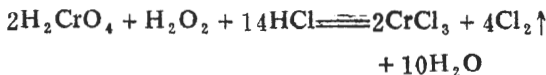
(溶液蒸发得结晶)



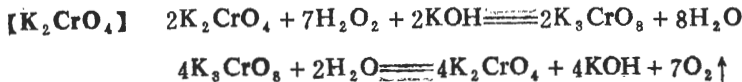
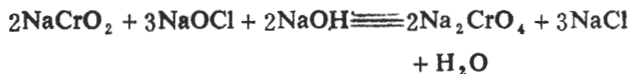
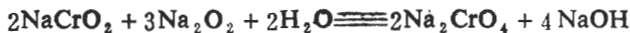


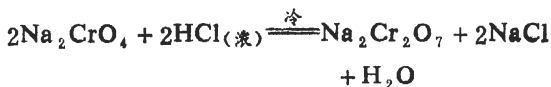
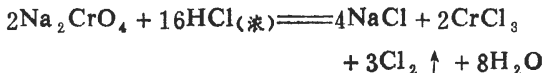
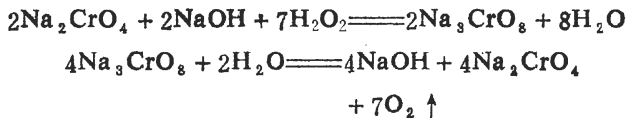
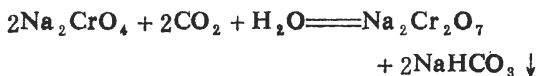
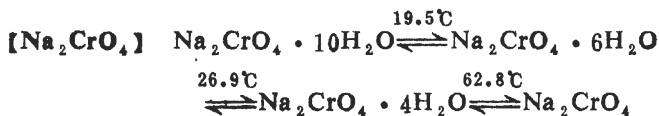
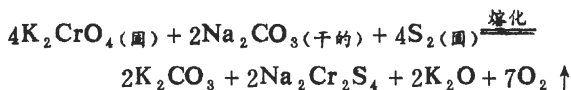
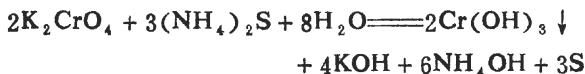
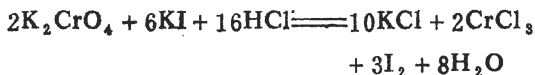
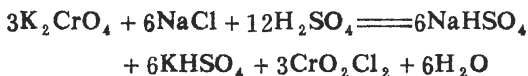
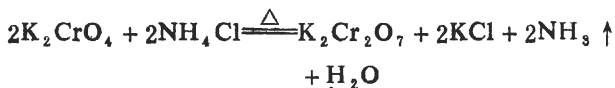
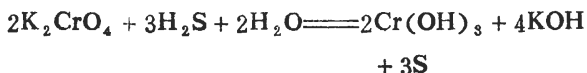
(过络酸, 红色)

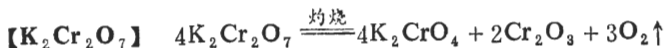
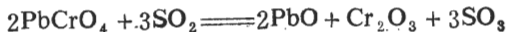
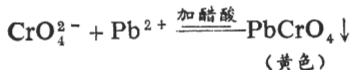
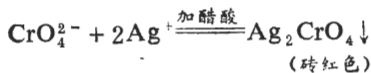
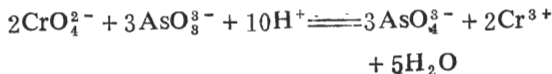
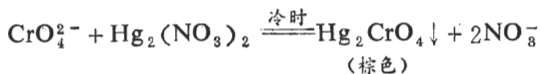
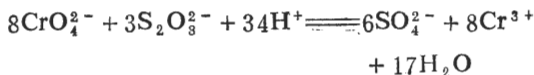
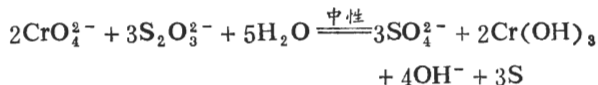
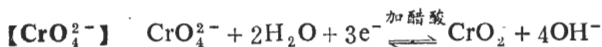
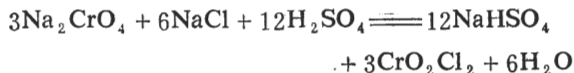
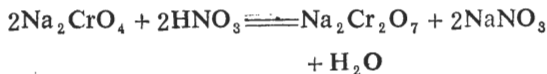
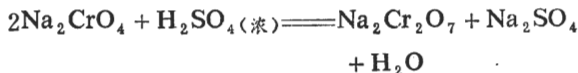
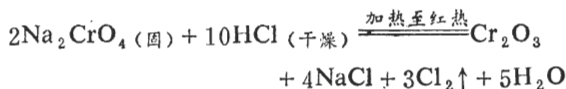


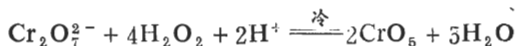
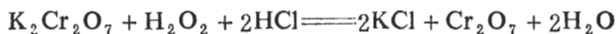
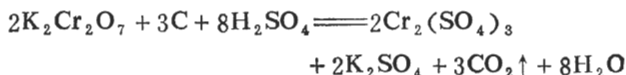
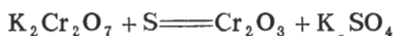


(Cl₂也有类似的反应)

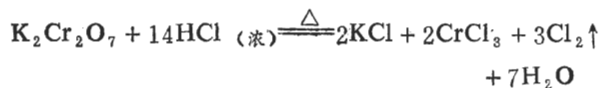
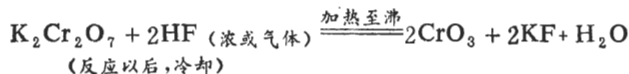
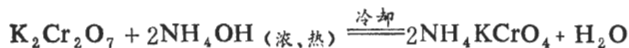
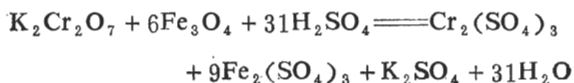
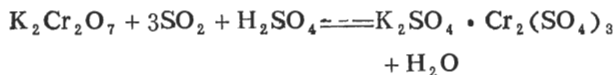
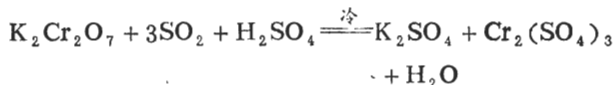
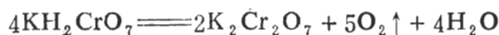
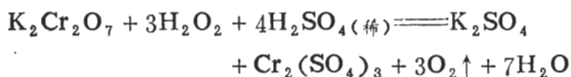


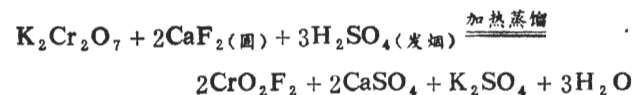
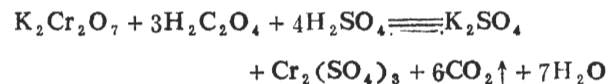
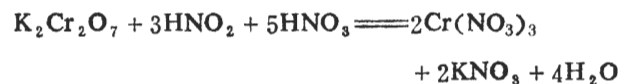
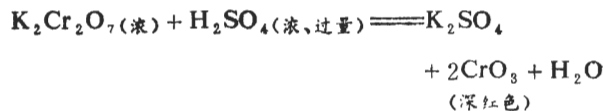
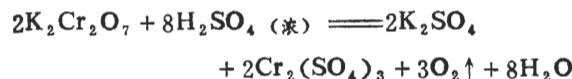
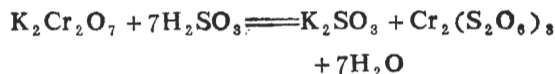
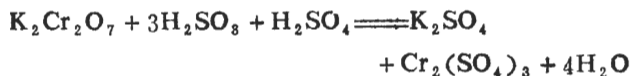
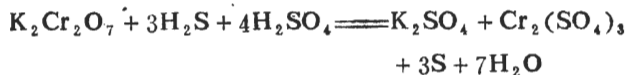
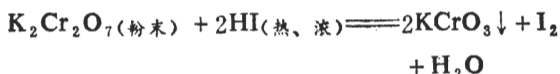


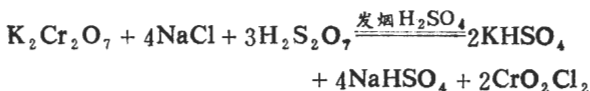
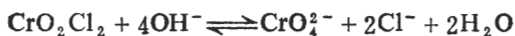
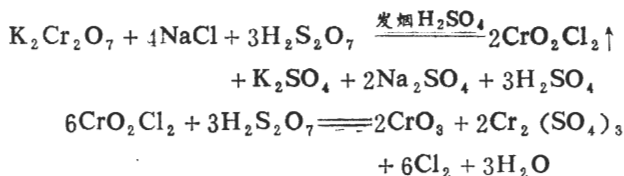
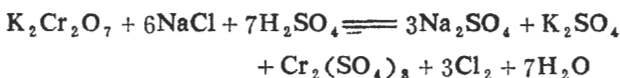
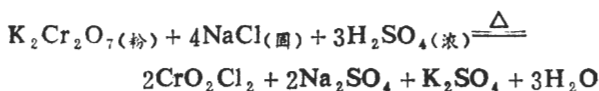
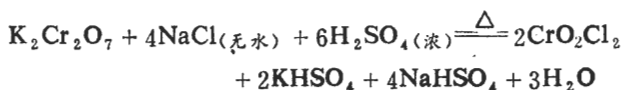
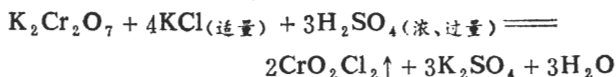
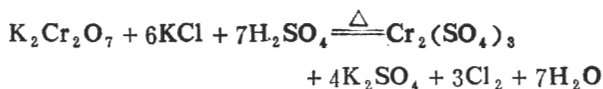




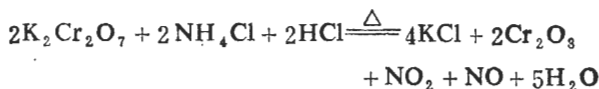
(在水中不稳定,可用乙醚萃取)



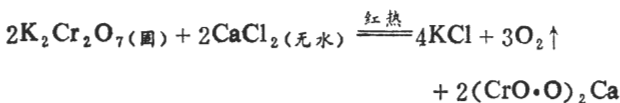


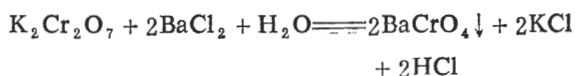


$\text{K}_2\text{Cr}_2\text{O}_7(\text{固})$ 与 $\text{NH}_4\text{Cl}(\text{固})$ 混合加热:

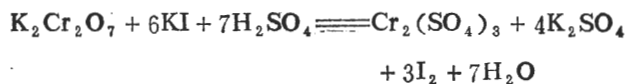
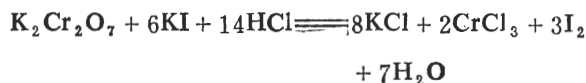
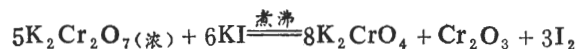
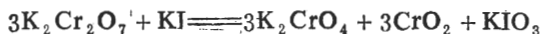
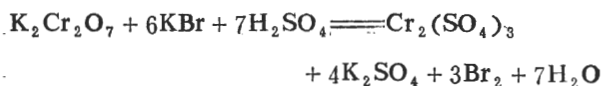
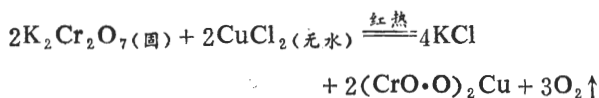
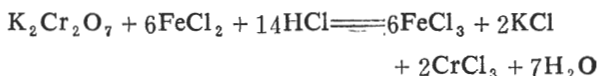
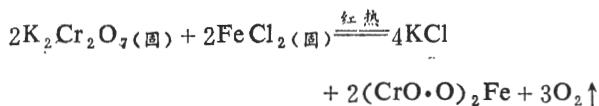
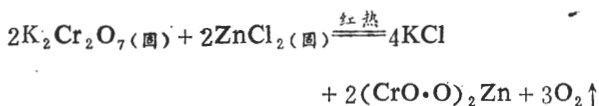
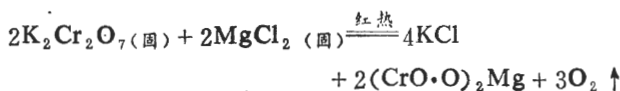
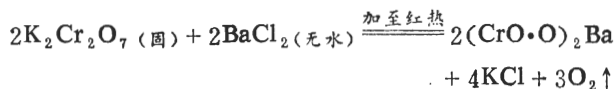


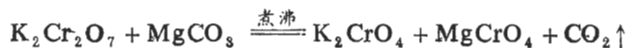
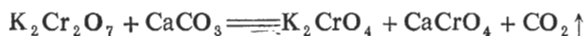
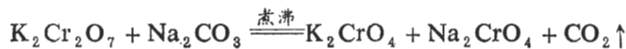
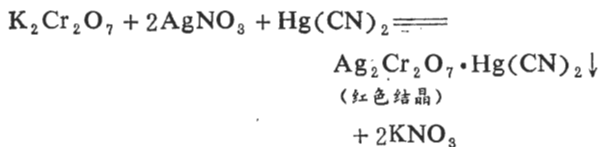
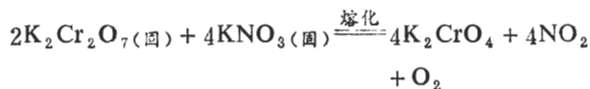
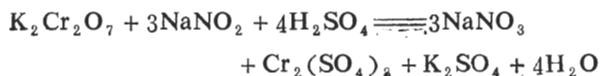
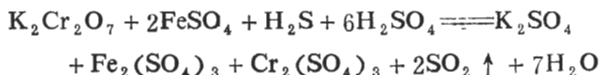
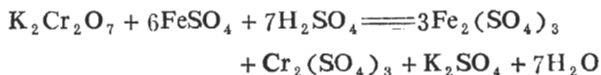
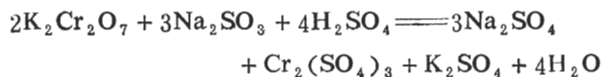
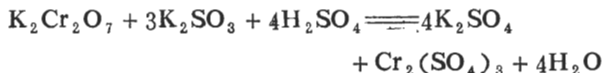
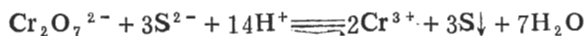
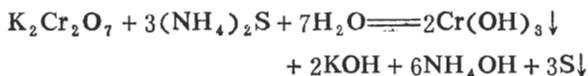
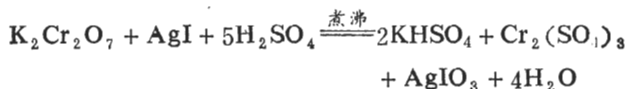
(首先 $\text{NH}_4\text{Cl} \xrightarrow{\Delta} \text{NH}_3\uparrow + \text{HCl}$)

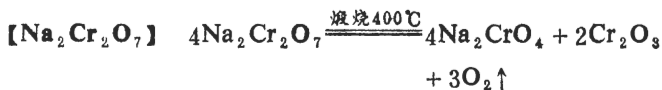
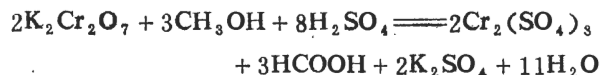
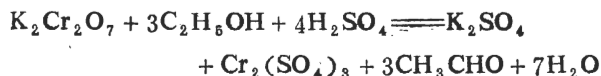
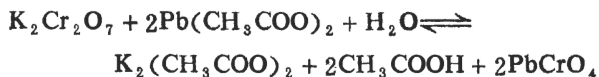
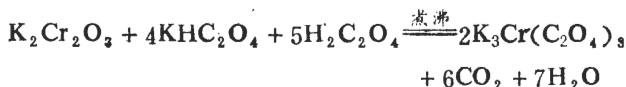




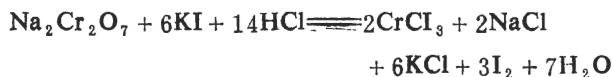
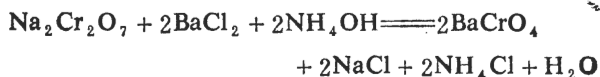
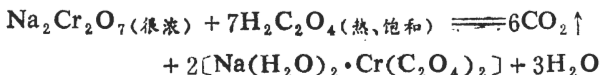
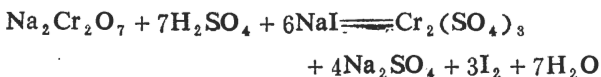
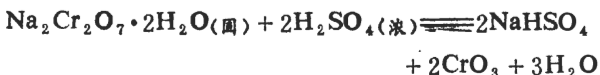
(SrCl₂、CaCl₂ 也有类似的反应)



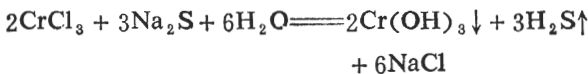
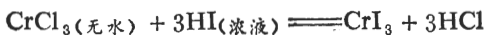
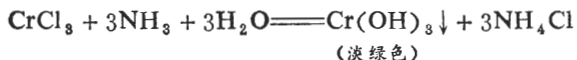
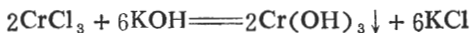
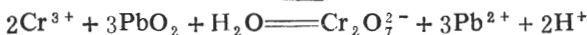
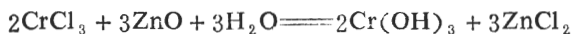
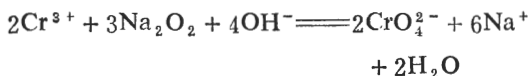
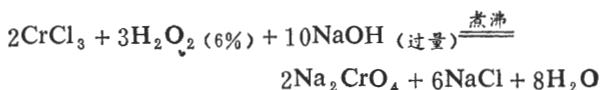
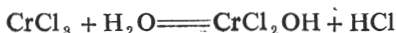
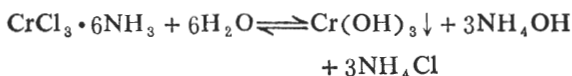
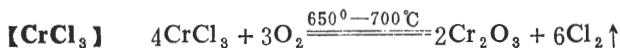
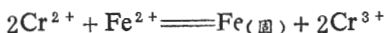
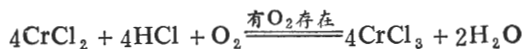
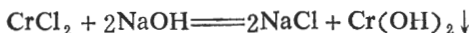
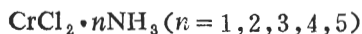


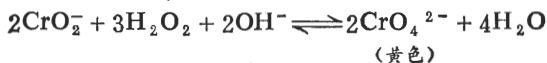
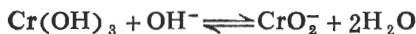
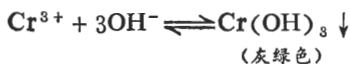
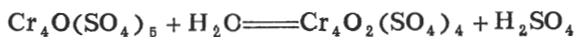
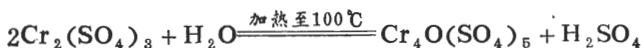
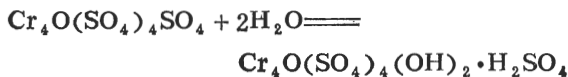
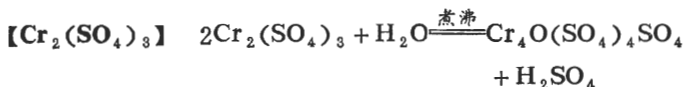
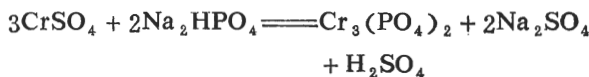
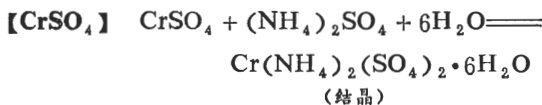
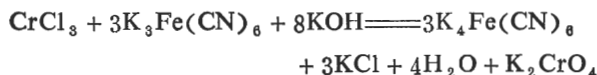
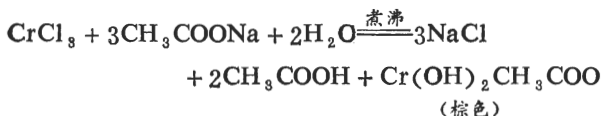
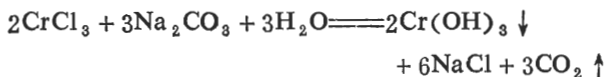
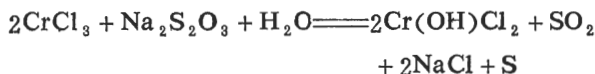
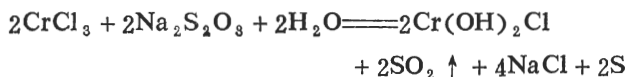


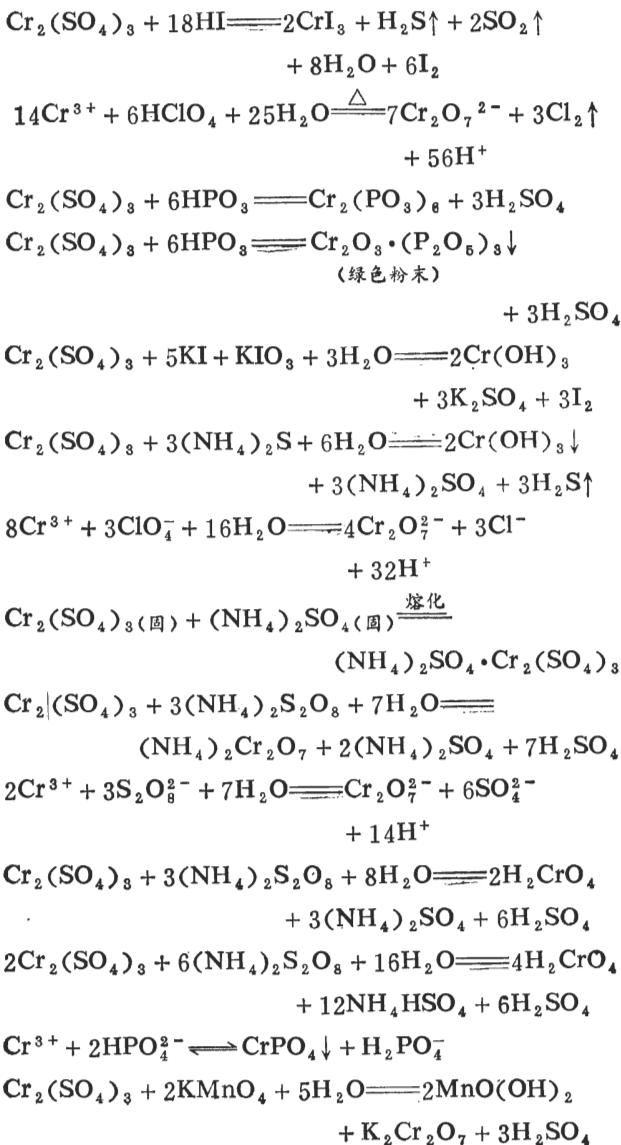
($\text{K}_2\text{Cr}_2\text{O}_7$ 有类似的反应)

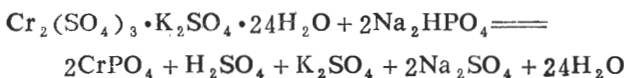
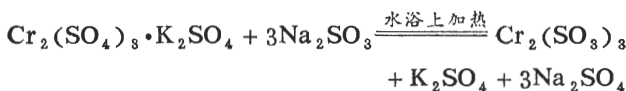
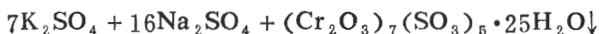
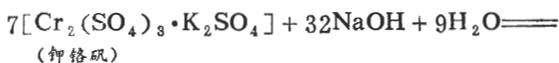
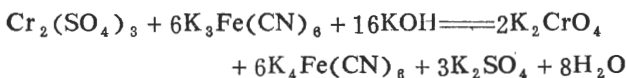
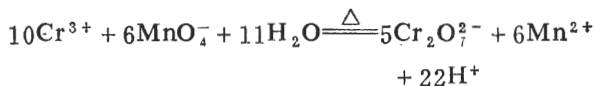
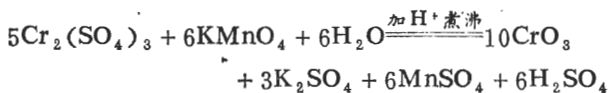


【 CrCl_2 】 注： CrCl_2 与 NH_3 能形成一系列的加合物如







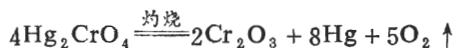
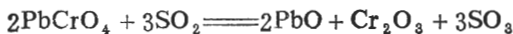
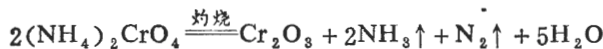
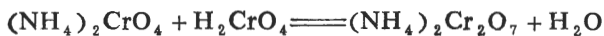
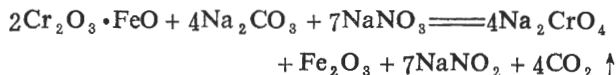
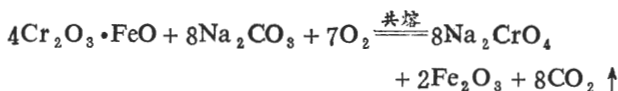


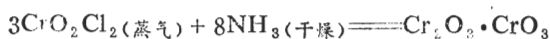
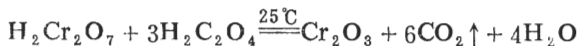
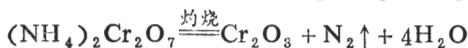
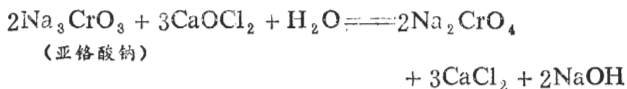
【其他含铬的化合物】



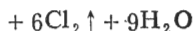
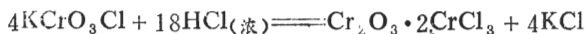
(铬铁矿)

(得到铬铁合金)





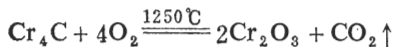
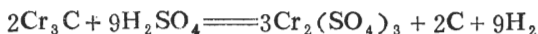
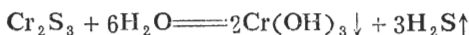
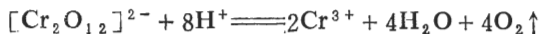
(黄色)



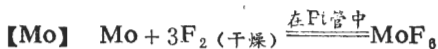
(氟化铬酸钾)



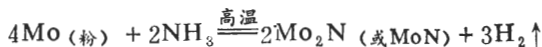
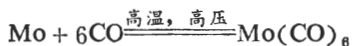
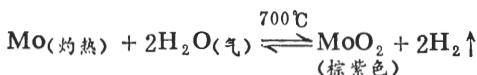
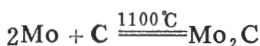
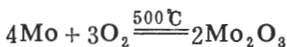
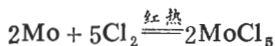
(过铬酸根)



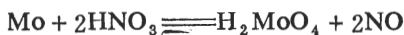
11.2 钼 $4d^5 5s^1$ $\text{Mo} = 95.94$



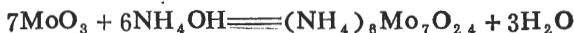
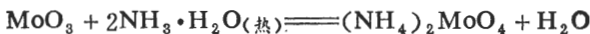
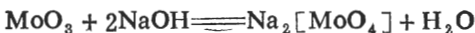
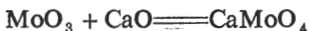
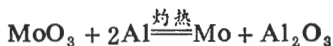
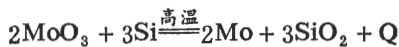
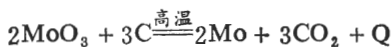
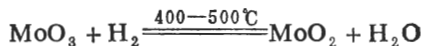
(Cl_3, Br_2 需加热才能反应)



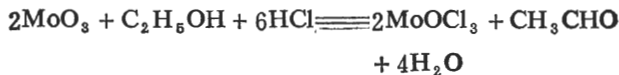
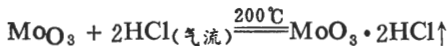
注: 钼与稀 H_2SO_4 、 HF 、 HCl 均无反应,但能溶于 HNO_3 和热浓 H_2SO_4 中。高温时,还能被碱熔融。

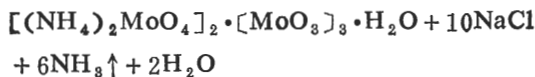
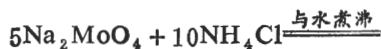
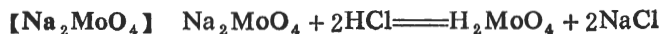
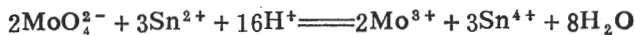
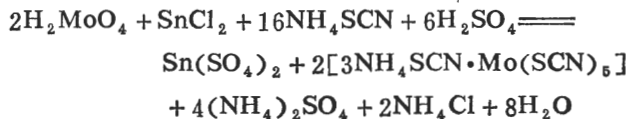
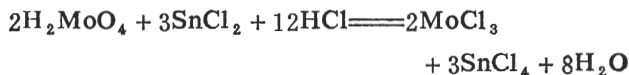
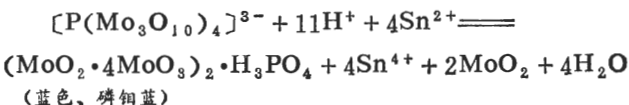
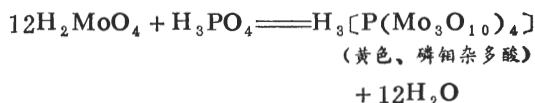
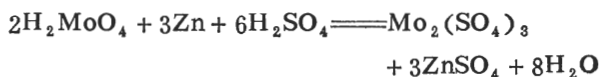
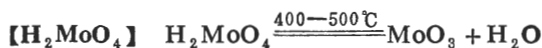
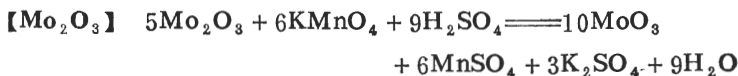
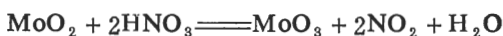
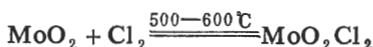
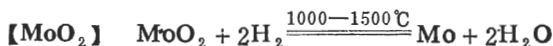


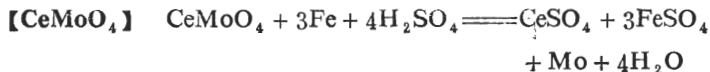
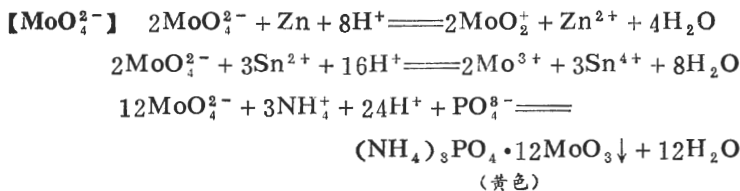
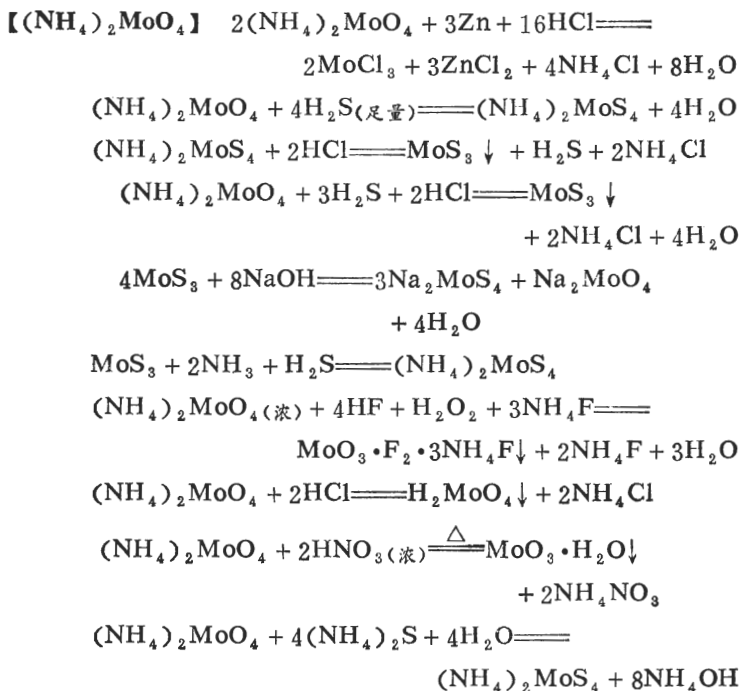
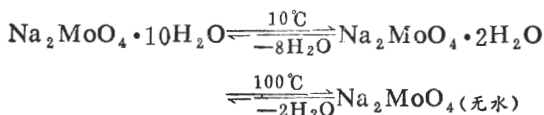
【 MoO_3 】

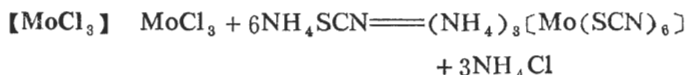


(异钼酸铵)

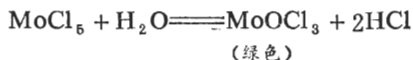
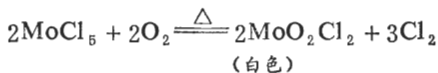
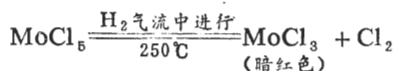




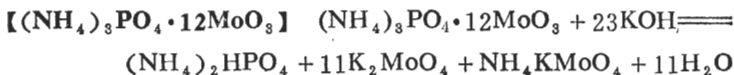
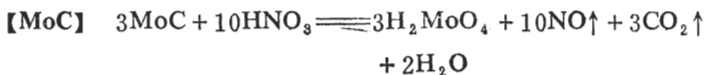
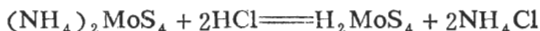
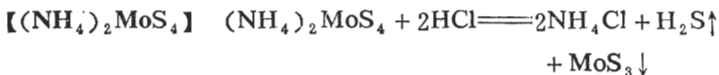
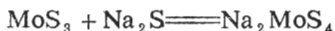
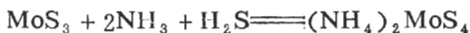
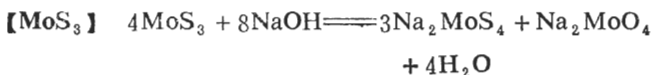
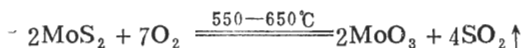


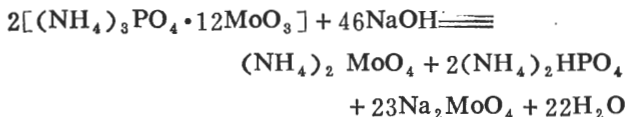


【MoCl₅】

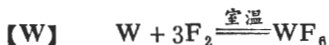


【MoS₂】



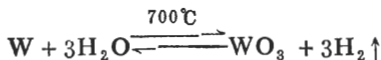
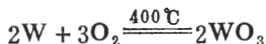
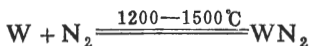


11.3 钨 $5d^46s^2$ $W=183.85$

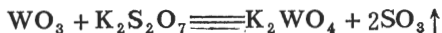
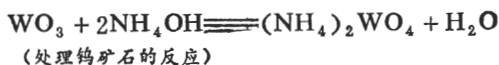
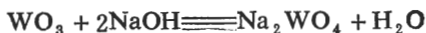
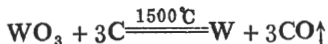
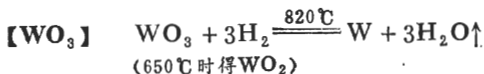
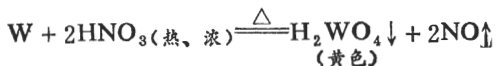


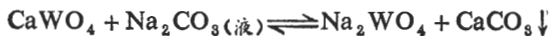
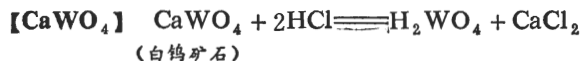
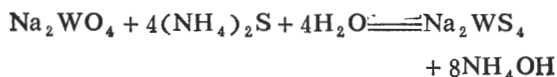
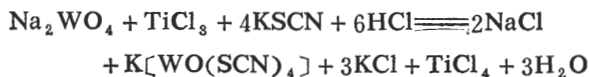
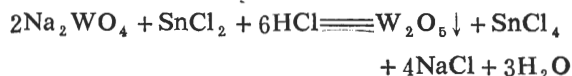
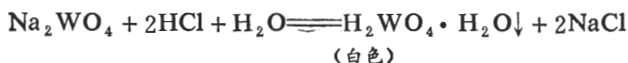
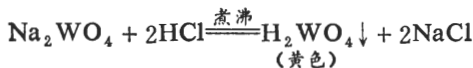
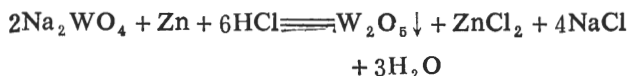
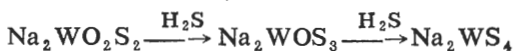
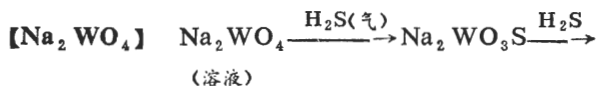
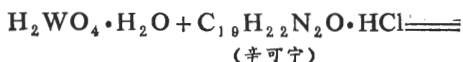
(与 Cl_2 需 250°C 、与 Br_2 、 I_2 需在红热下。)

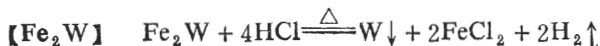
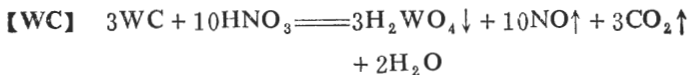
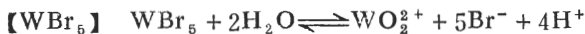
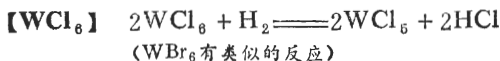
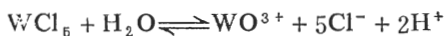
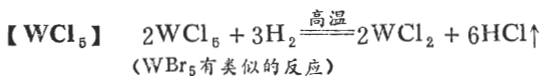
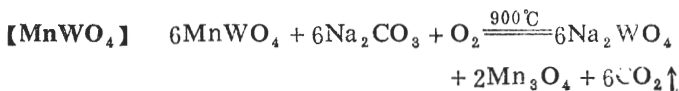
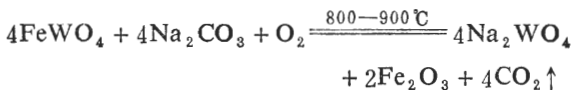
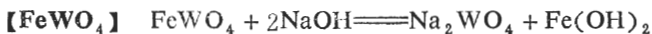
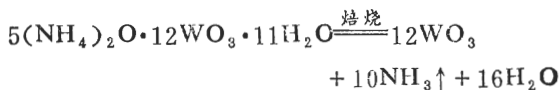
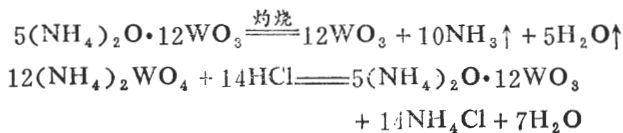
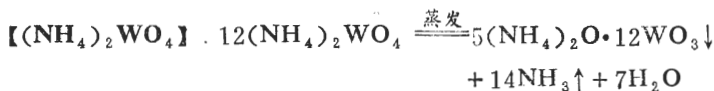
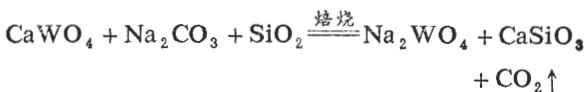
注：W与S不起反应，高温时，能与C生成WC和 W_2C 。



注：W与稀、浓、冷热的 HCl 、 H_2SO_4 、 HNO_3 均不起反应，只能跟“王水”或 HF 和 HNO_3 的混合酸液起反应。



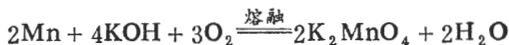
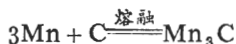
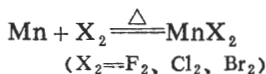




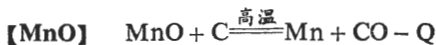
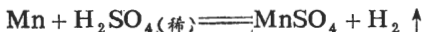
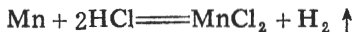
第十二章 锰分族

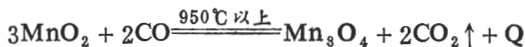
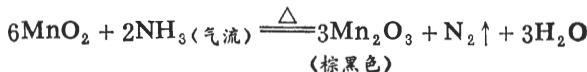
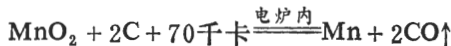
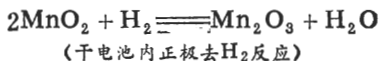
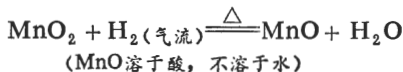
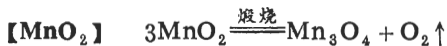
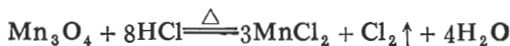
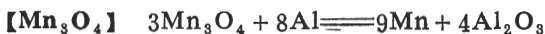
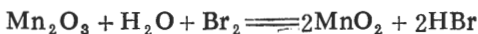
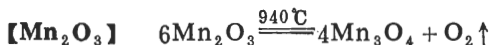
12.1 锰 $3d^5 4s^2$ Mn = 54.9380

【Mn】 注：锰在高温下能与卤素、S、N₂、C等直接化合。



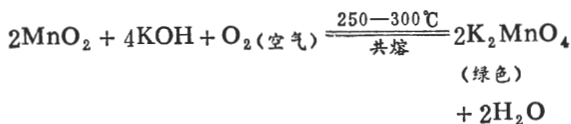
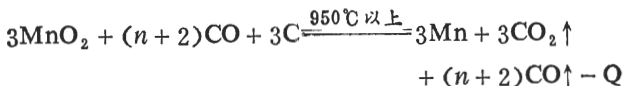
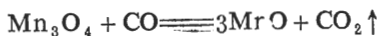
注：锰易溶于酸，甚至醋酸也能使它溶解。



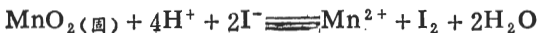
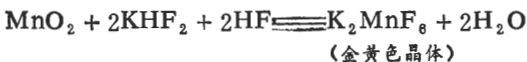
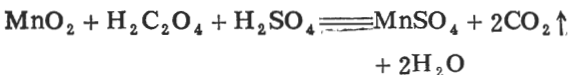
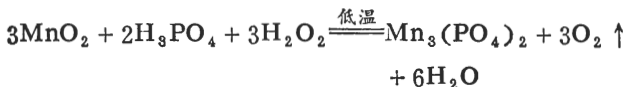
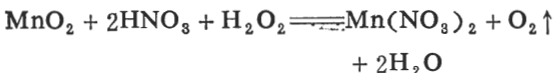
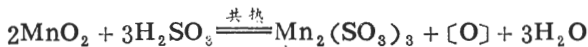
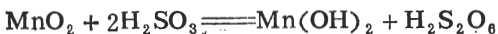
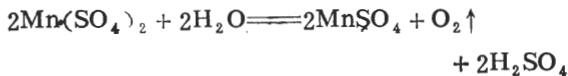


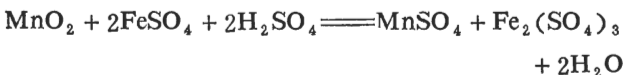
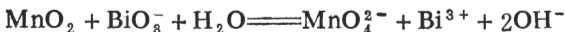
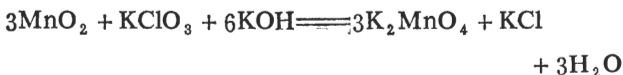
注: 在炼钢炉内锰的氧化物的还原顺序为:



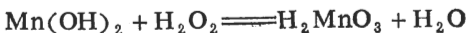
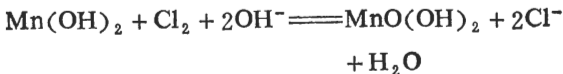
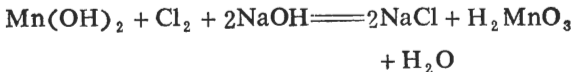
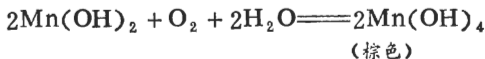
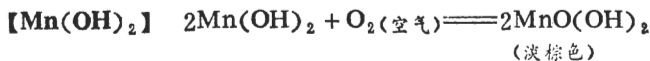
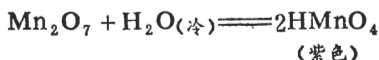
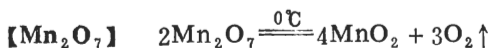
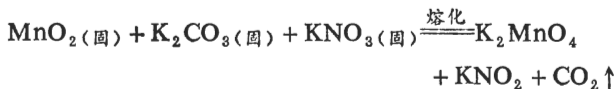
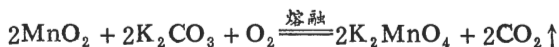
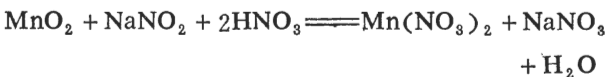
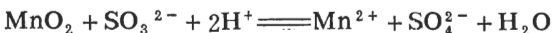


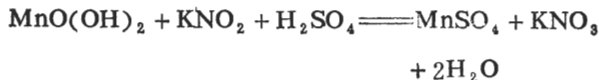
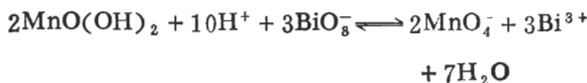
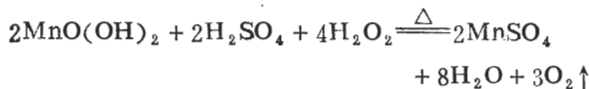
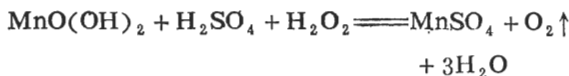
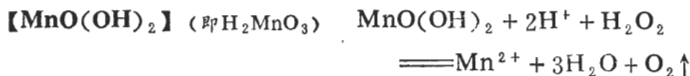
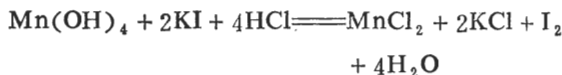
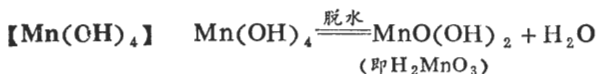
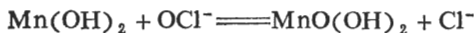
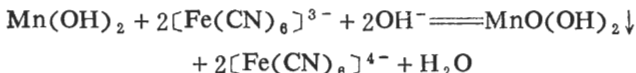
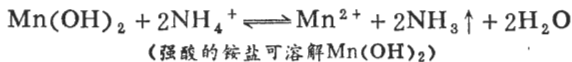
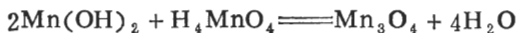
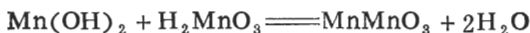
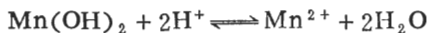
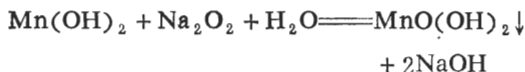
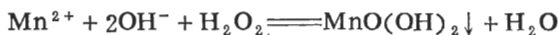
注: MnO_2 跟稀 H_2SO_4 、稀 HNO_3 不起反应。

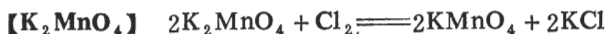
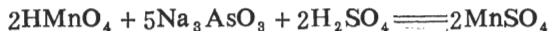
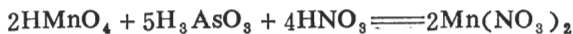
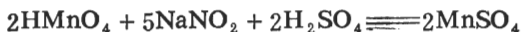
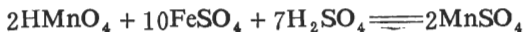
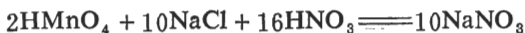
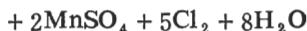
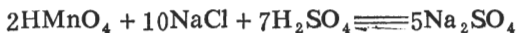
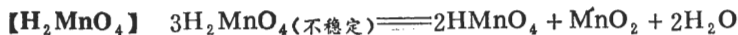
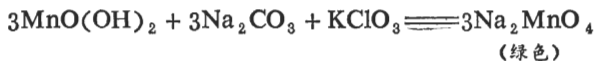




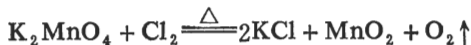
注: MnO_2 可溶于 Na_2SO_3 和酸的混合液中。





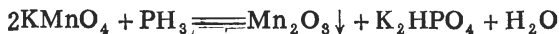
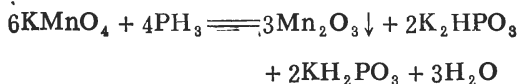
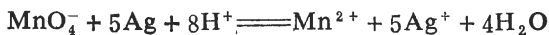
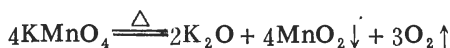
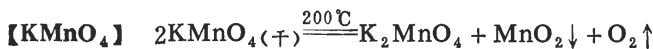
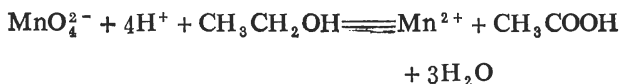
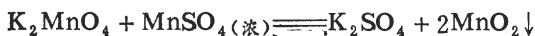
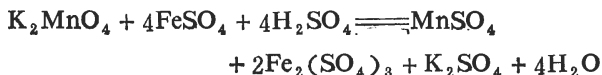
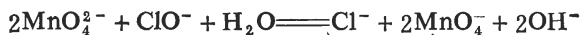
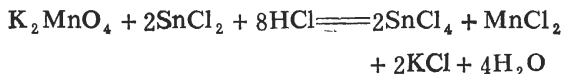
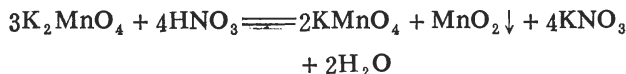
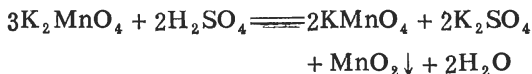
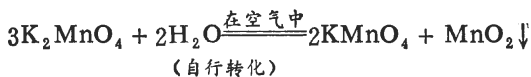


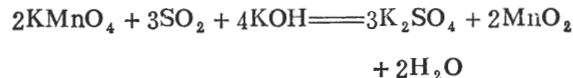
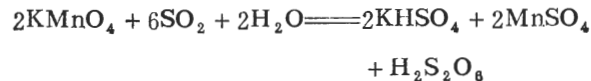
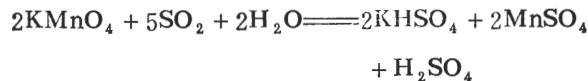
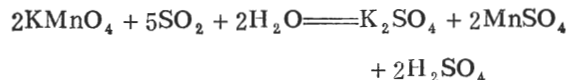
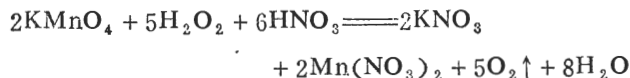
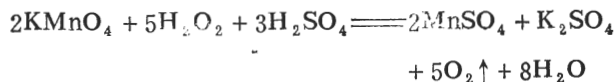
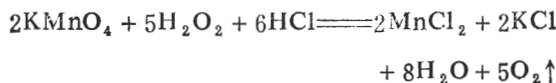
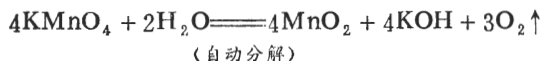
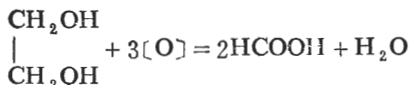
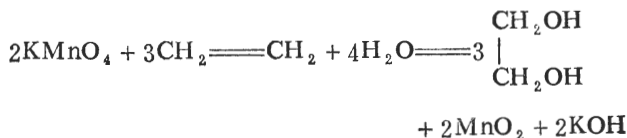
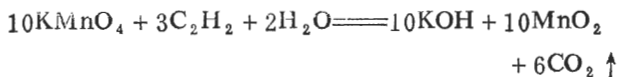
(反应需在碱性溶液中进行)

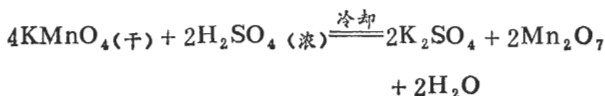
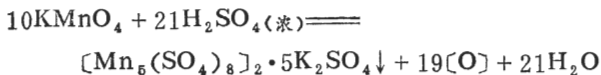
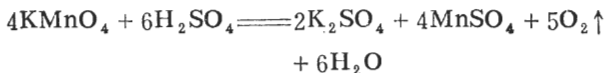
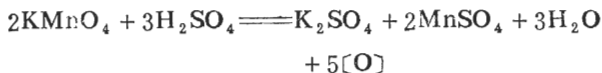
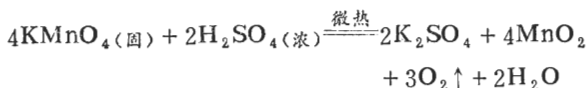
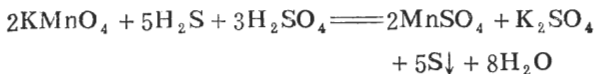
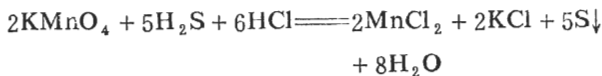
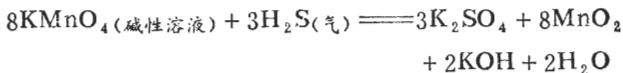
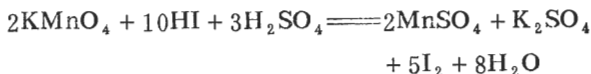
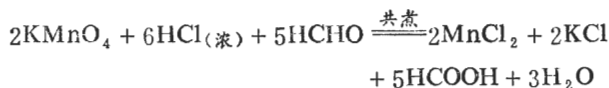
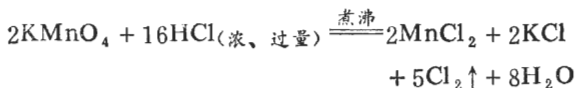
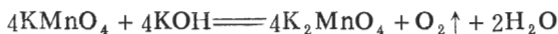
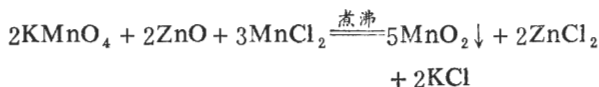


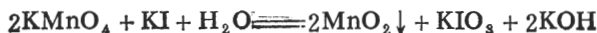
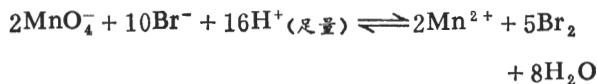
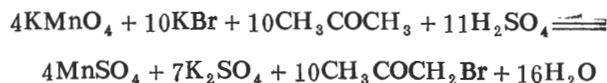
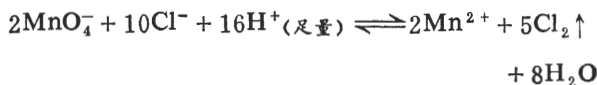
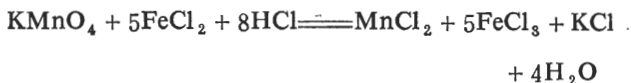
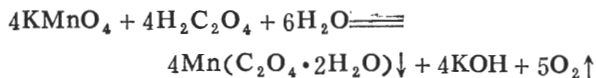
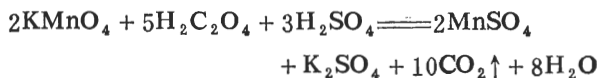
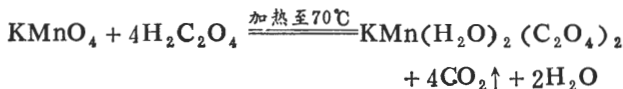
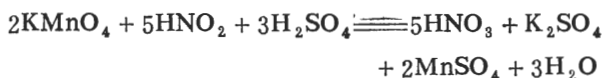
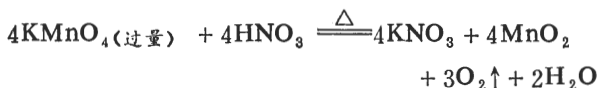
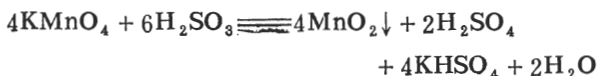
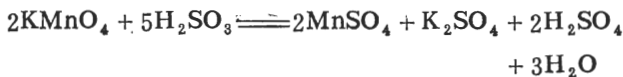
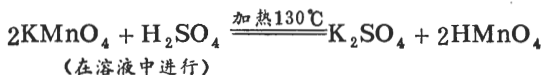
注: K_2MnO_4 不稳定, 在酸性、碱性、中性、水溶液中

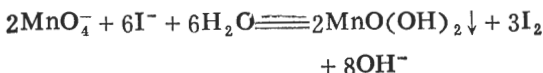
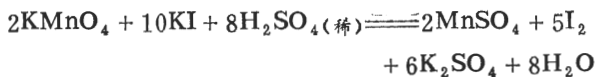
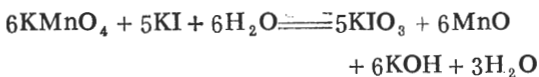
均可转化。



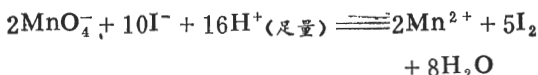




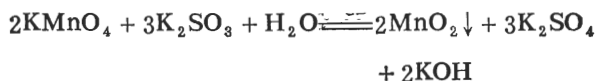
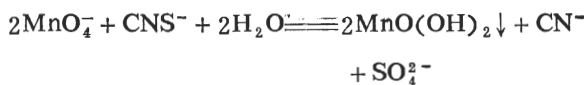
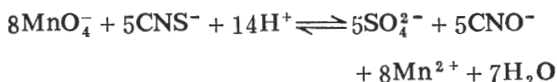




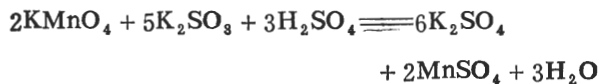
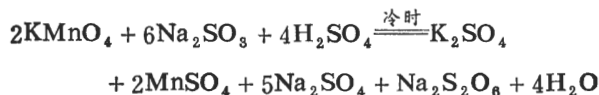
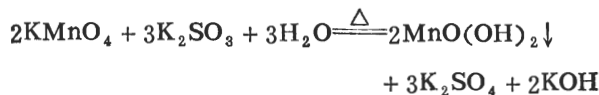
(在碱性溶液中进行反应)



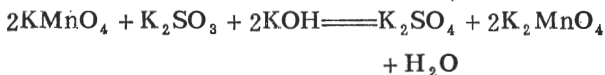
(反应在碱性溶液中进行)



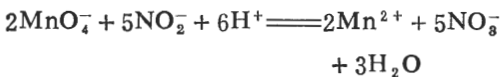
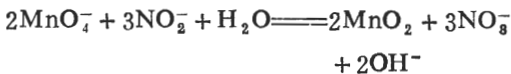
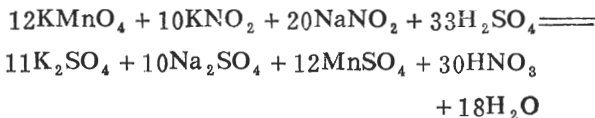
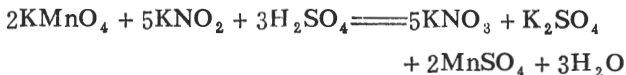
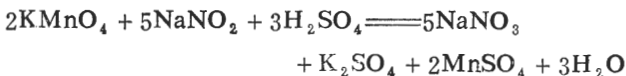
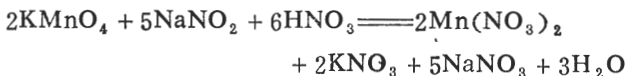
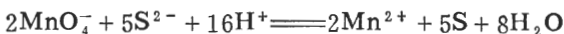
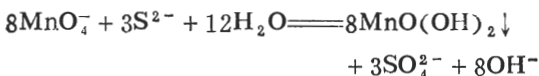
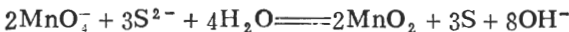
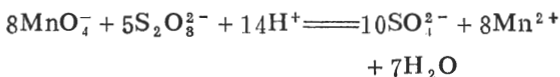
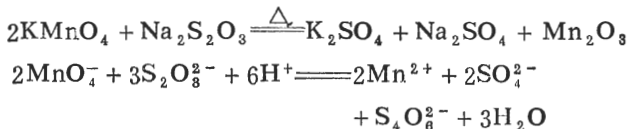
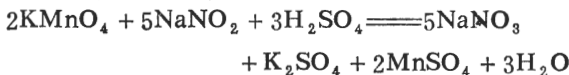
(在中性溶液中反应)

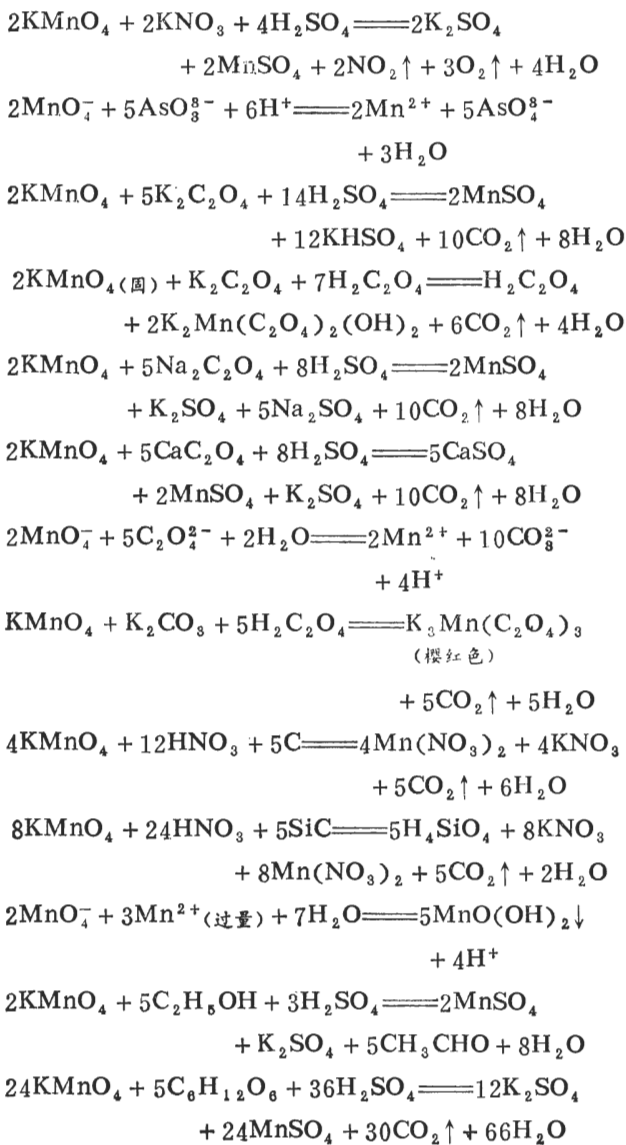


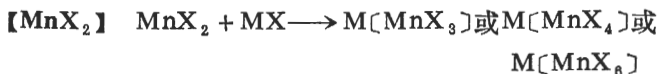
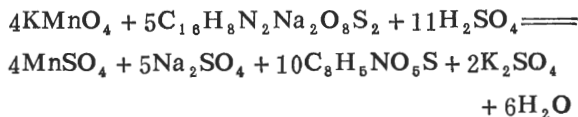
(在酸性溶液中的反应)



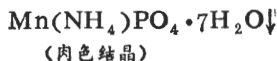
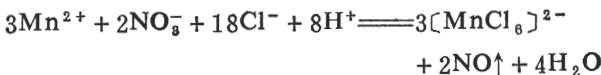
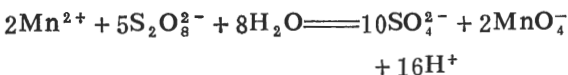
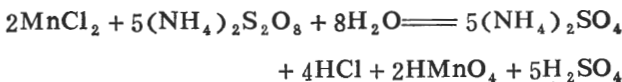
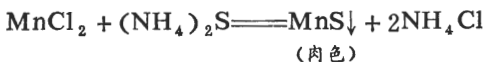
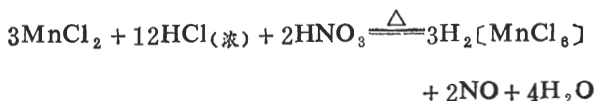
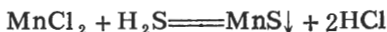
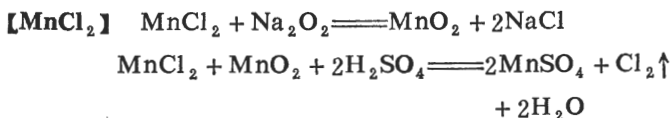
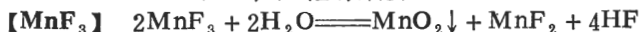
(在碱性溶液中的反应)

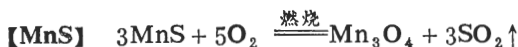
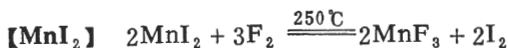
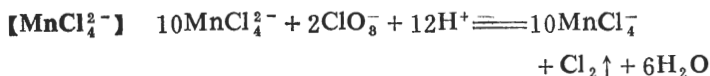
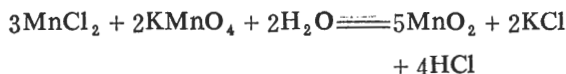
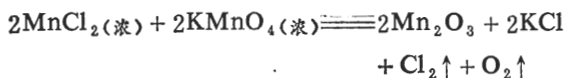




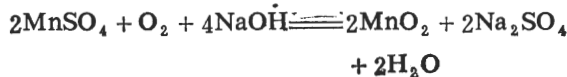
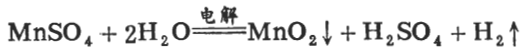
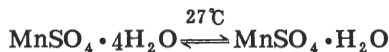
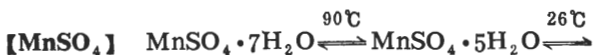
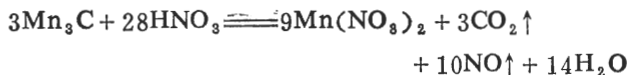
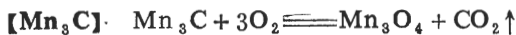
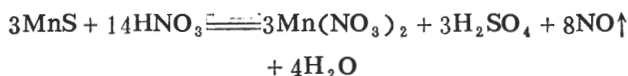
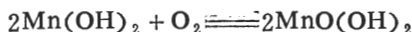
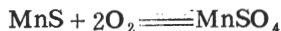


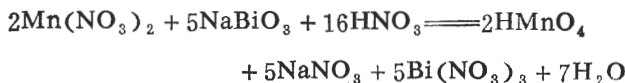
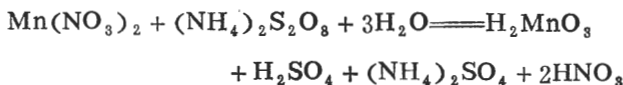
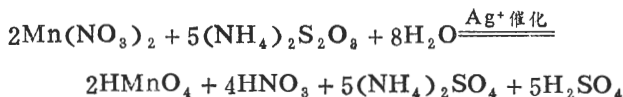
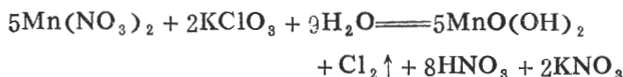
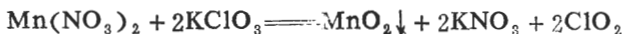
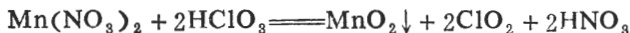
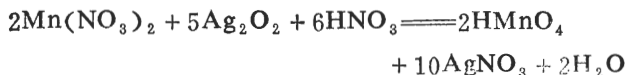
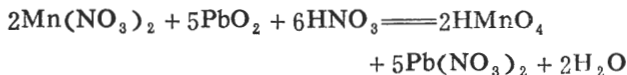
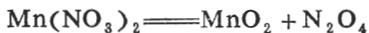
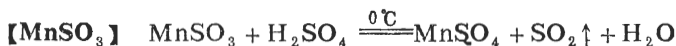
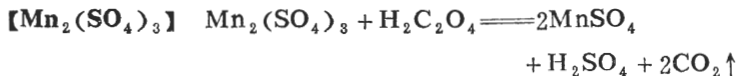
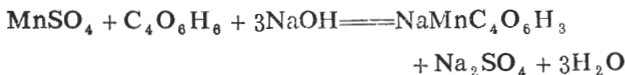
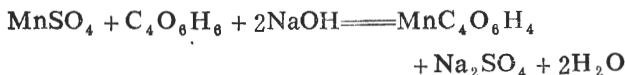
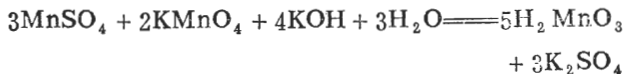
(MX表示碱金属卤化物)

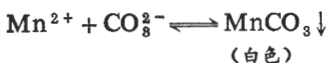
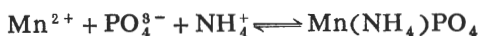
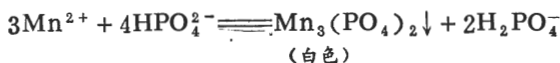
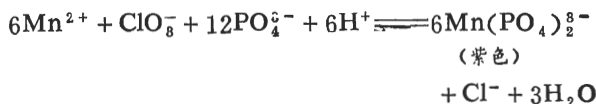
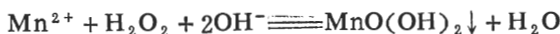
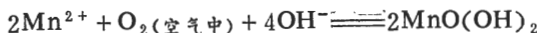
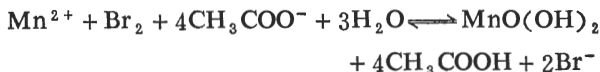
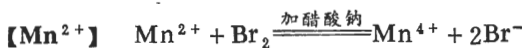
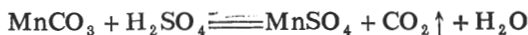
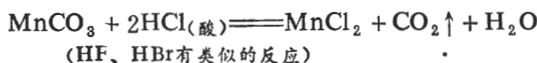
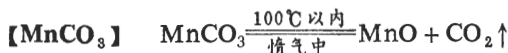
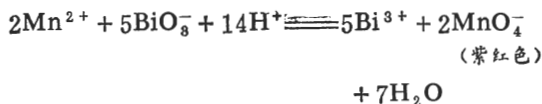


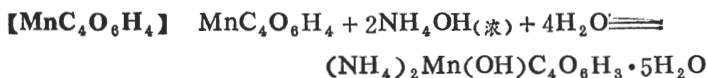
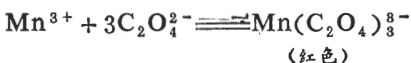
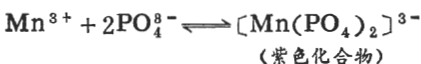
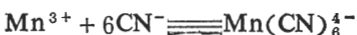
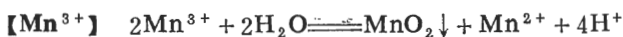
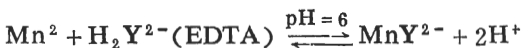
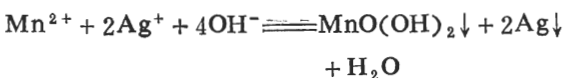
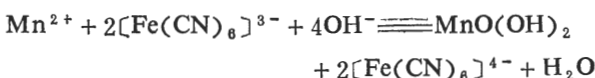
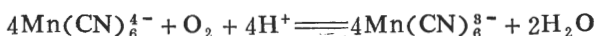
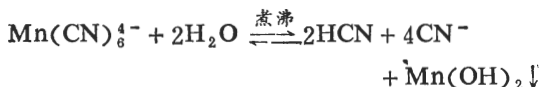
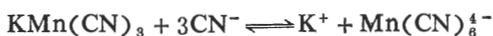


注: MnS在空气中氧化是分步进行的:







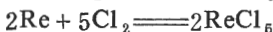
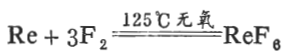


12.2 铈 $4d^5 5s^2$ Tc = 98.9062

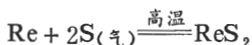
镱 $5d^5 6s^2$ Re = 186.2

注：铈和镱的化学性质很相似，下面收集的是以镱为代表的化学反应方程式。

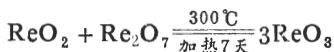
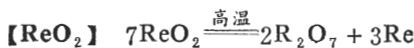
【Re】 注：Re不溶解于HCl和HF，与N₂、H₂均无作用。



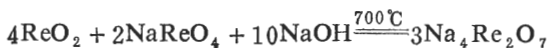
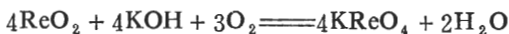
(I₂不能发生此反应)



(Tc也可发生类似反应)

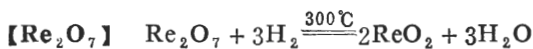


(在石英管内进行)

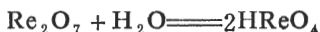


(土黄色)

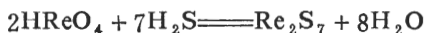
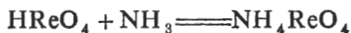
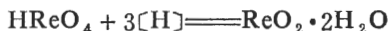
+ 5H₂O



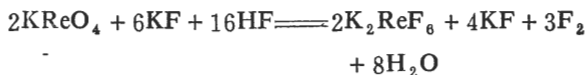
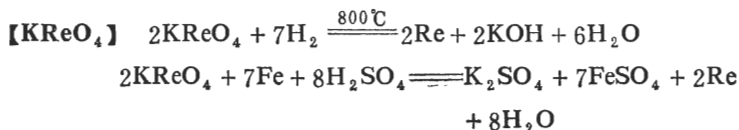
(暗棕色)



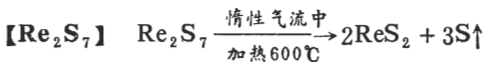
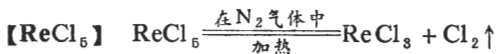
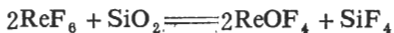
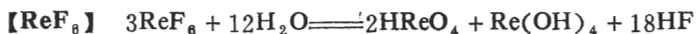
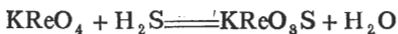
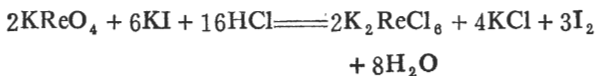
【HReO₄】 注: HReO₄能溶解各种金属、某些金属氧化物、氢氧化物和碳酸盐,生成高铼酸盐(如KReO₄、NaReO₄)。但NaReO₄极不稳定,遇水立即分解为ReO₄⁻和Na⁺。



(暗棕色固体)

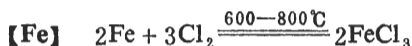


(用HCl有类似的反应)

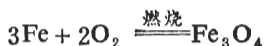
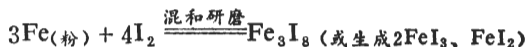


第十三章 铁系元素

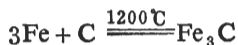
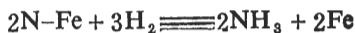
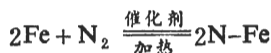
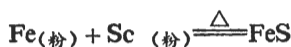
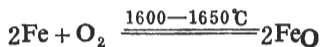
13.1 铁 $3d^6 4s^2$ Fe = 55.847



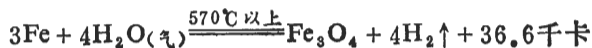
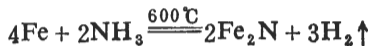
(Br₂、F₂有类似的反应)

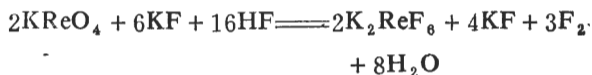
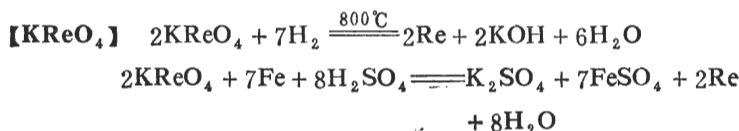


(温度再高生成Fe₂O₃)

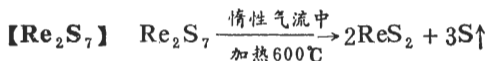
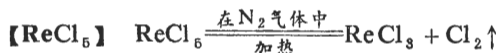
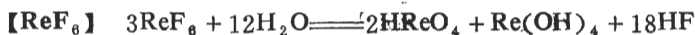
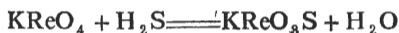
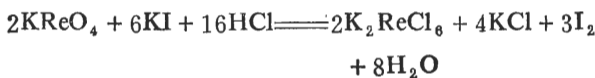


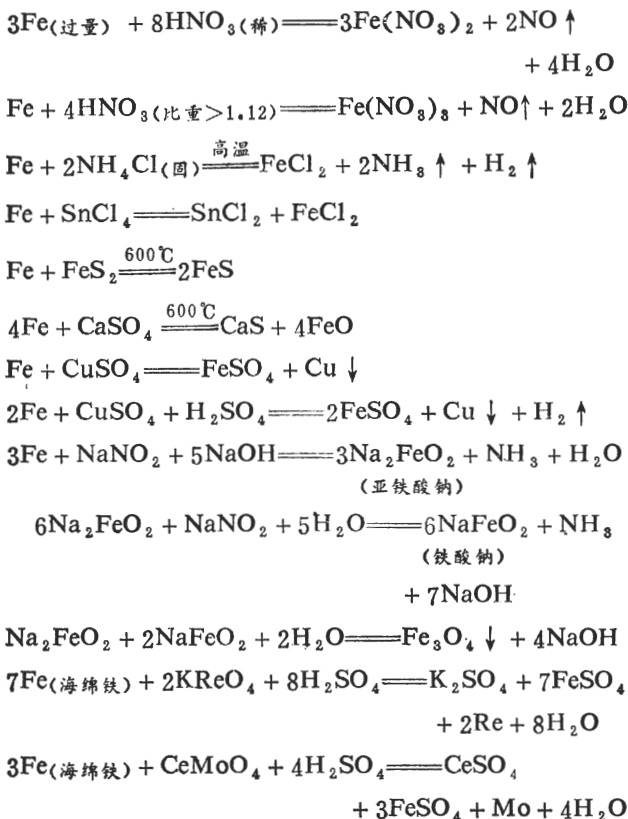
(在高炉内发生的反应)



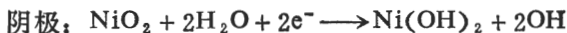


(用HCl有类似的反应)

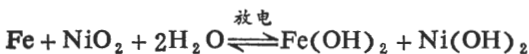




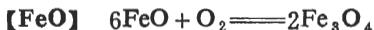
注：爱迪生蓄电池：

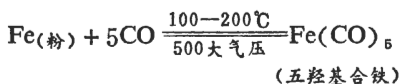


电池内净反应为下式：

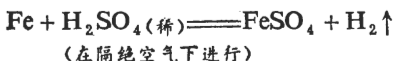
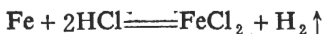
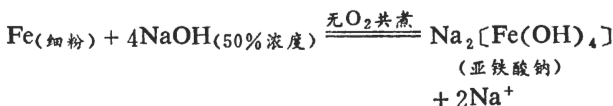
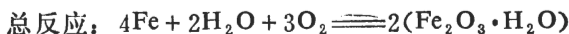
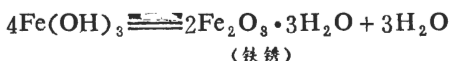
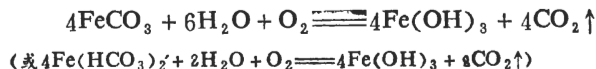
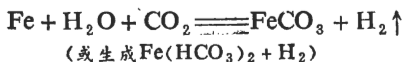


注：有关钢铁冶炼炉内的一系列反应详见其他书籍。

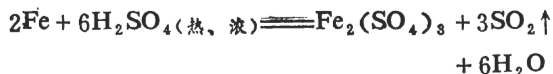




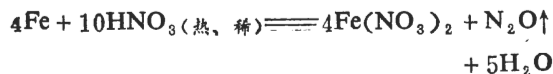
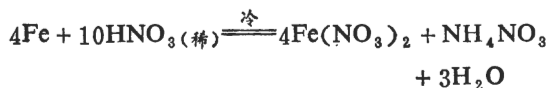
注：铁生锈的反应：

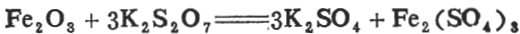
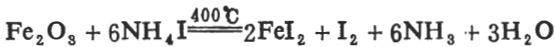
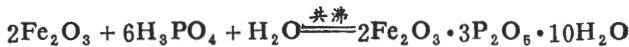
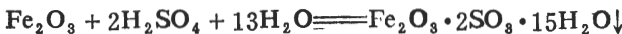
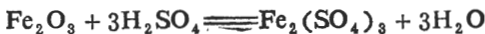
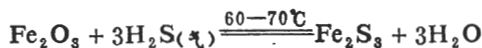
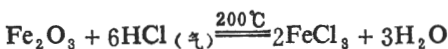
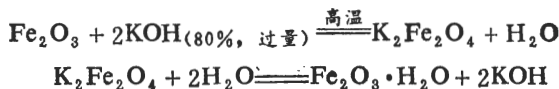
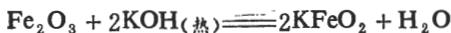
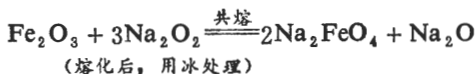
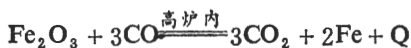
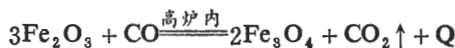
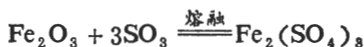
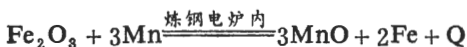
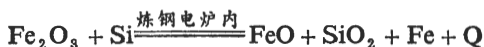
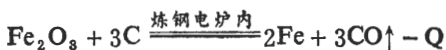


注：冷浓 H_2SO_4 与 Fe 不起反应，使 Fe 呈“钝态”。碱不与铁起反应。

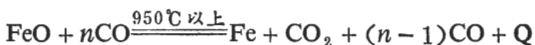
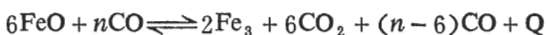
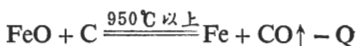


注：冷、浓 HNO_3 与 Fe 不起反应，使 Fe 呈“钝态”，“钝态”后的 Fe 不再与 HNO_3 反应，也不能从硫酸铜溶液中置换出 Cu。

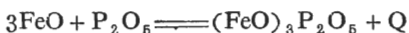
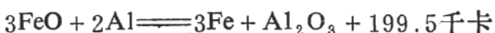
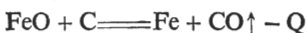
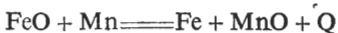
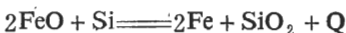




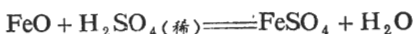
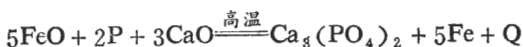
注：高炉内的反应：



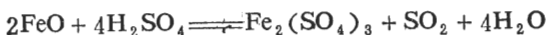
注：转炉内的反应：



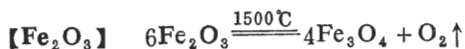
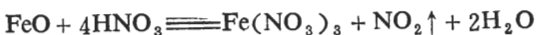
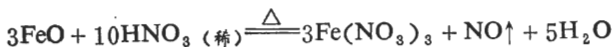
(磷酸铁)



(FeO与无氧化性的酸反应)

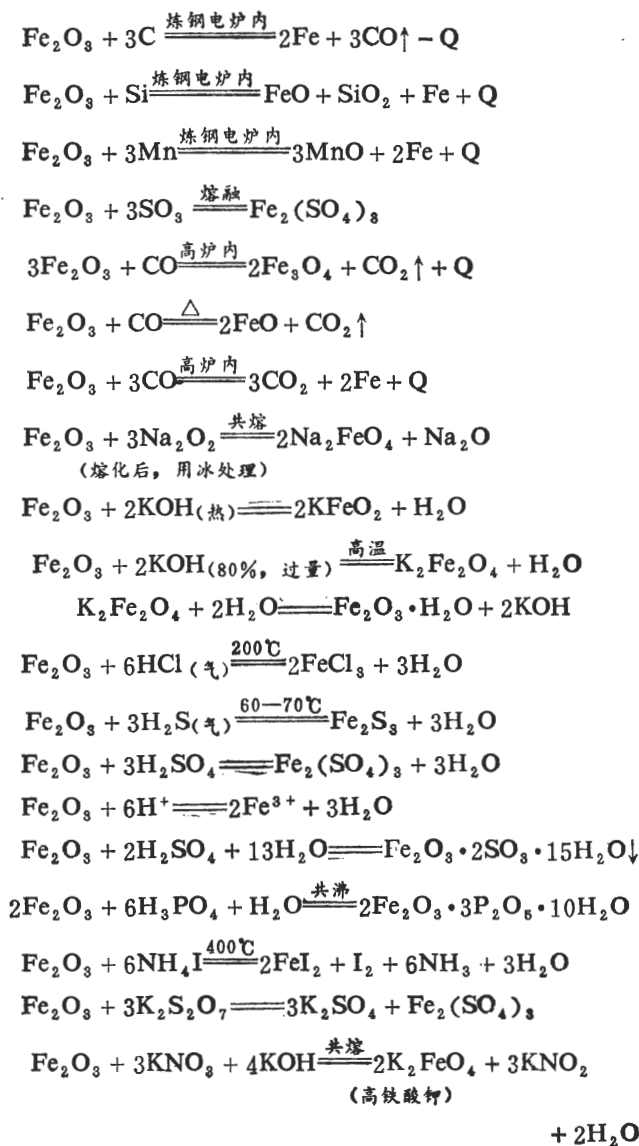


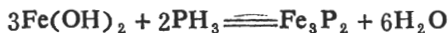
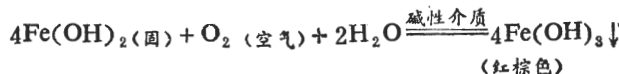
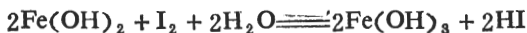
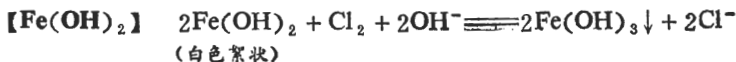
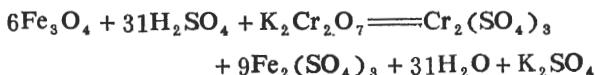
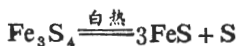
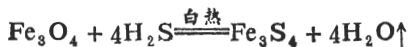
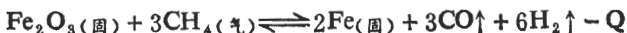
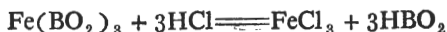
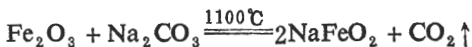
(有H₃PO₄参加的反应)



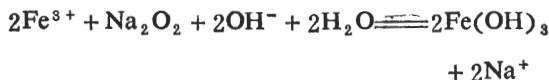
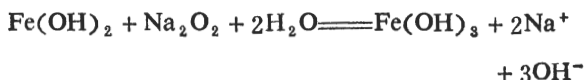
(中间还可生成FeO)

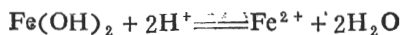




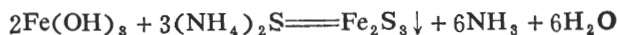
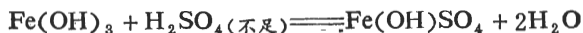
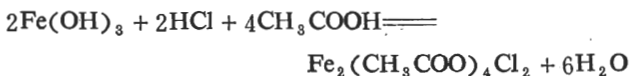
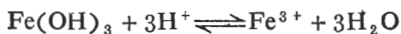
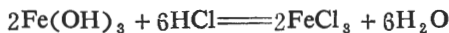
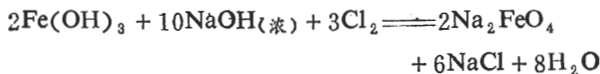
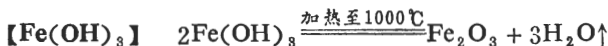
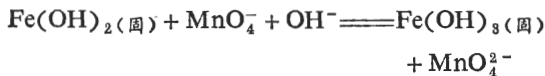
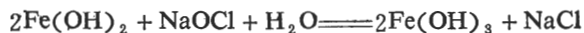
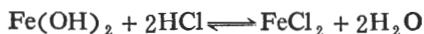
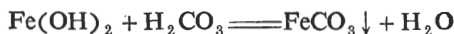


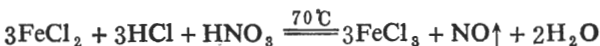
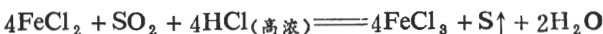
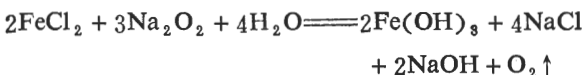
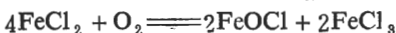
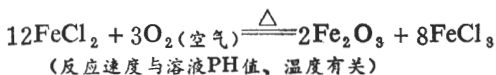
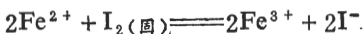
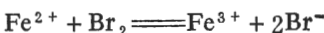
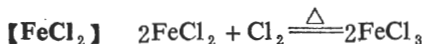
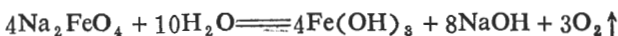
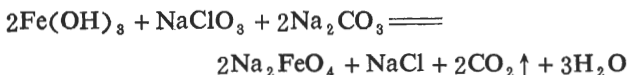
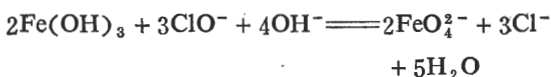
(此反应和 $\text{FeSO}_4 + \text{KOH} + \text{P}$ 的反应相类似)



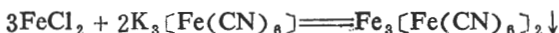
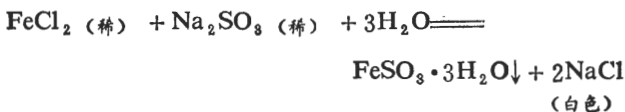


($\text{Fe}(\text{OH})_2$ 不溶于碱)





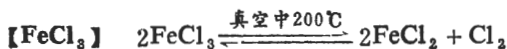
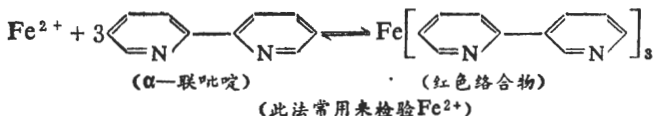
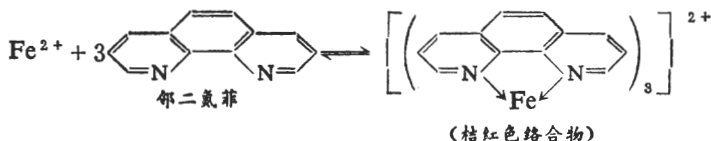
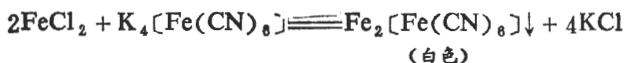
(M表示碱金属)



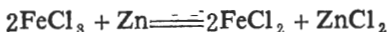
(钾氰化钾又叫赤血盐) (亚铁氰化铁又叫滕氏蓝)



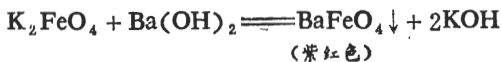
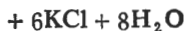
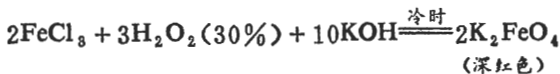
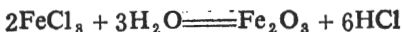
(常用此法检验Fe²⁺)



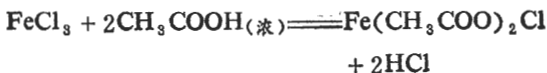
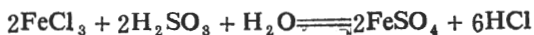
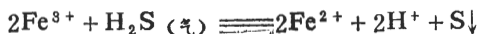
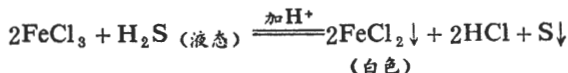
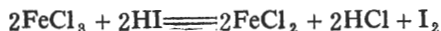
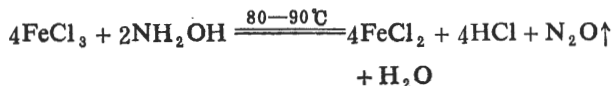
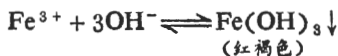
(FeBr₃更易分解, FeCl₃只部分分解)



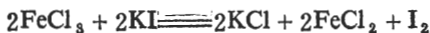
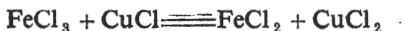
(在酸性溶液中进行反应)



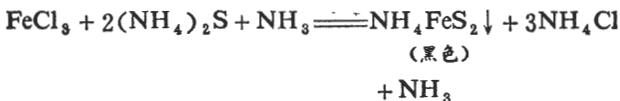
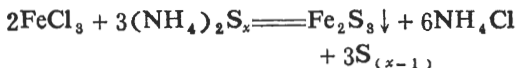
(HgO有类似的反应)

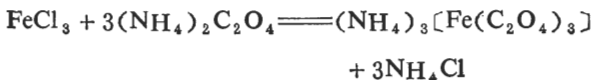
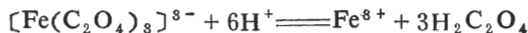
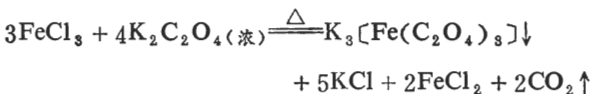
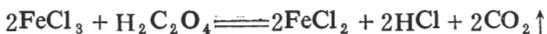
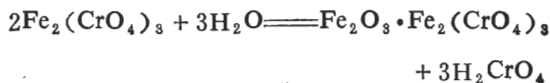
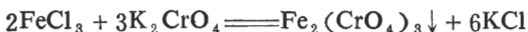
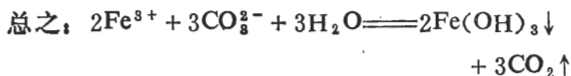
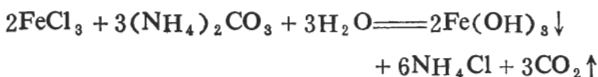
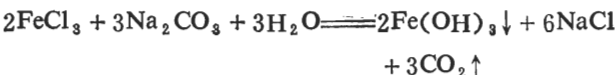
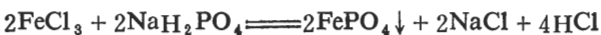
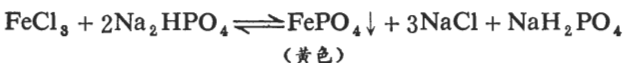
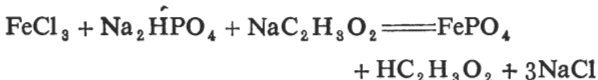
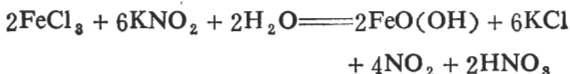
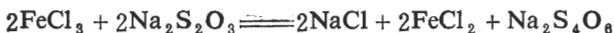
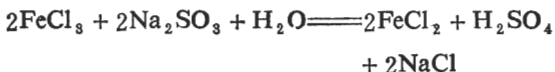


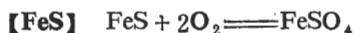
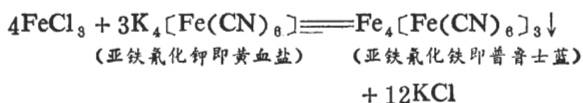
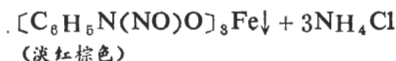
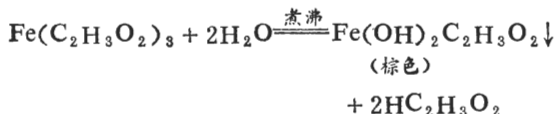
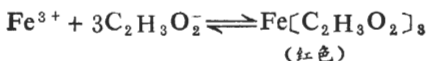
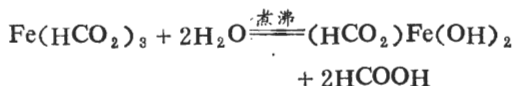
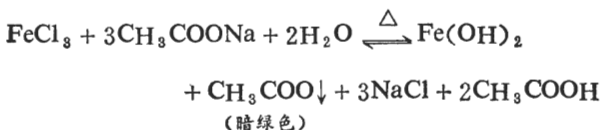
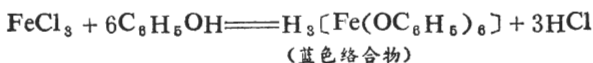
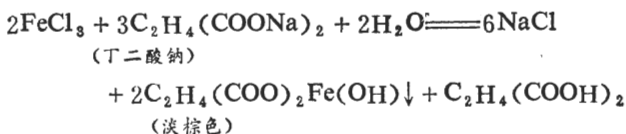
(FeBr₃有类似的反应)



(与Br⁻也有类似的反应)

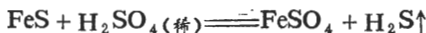
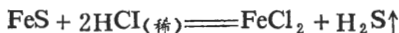
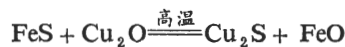
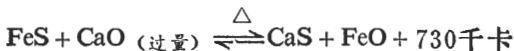
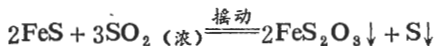
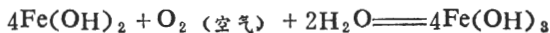
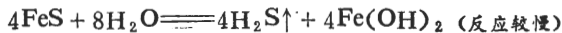








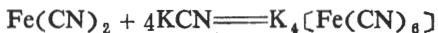
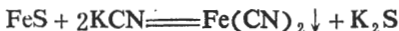
(炼铁炉内的反应)



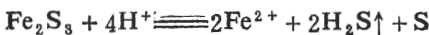
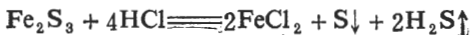
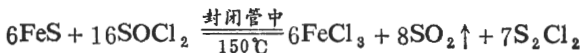
(不能生成 H_2S)



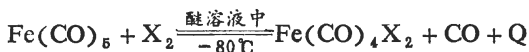
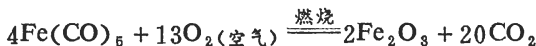
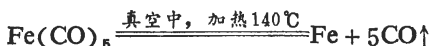
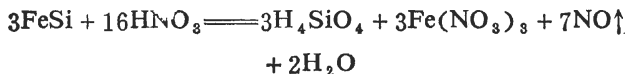
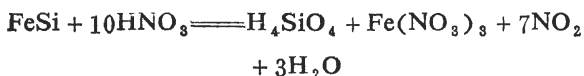
(因, $\text{S} + 2\text{HNO}_3 \rightleftharpoons \text{H}_2\text{SO}_4 + 2\text{NO}\uparrow$)



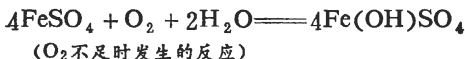
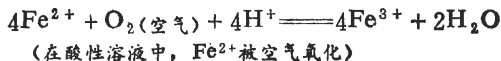
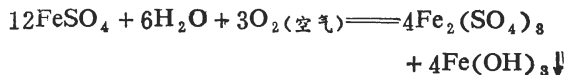
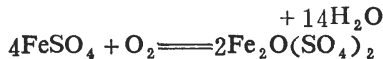
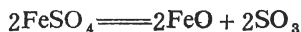
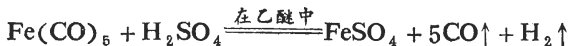
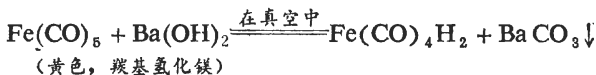
(FeS与过量的KCN反应)

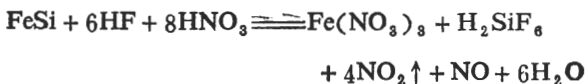
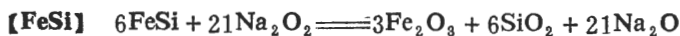
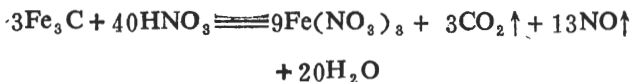
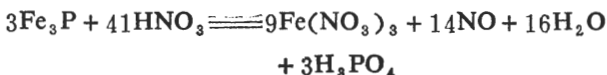
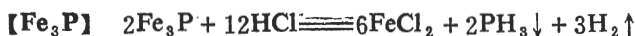
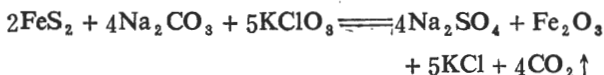
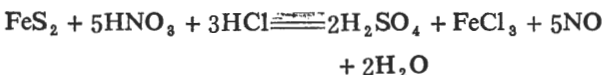
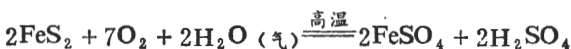
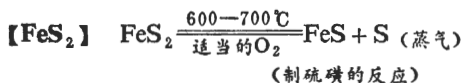
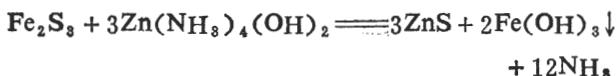


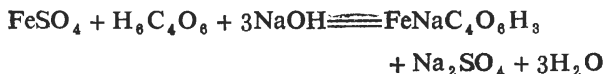
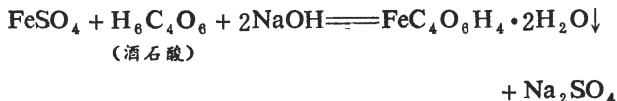
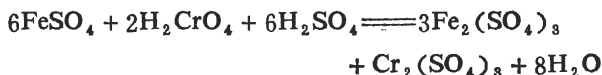
(Fe₂S₃溶于酸而不溶于碱)



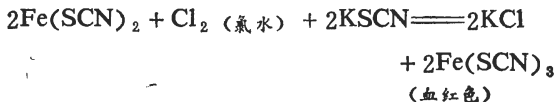
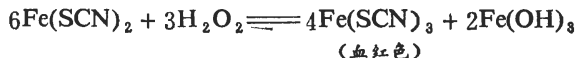
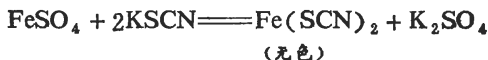
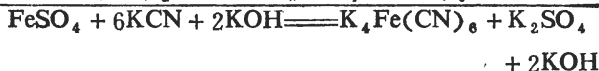
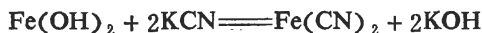
(X表示卤素)



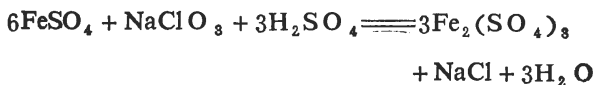
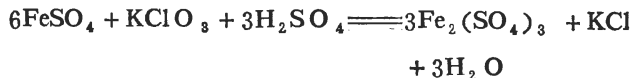
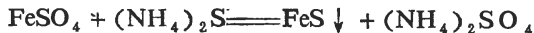
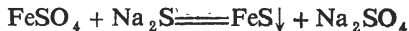




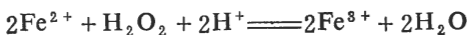
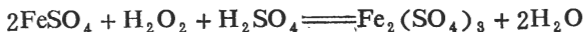
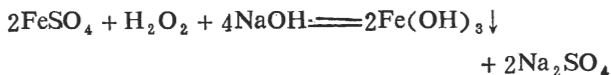
FeSO_4 与 KCN 、 KOH 作用:



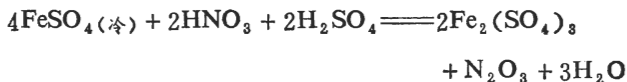
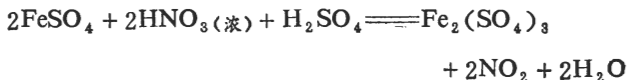
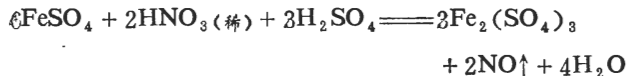
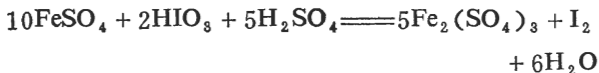
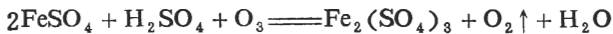
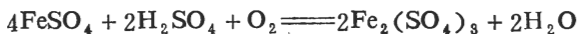
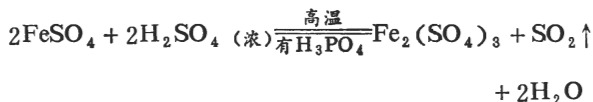
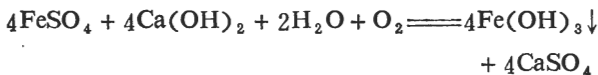
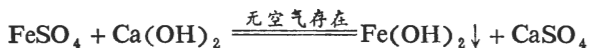
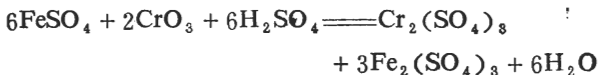
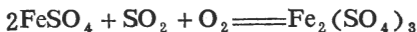
(此法用来检验 Fe^{2+} 的存在)

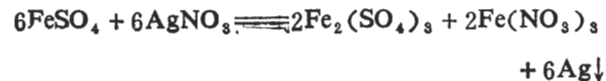
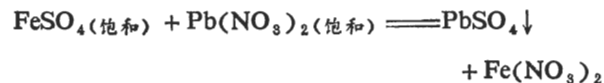
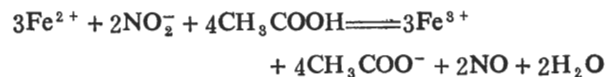
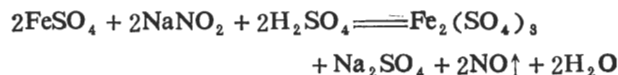
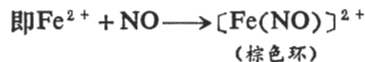
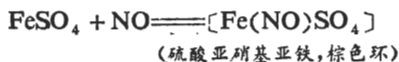
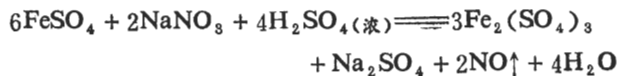
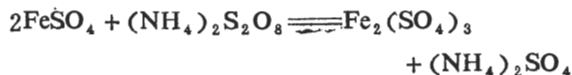
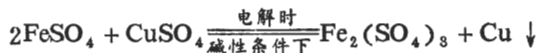
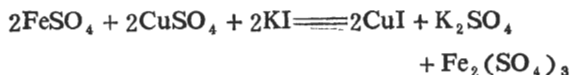
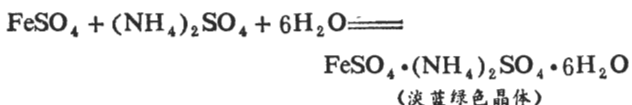
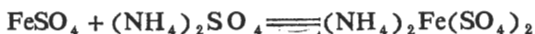
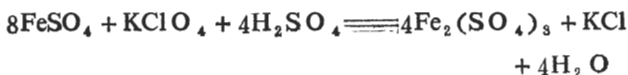


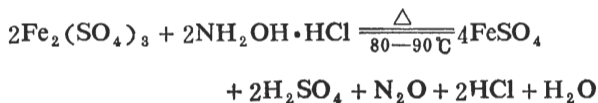
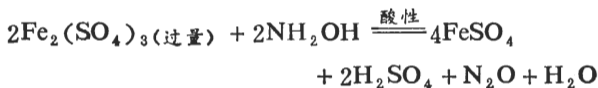
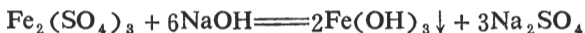
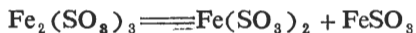
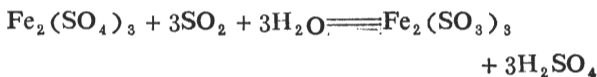
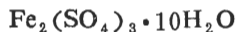
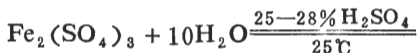
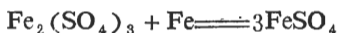
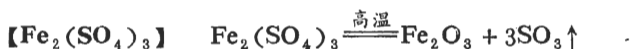
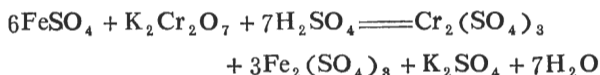
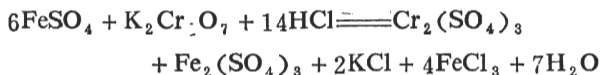
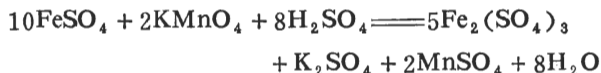
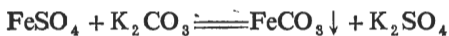
(KBrO_3 有类似的反应)

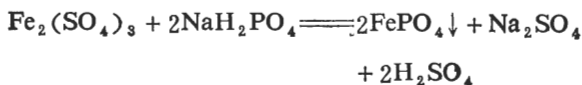
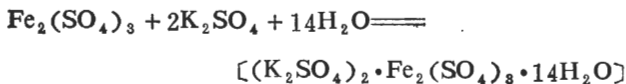
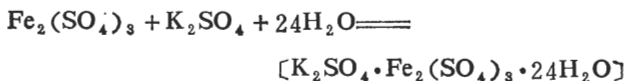
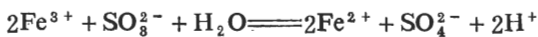
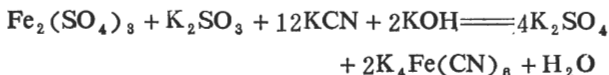
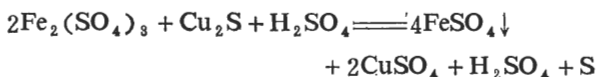
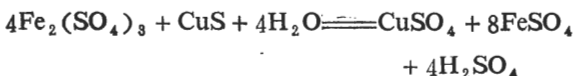
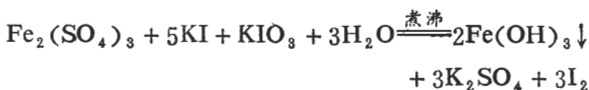
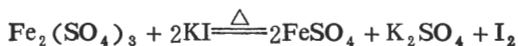
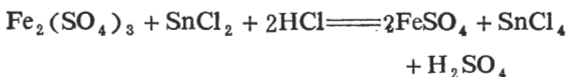
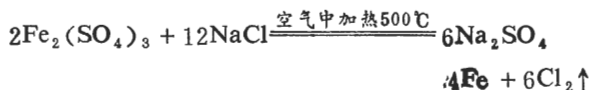
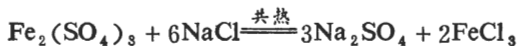
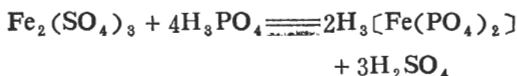
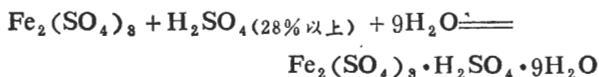


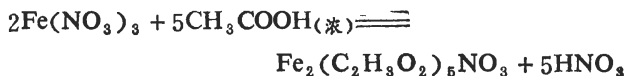
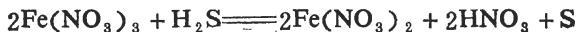
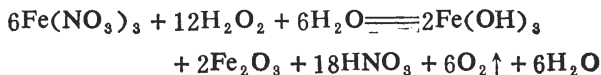
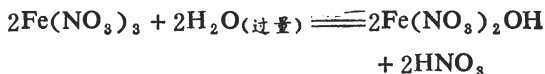
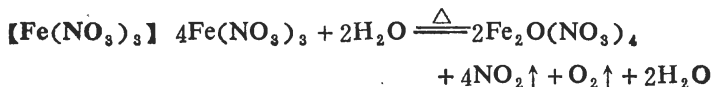
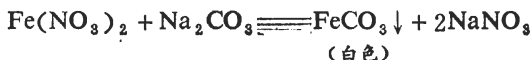
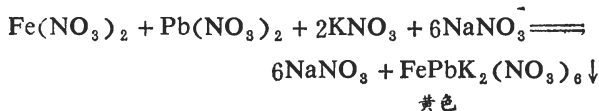
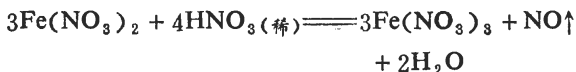
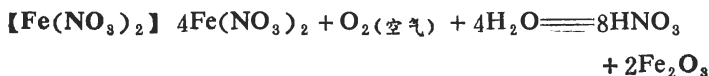
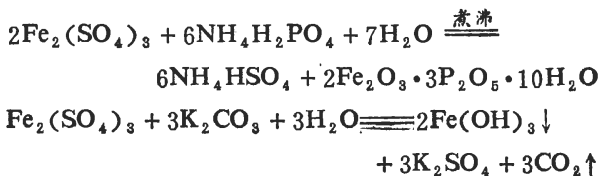
(H_2O_2 作为氧化剂)





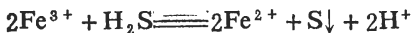




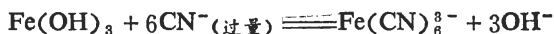


【Fe³⁺】 注：三价铁盐水解是逐步进行的，溶液的颜色由棕黄变深棕色。



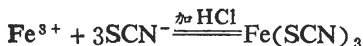


(反应需在酸性溶液中进行)

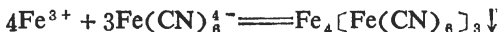


(红色)

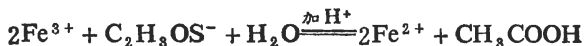
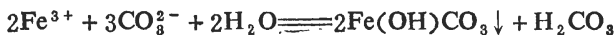
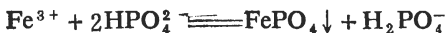
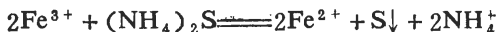
(式中 $n=1-6$)



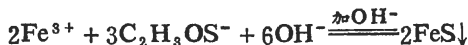
(血红色)



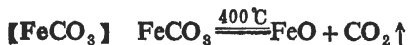
(黑蓝色)

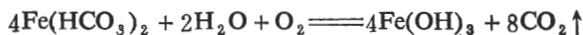
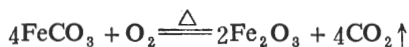


+ S↓ + H⁺

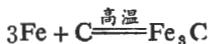
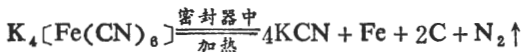
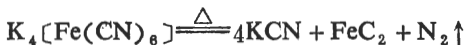
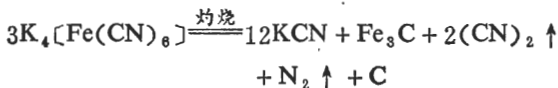
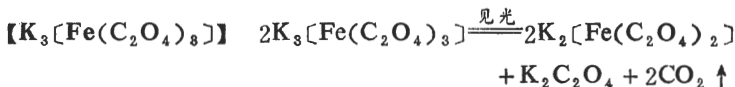
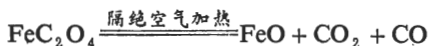
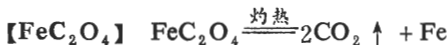
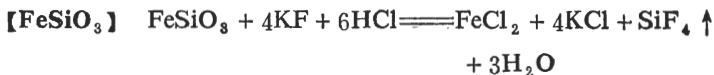
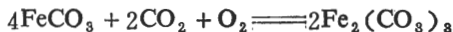


+ 3CH₃COO⁻ + S + 3H₂O



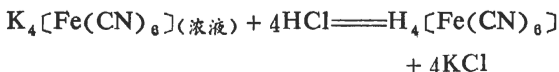
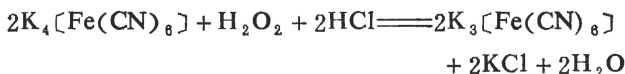
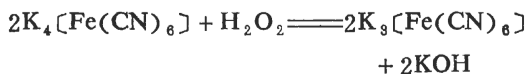
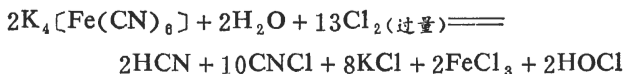
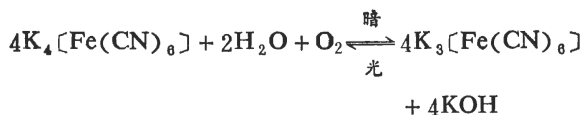
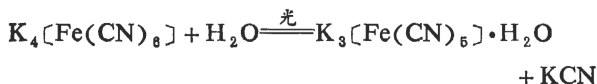


(铁菌体内的反应)

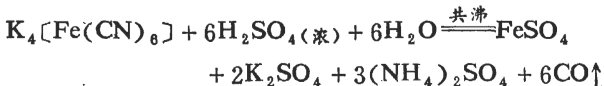
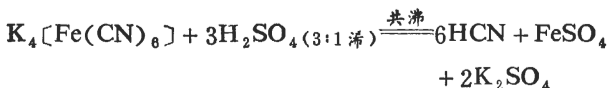
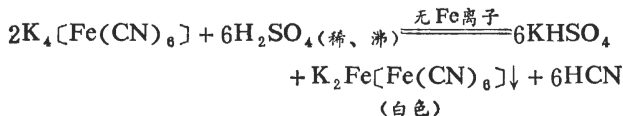


注: $\text{K}_4[\text{Fe}(\text{CN})_6]$ 在溶液中的分解。

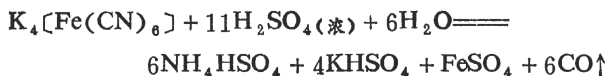


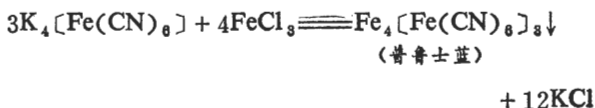
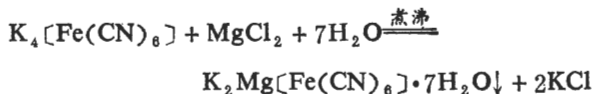
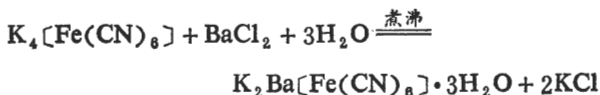
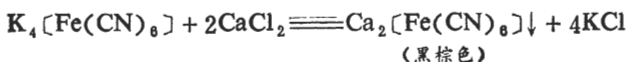
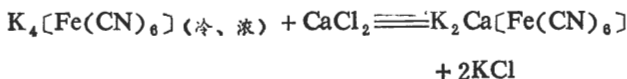
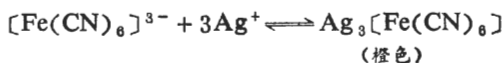
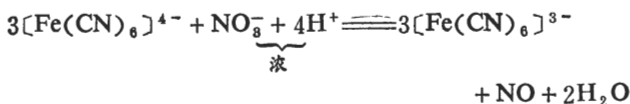
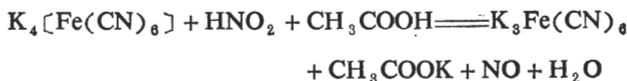
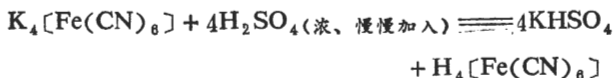
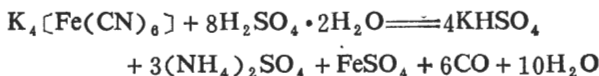
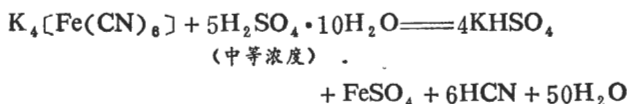


(生成物用醚抽取后可得一种白色固体)

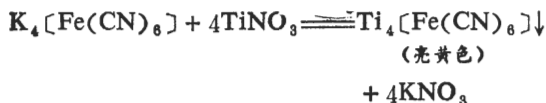
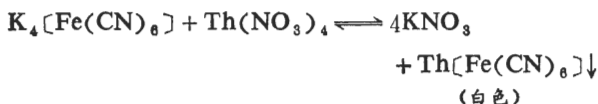
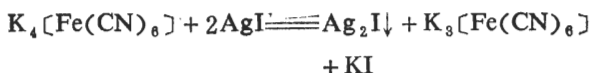
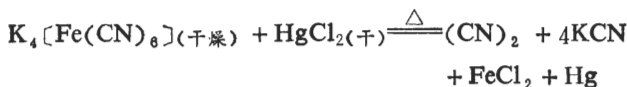
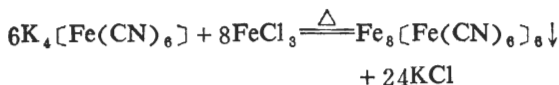
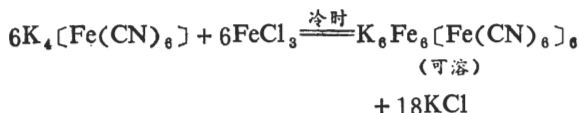


(上反应还有 SO_2 放出, 因为:

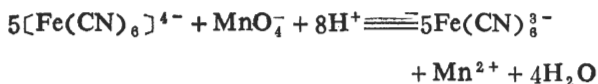
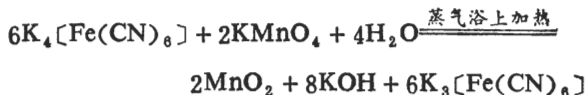
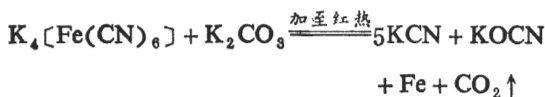
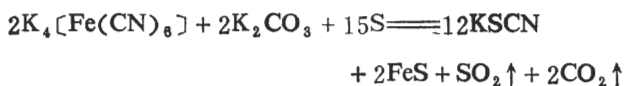


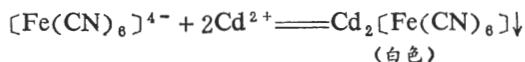
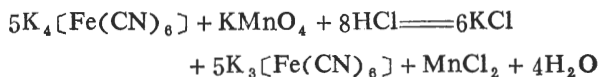
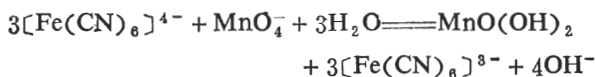


(普鲁士蓝沉淀不溶于稀酸，能被KOH所分解)

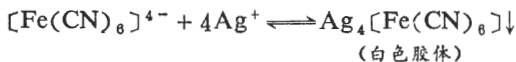
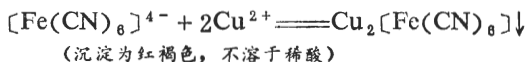
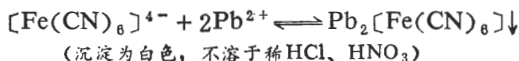
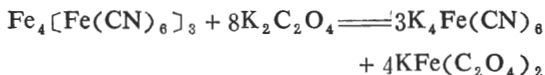
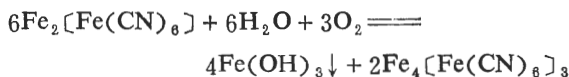
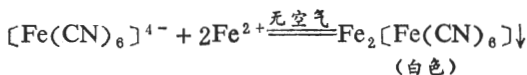


注: $[\text{Fe}(\text{CN})_6]^{4-}$ 与 TiCl_4 作用生成淡红棕色的 $\text{Ti}[\text{Fe}(\text{CN})_6]$ 沉淀, 沉淀不溶于 NH_4Cl 。

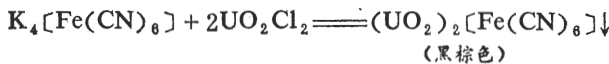
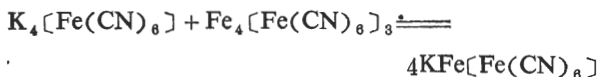




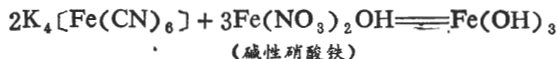
(沉淀不溶于稀HCl)



(Ag₄[Fe(CN)₆]不溶于稀HNO₃和NH₄OH浓硝酸能氧化它为橙色铁氯化银Ag₃[Fe(CN)₆])

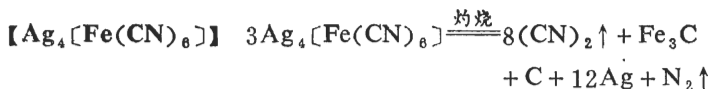
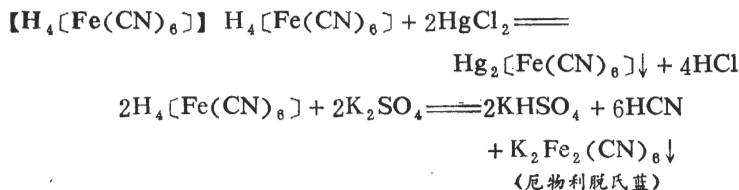
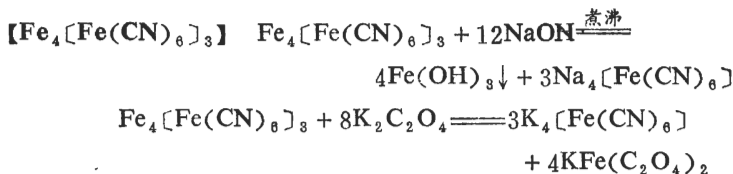


+ 4KCl

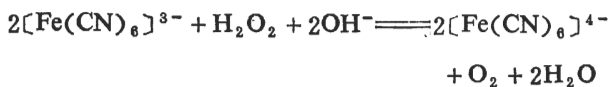
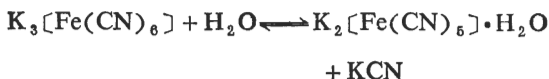
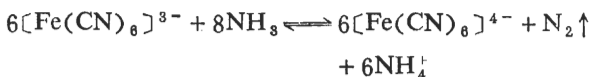
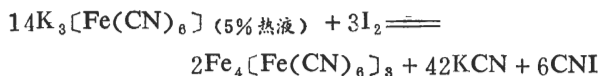
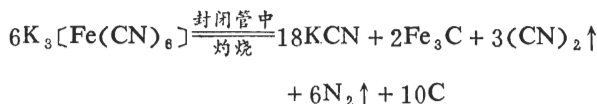


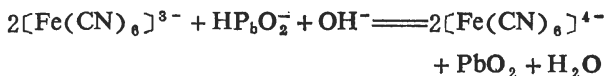
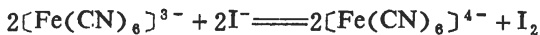
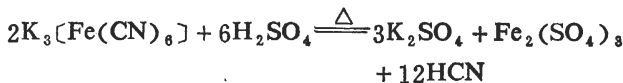
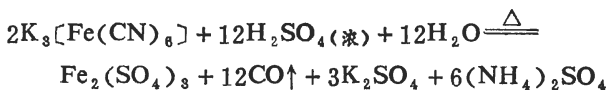
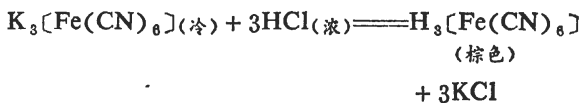
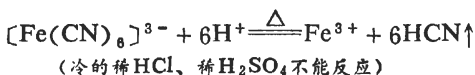
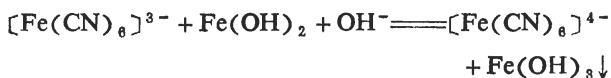
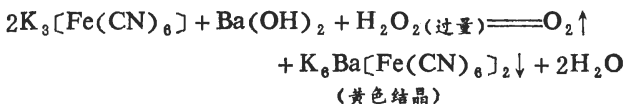
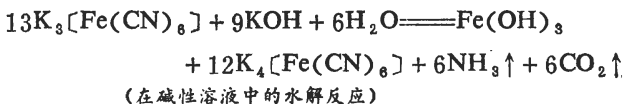
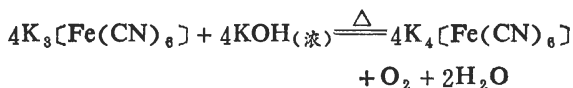
注: [Fe(CN)₆]⁴⁻与钼酸铵的盐酸溶液作用时, 生成棕

色的亚铁氰化钼沉淀，此沉淀不溶于稀酸，但溶于碱金属氢氧化物。

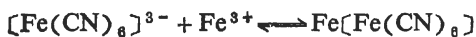


【K₃[Fe(CN)₆]】和【[Fe(CN)₆]³⁻】

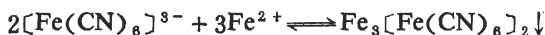




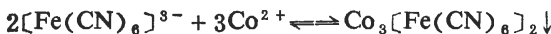
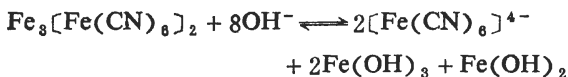
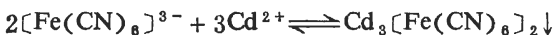
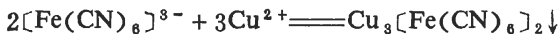
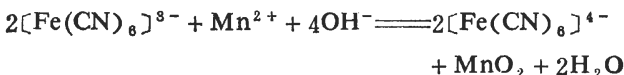
注: Fe³⁺跟[Fe(CN)₆]³⁻在溶液中不产生沉淀, 但使溶液变成暗棕色。如:



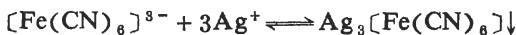
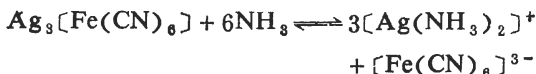
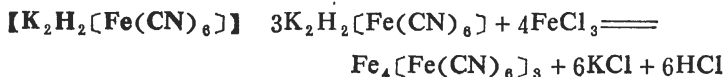
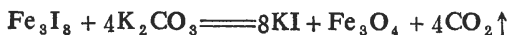
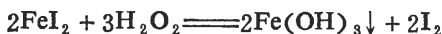
(暗棕色溶液)



(所生沉淀为深蓝色叫邓布兰, 不溶于酸, 可被碱分解)

(Co₃[Fe(CN)₆]₂为红色沉淀, 不溶于HCl, 溶于氨水中)(Cd₃[Fe(CN)₆]₂为橙色沉淀, 不溶于稀酸, 但溶于浓HNO₃中)

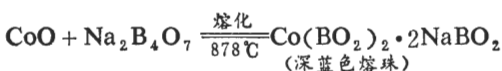
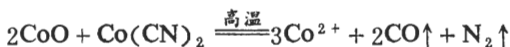
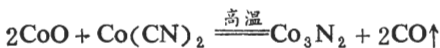
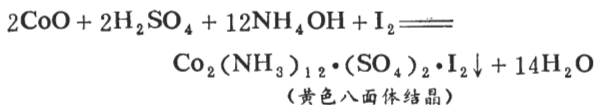
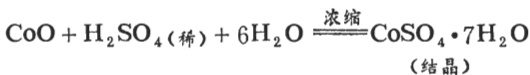
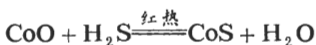
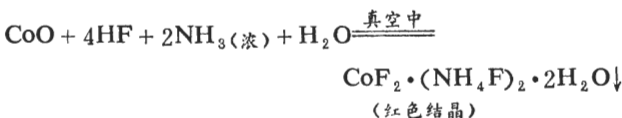
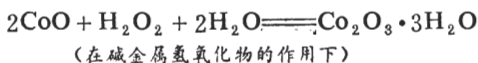
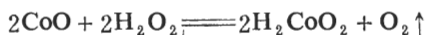
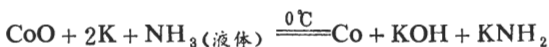
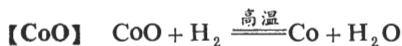
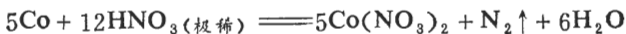
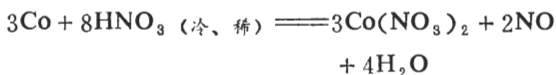
(生成物为绿色沉淀, 不溶于盐酸)

(Ag₃[Fe(CN)₆]为橙色沉淀, 不溶于HNO₃, 溶于稀氨溶液, 与亚铁氰酸根离子不同)**注:** K₃[Fe(CN)₆](稀)与钡盐、钙盐均无作用。**【其他含铁的化合物】**

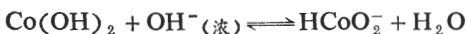
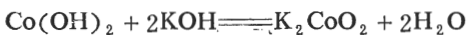
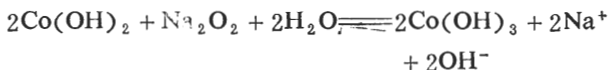
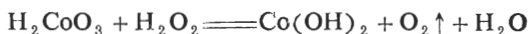
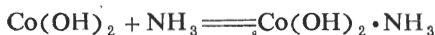
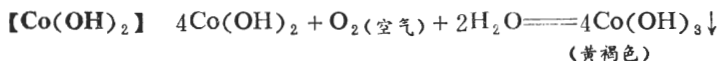
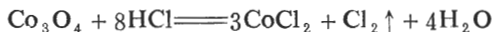
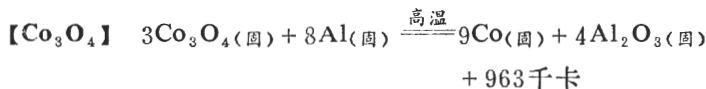
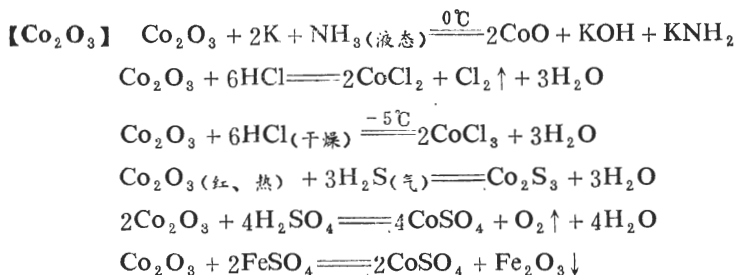
(在溶液中反应)



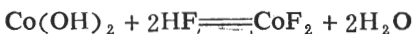
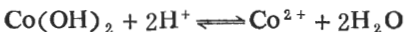
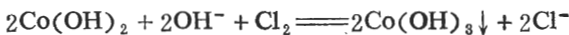
Cl₂等反应。反应情况很象铁。



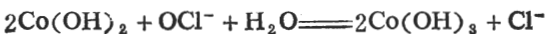
(Fe₂O₃与Na₂B₄O₇或NiO与Na₂B₄O₇均有类似的反应)

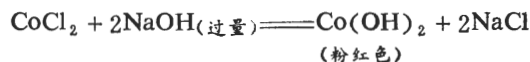
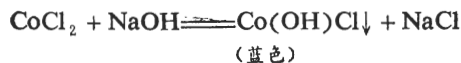
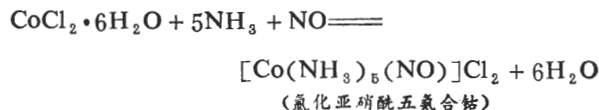
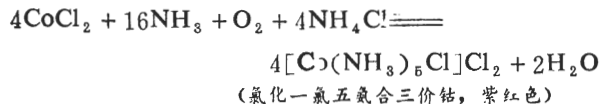
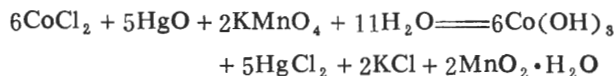
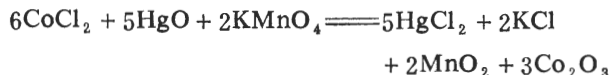
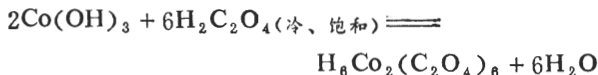
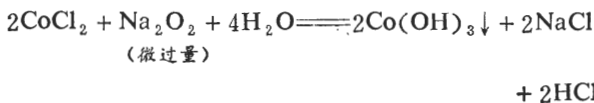
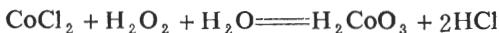
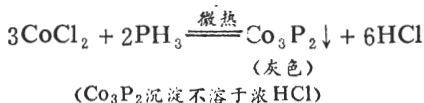
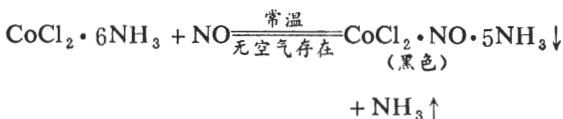
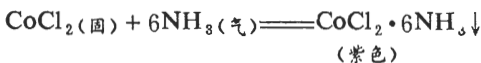


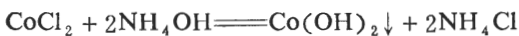
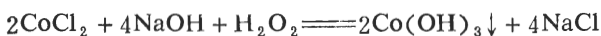
(此反应较慢)



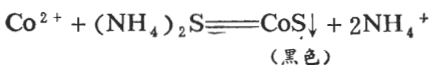
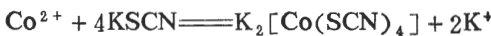
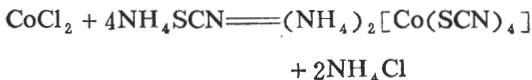
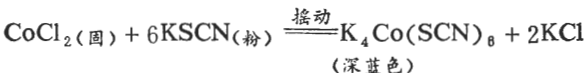
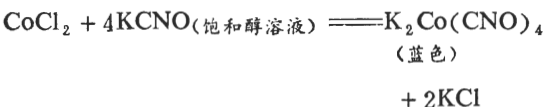
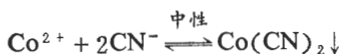
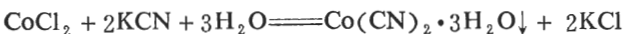
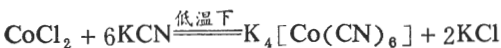
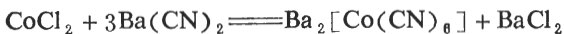
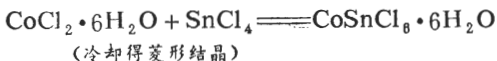
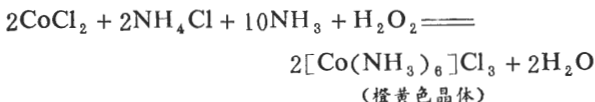
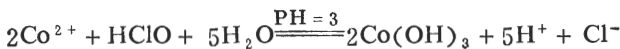
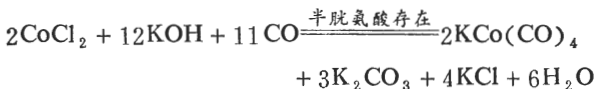
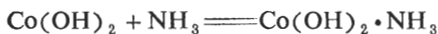
(暗红色结晶)

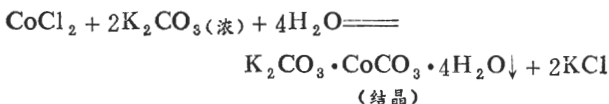
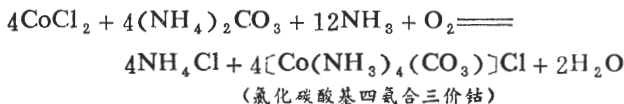
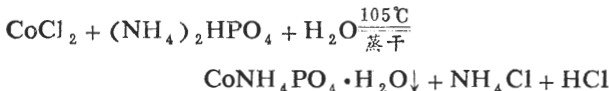
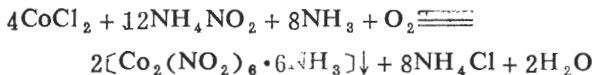
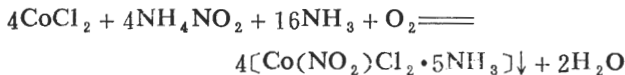
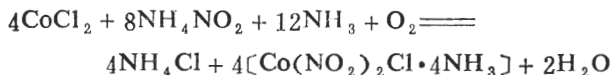
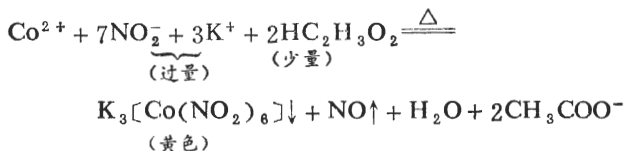
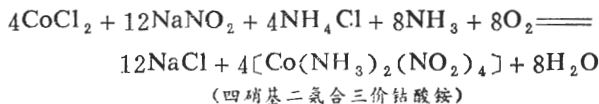
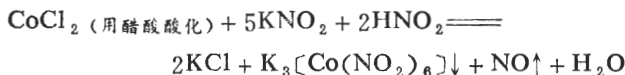
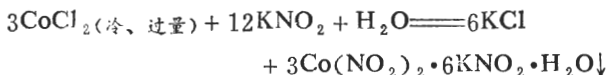
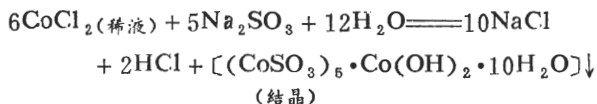


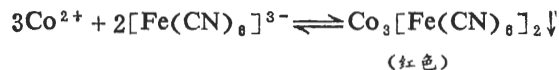
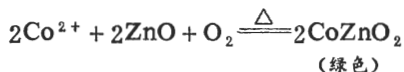
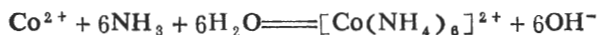
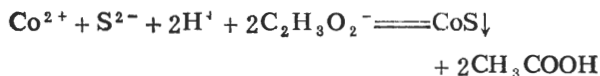
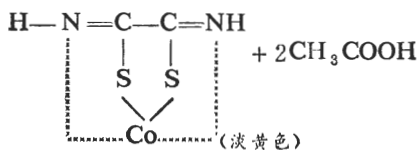
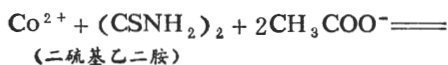
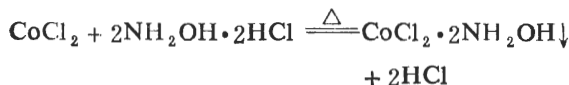
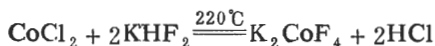
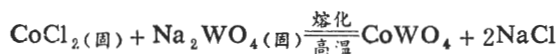
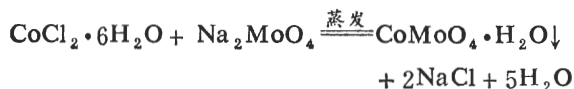
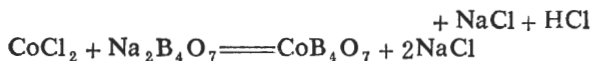
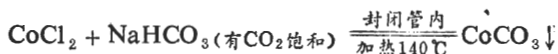
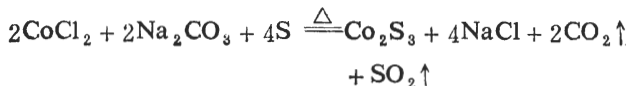


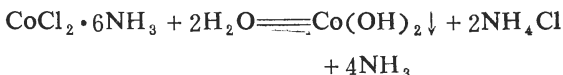
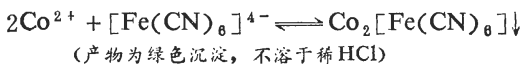


($\text{Co}(\text{OH})_2$ 沉淀溶于过量的 NH_3)

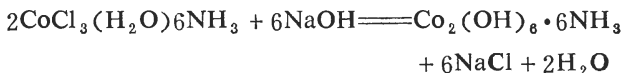
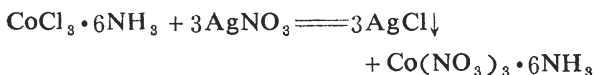
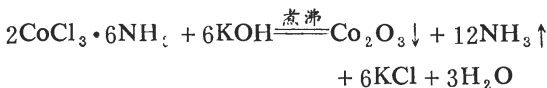
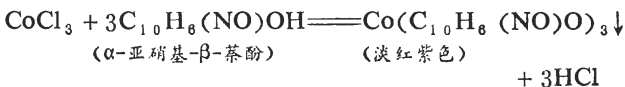
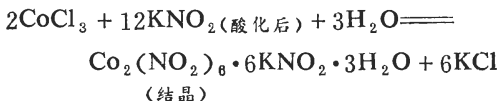




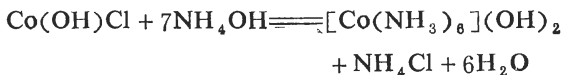




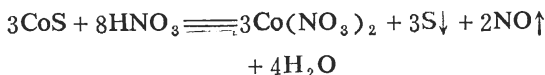
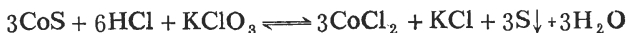
【CoCl₃】、**【CoCl₃·xNH₃】**、**【CoCl₃·xNH₃·少量H₂O】**



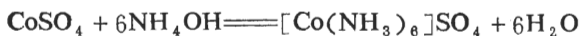
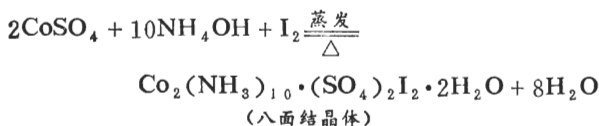
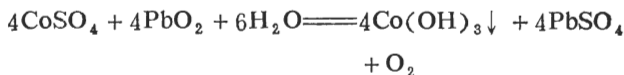
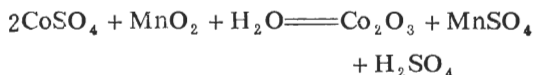
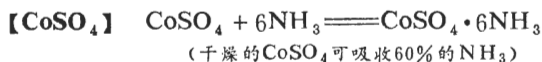
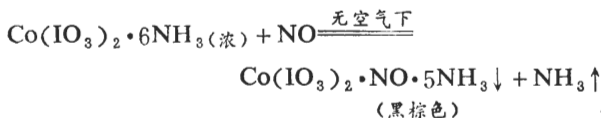
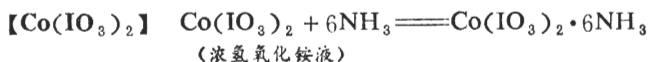
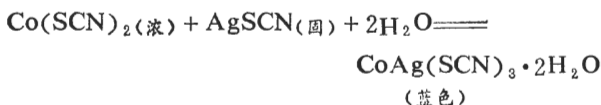
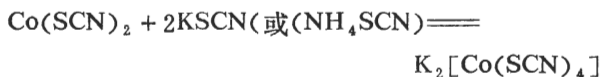
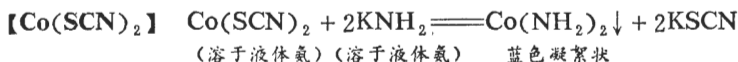
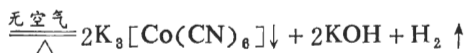
【Co(OH)Cl】 $\text{Co}(\text{OH})\text{Cl} + \text{NaOH} \rightleftharpoons \text{Co}(\text{OH})_2 \downarrow + \text{NaCl}$



【CoS】 $\text{CoS} + 2\text{H}^+ + \text{H}_2\text{O}_2 \xrightarrow{\Delta} \text{Co}^{2+} + \text{S} \downarrow + 2\text{H}_2\text{O}$

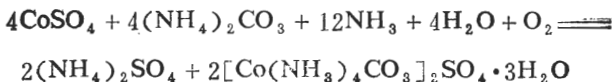
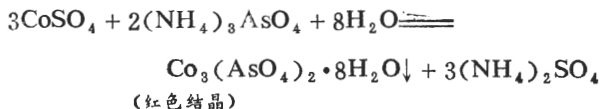
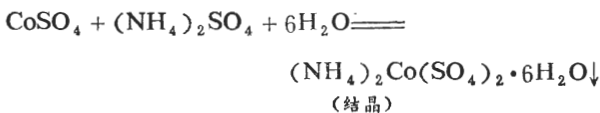
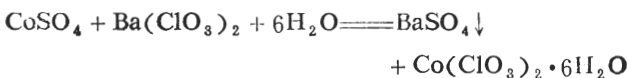
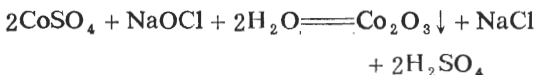
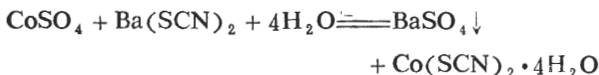
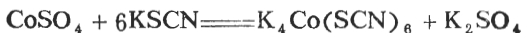
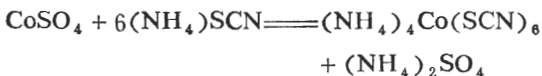
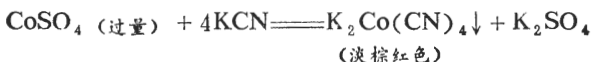
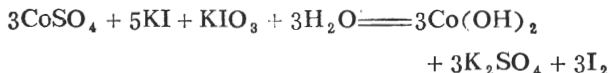
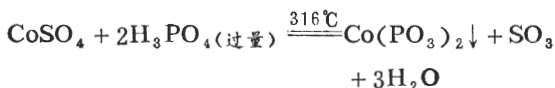
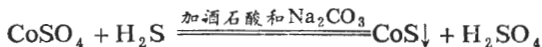


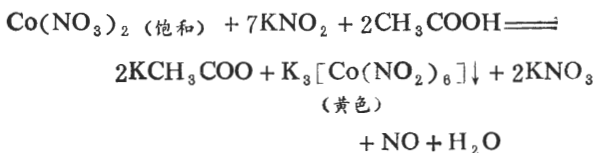
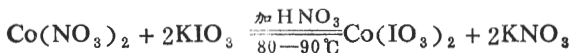
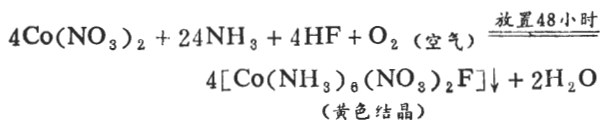
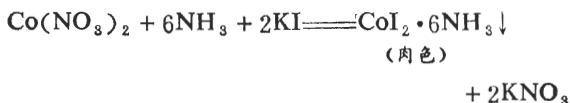
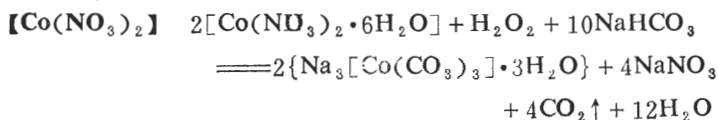
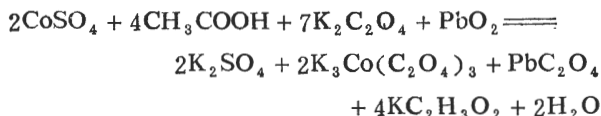
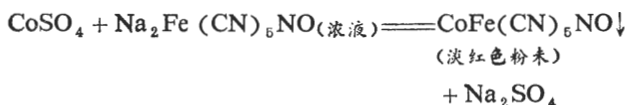
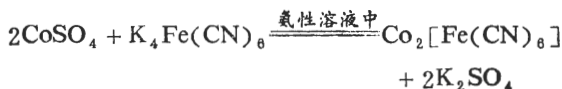
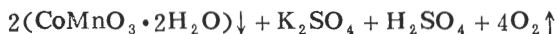
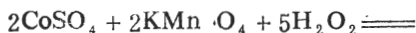
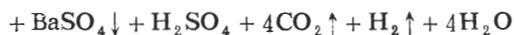
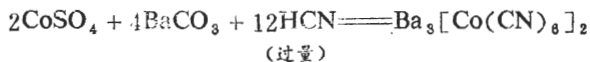
【Co(CN)₂】 $2\text{Co}(\text{CN})_2 + 8\text{KCN} + 2\text{H}_2\text{O}$

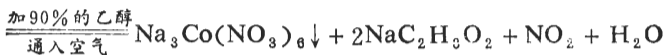
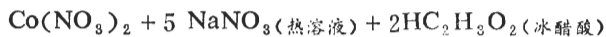




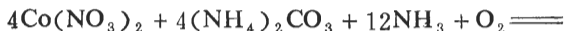
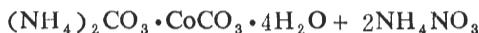
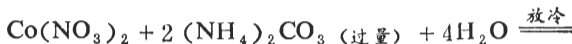
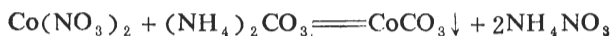
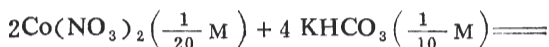
(加NaOH有类似的反应)



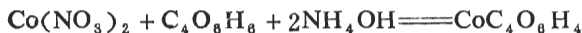
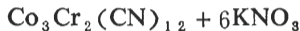
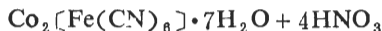
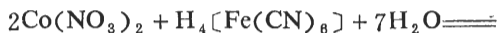




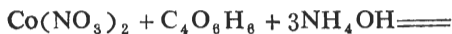
(硝酸六氨合三价钴)



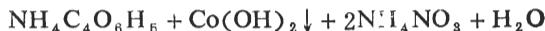
(硝酸—碳酸基四氨合三价钴)

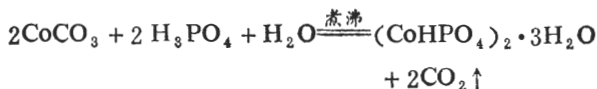
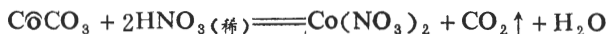
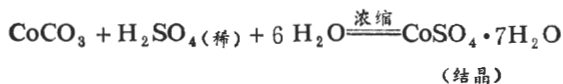
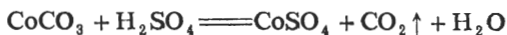
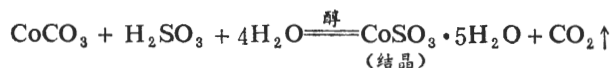
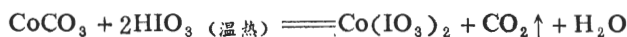
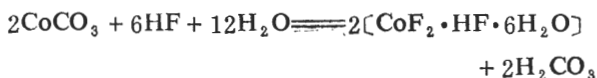
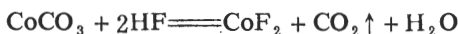
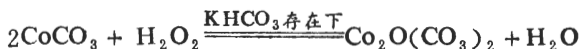
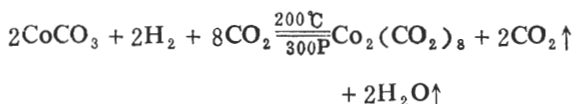
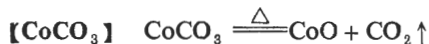
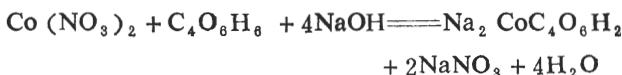
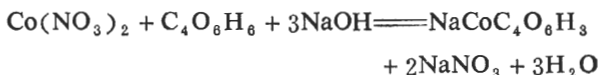
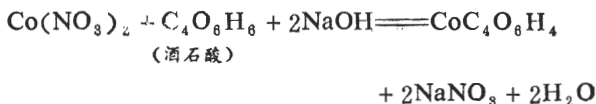


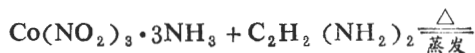
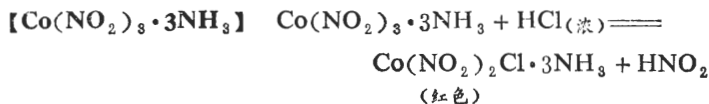
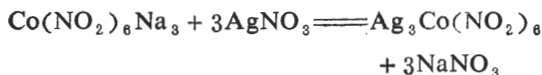
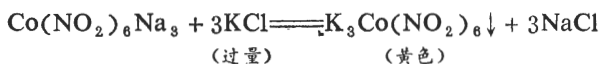
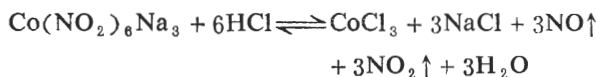
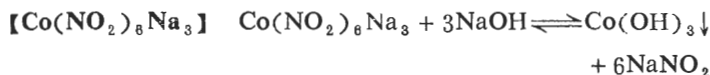
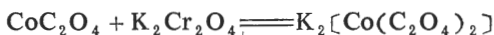
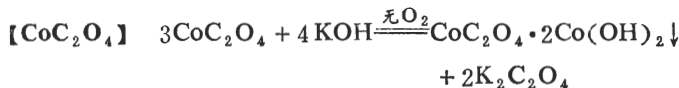
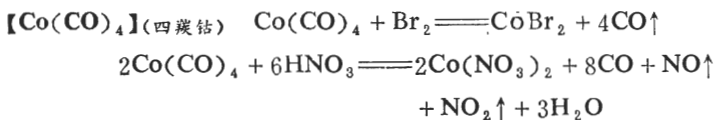
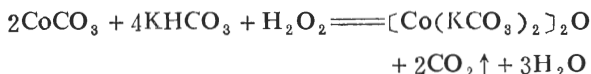
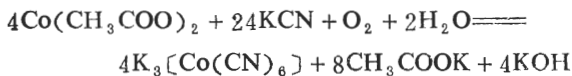
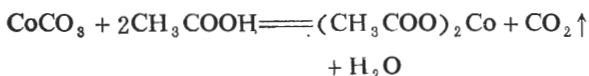
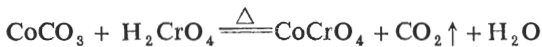
(酒石酸)



(酒石酸)

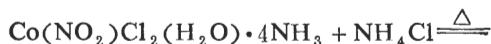
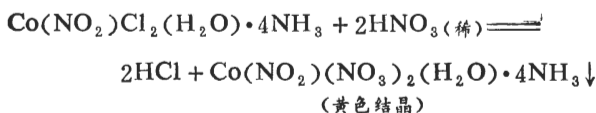
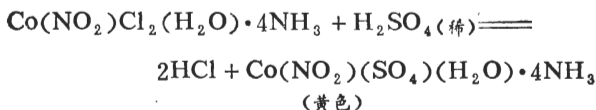
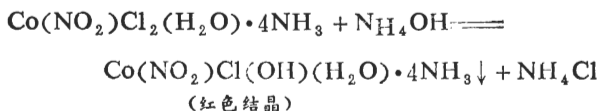
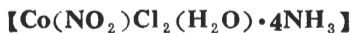
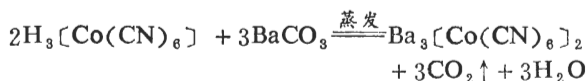
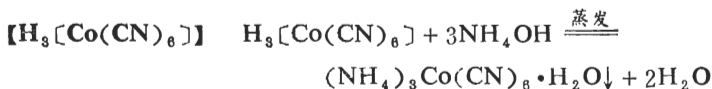
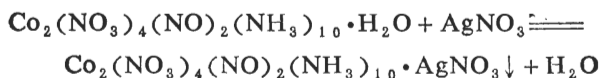
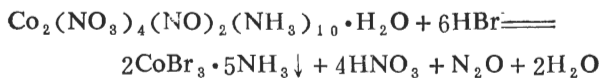
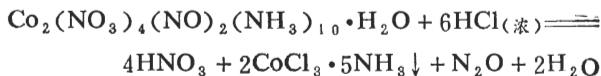
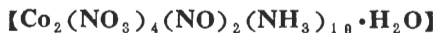
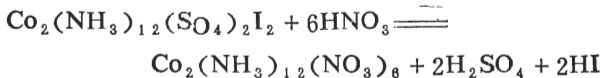
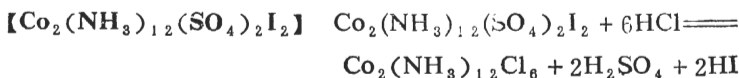


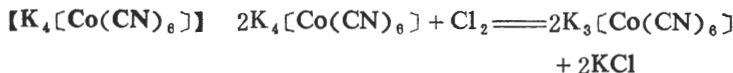
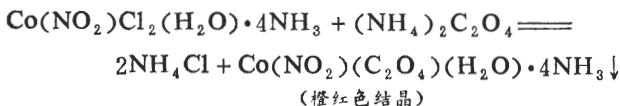




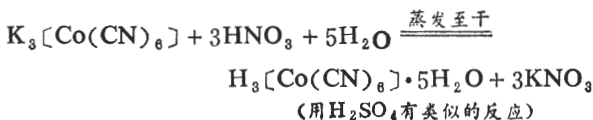
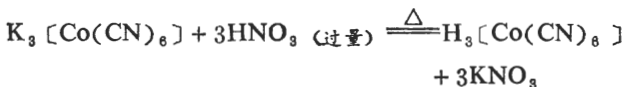
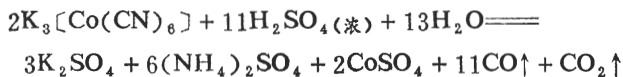
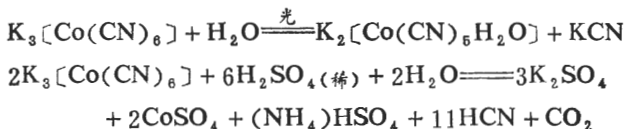
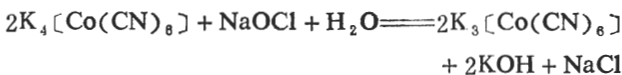
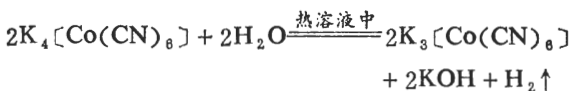
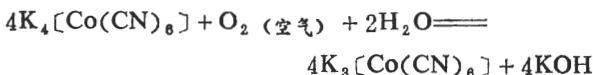
(10% 乙二胺)

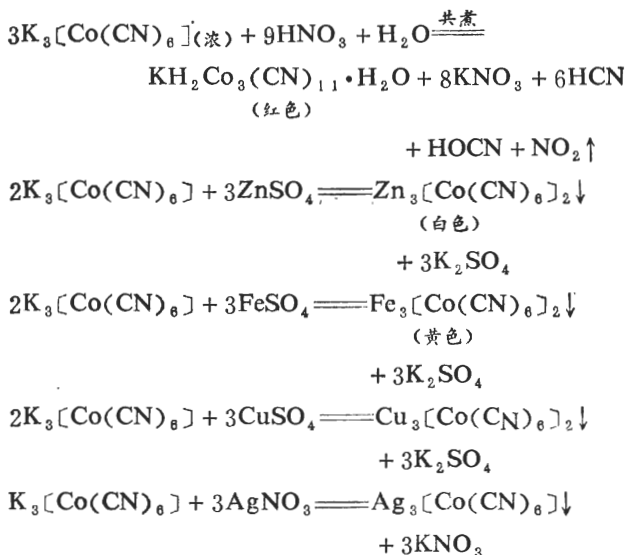




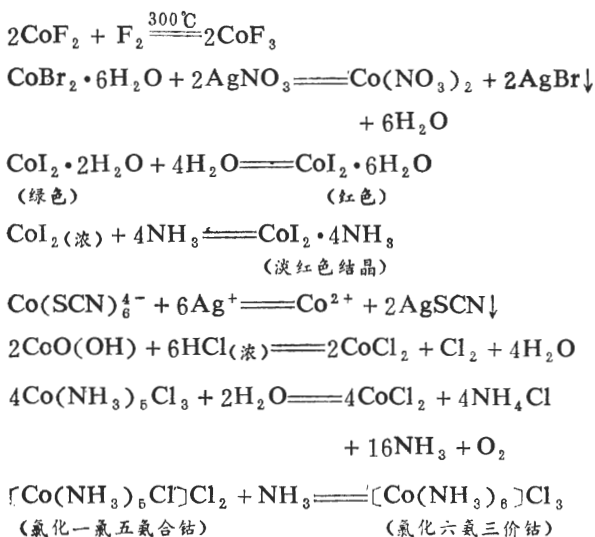


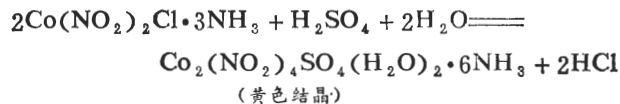
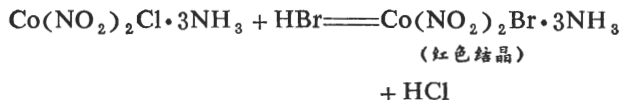
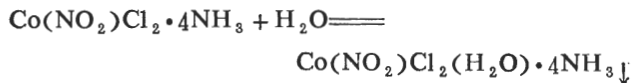
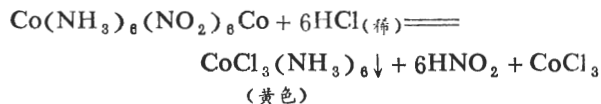
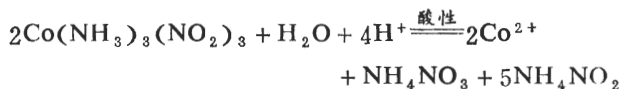
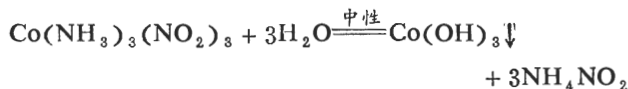
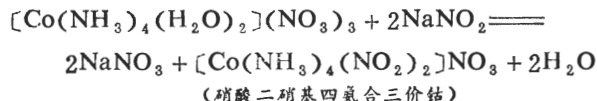
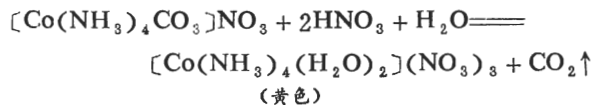
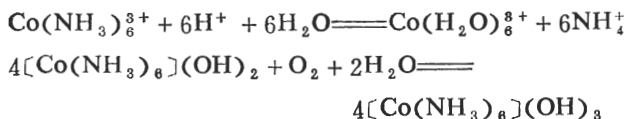
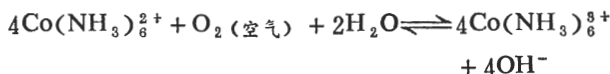
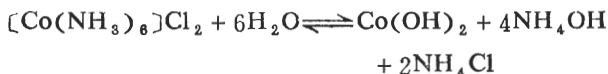
(用 H_2O_2 、 HOCl 、 HClO_3 等替代 Cl_2 均有类似的反应)

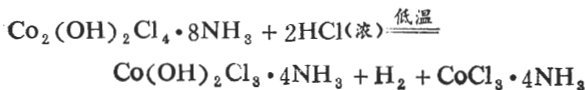
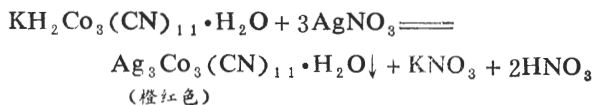
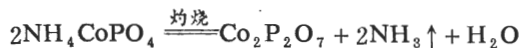
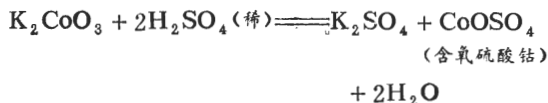
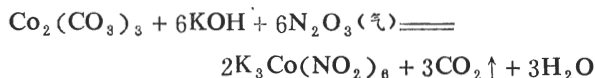
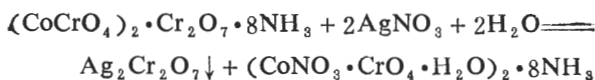
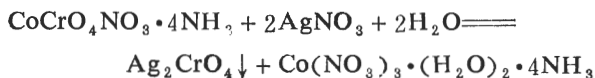
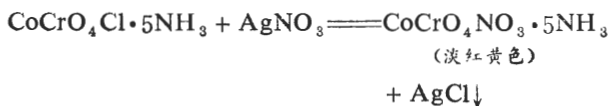
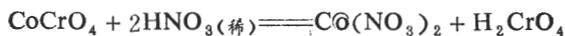
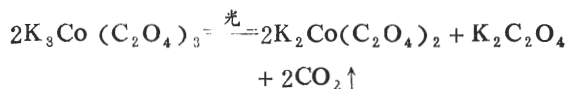
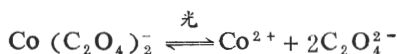
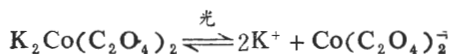
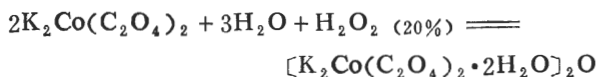


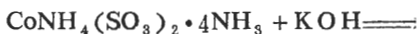
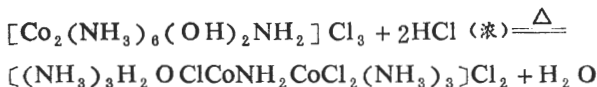
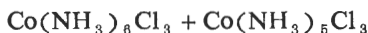
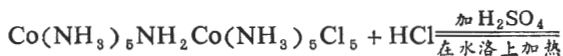
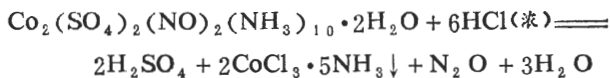


【其他含钴的化合物】

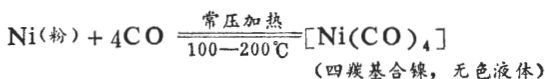




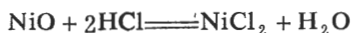
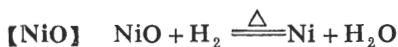
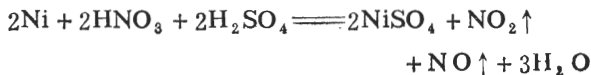
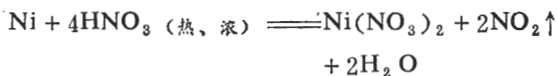


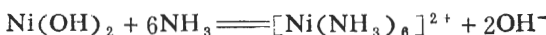
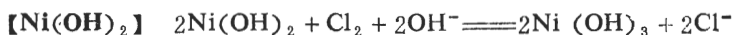
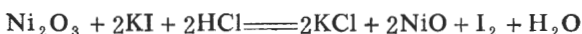
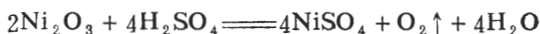
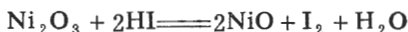
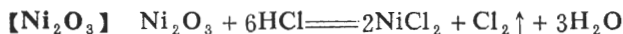
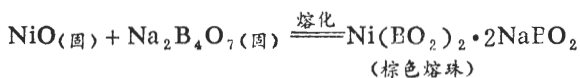


13.3 镍 $3d^8 4s^2$ Ni = 58.71

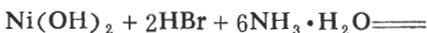


注: Ni难溶于HCl、 H_2SO_4 , 遇发烟的 HNO_3 呈“钝态”。

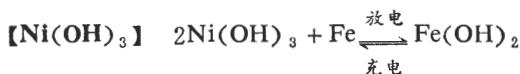
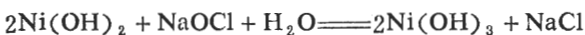
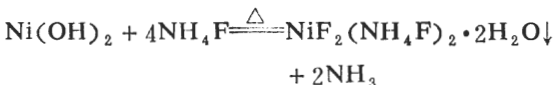




〔使Ni(OH)溶解〕

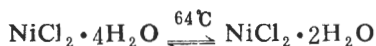
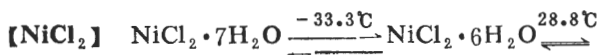
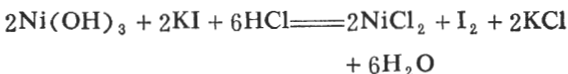
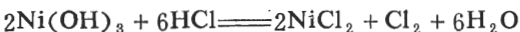


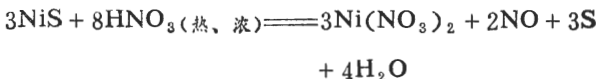
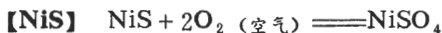
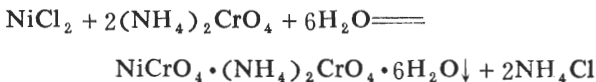
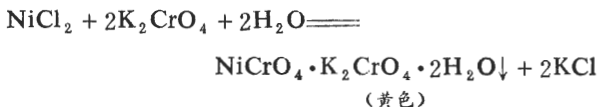
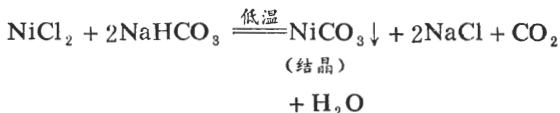
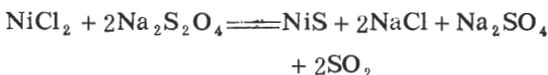
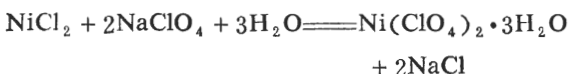
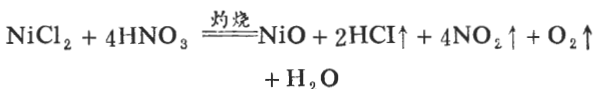
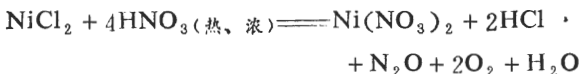
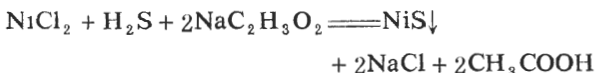
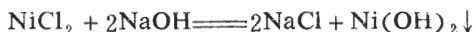
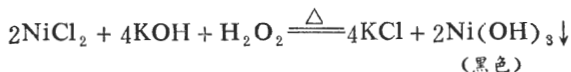
(黄色结晶)

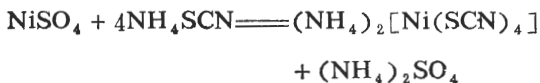
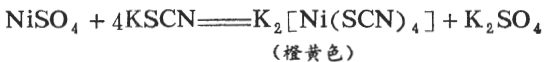
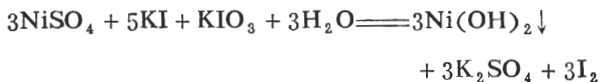
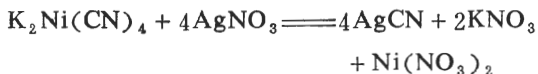
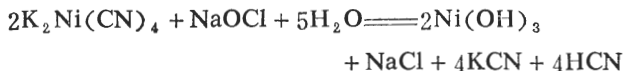
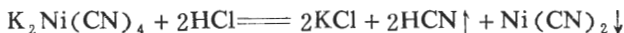
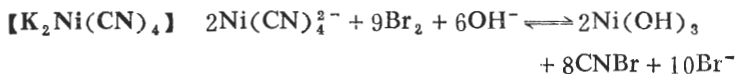
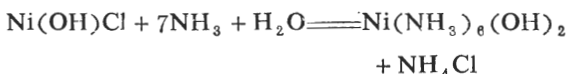
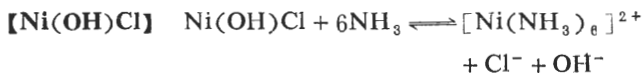
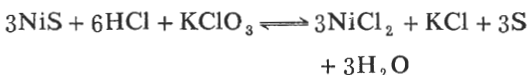
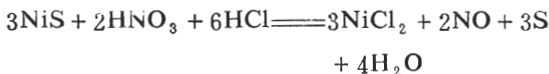


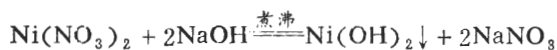
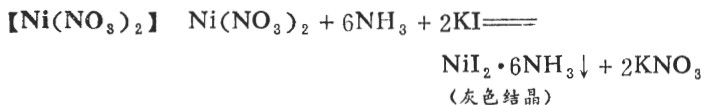
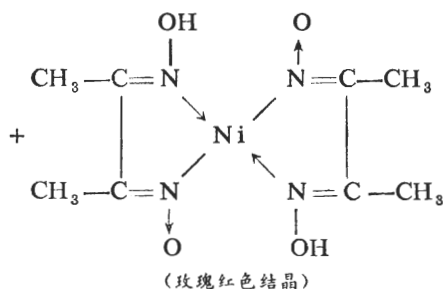
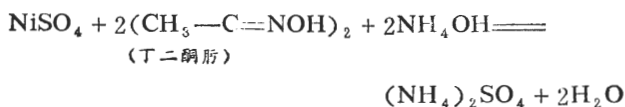
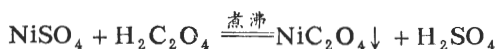
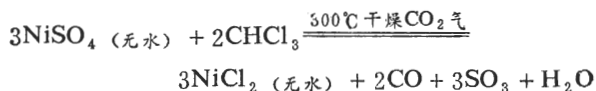
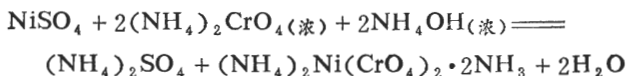
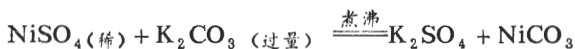
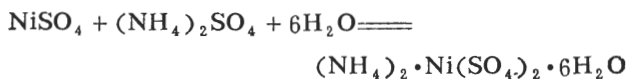
充电

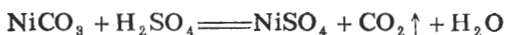
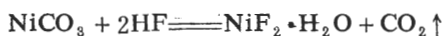
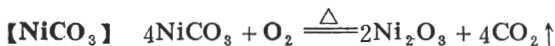
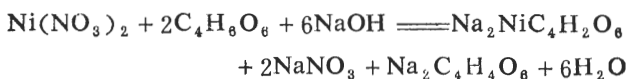
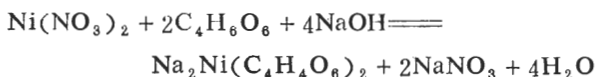
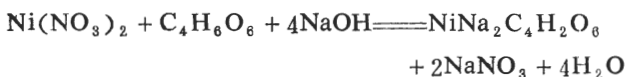
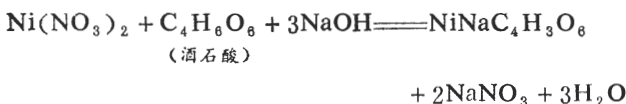
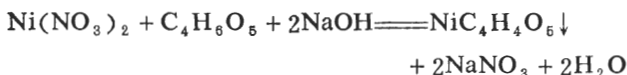
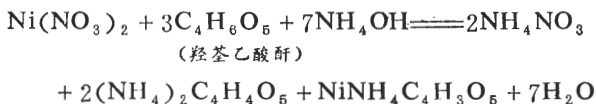
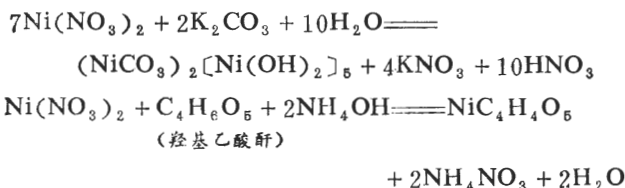
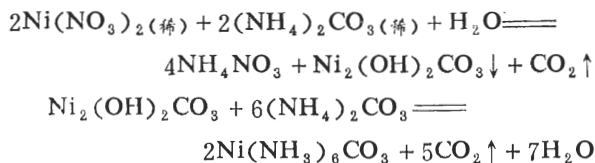
+ 2Ni(OH)₂ (碱性蓄电池的化学反应)

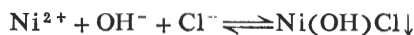
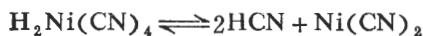
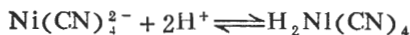
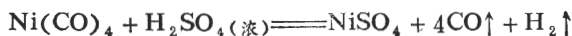
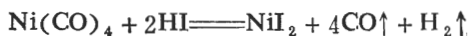
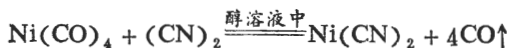
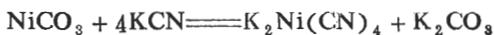




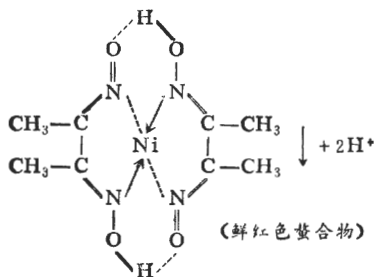
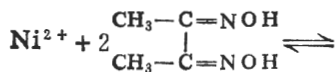
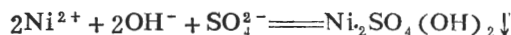




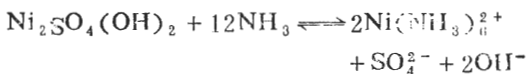
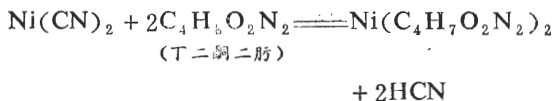
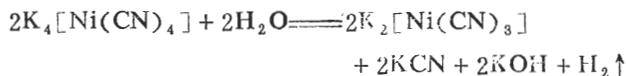
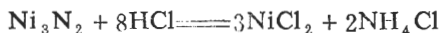


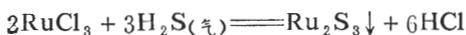
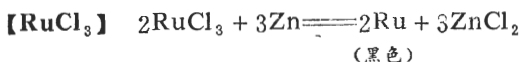
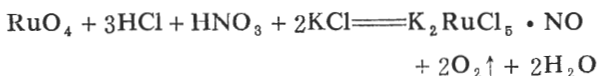


(无 NH_4^+ 存在)



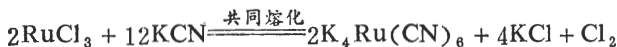
【其他含镍的化合物】



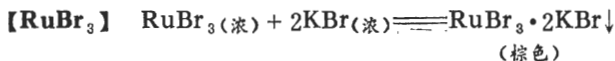
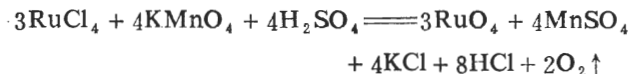
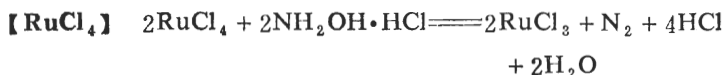
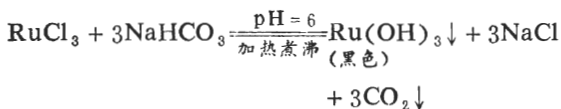


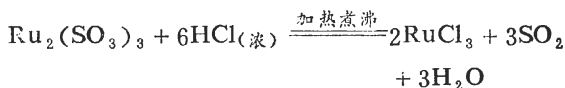
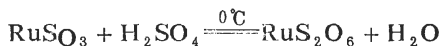
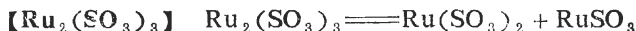
(棕色)

(与(NH₄)₂S有类似的反应)

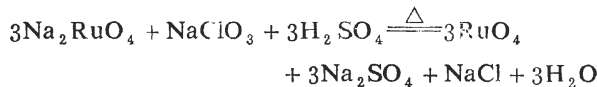
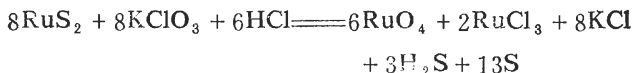
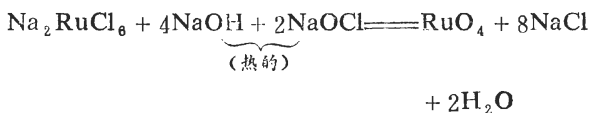
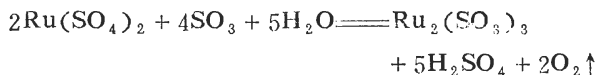
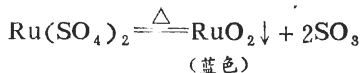


(橙黄色)

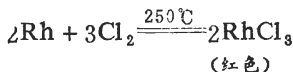
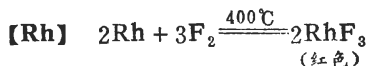


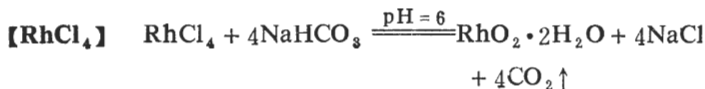
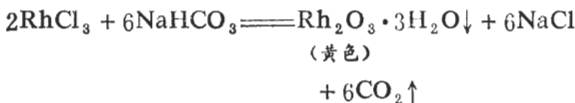
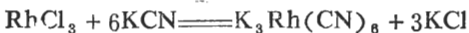
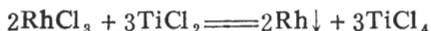
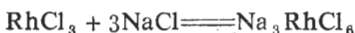
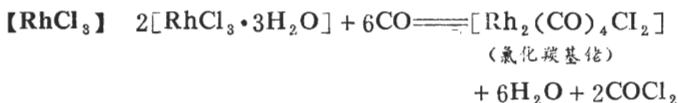
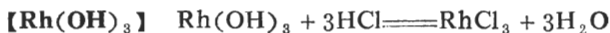
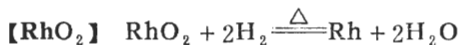
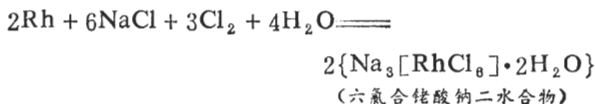
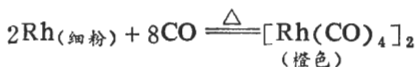
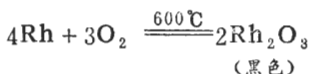


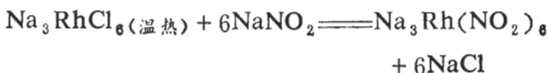
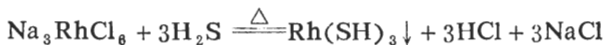
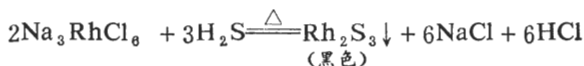
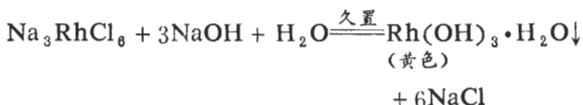
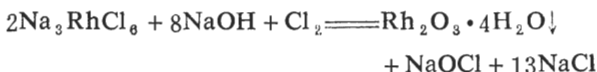
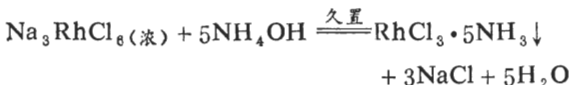
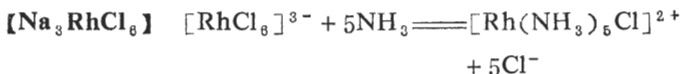
【其他含钌的化合物】



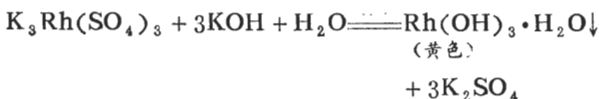
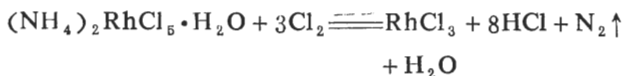
14. 2 铑 $4d^8 5s^1$ Rh = 102.5099



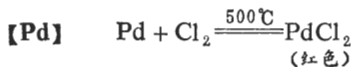


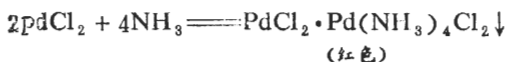
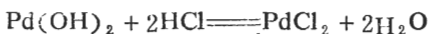
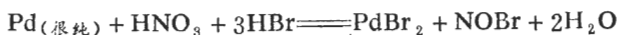
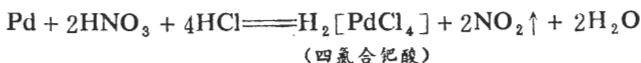
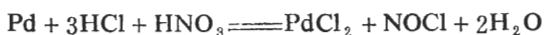
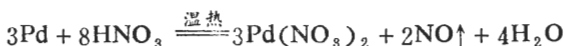
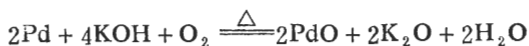
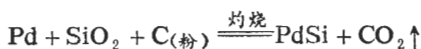
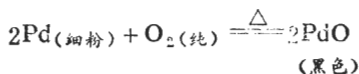


【其他含铑的化合物】

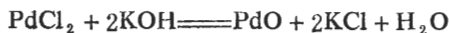
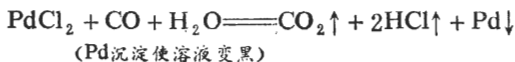
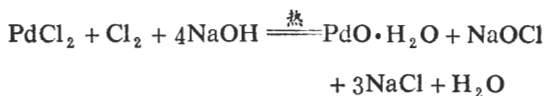
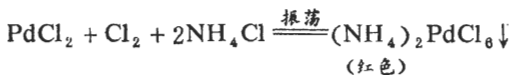


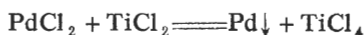
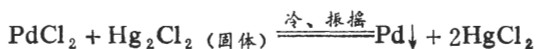
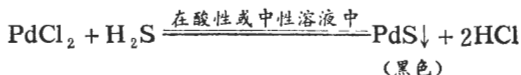
14.3 钯 $4d^{10}$ Pd = 106.4



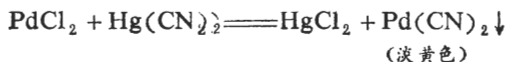


(所生沉淀溶于过量的NH₃)

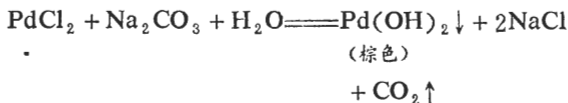
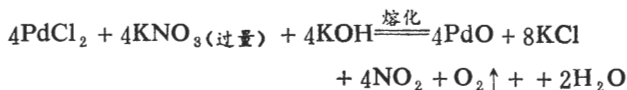
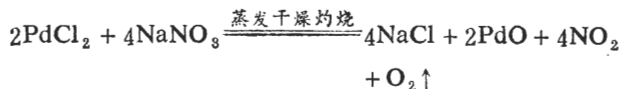
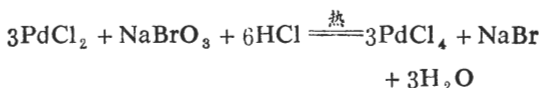




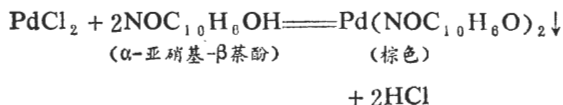
(所生沉淀溶于过量的KI、生成棕色 K_2PdI_4)



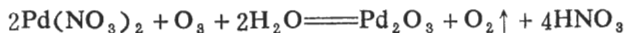
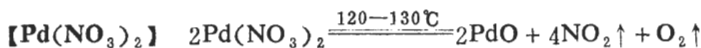
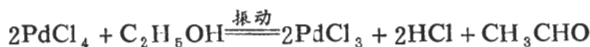
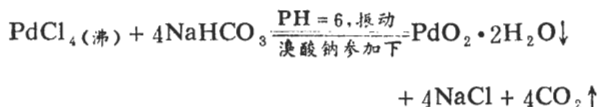
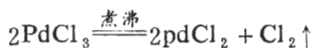
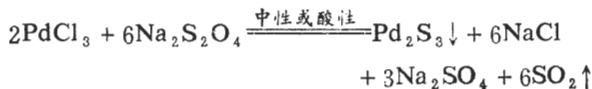
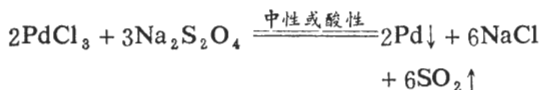
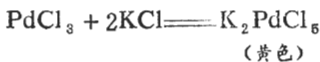
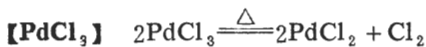
(所生沉淀难溶于稀HCl, 易溶于KCN和氨水)



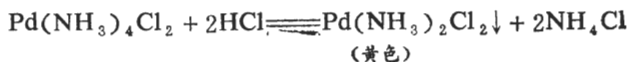
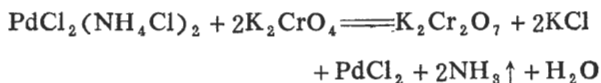
($\text{Pd}(\text{OH})_2$ 沉淀溶于过量的 Na_2CO_3)

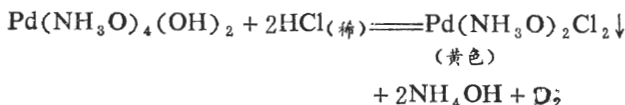


($\text{NOC}_{10}\text{H}_6\text{OH}$ 是饱和溶液, 反应在50%的醋酸中进行)

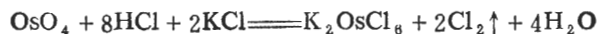
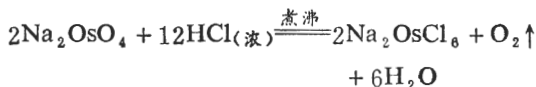
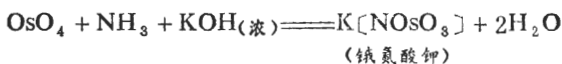
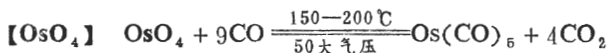
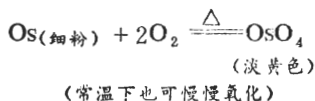
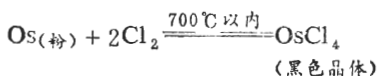
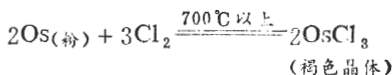
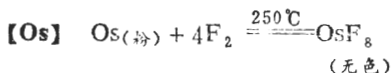


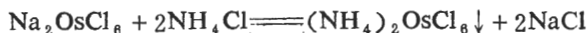
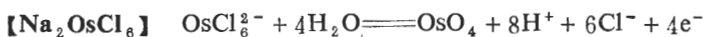
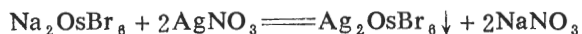
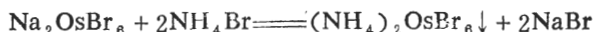
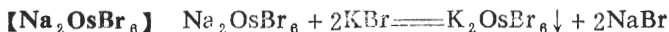
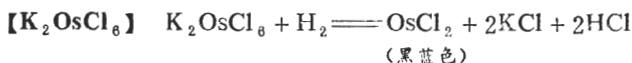
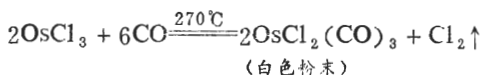
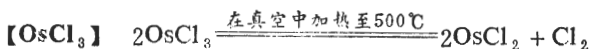
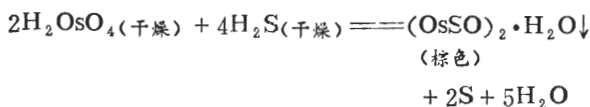
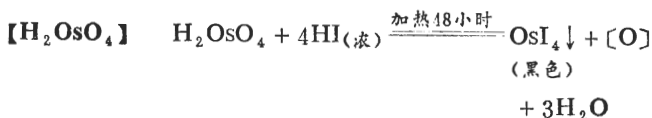
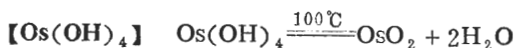
【其他含钯的化合物】



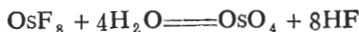


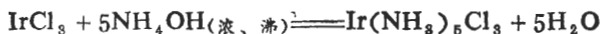
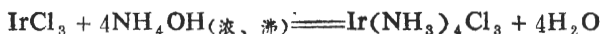
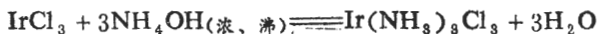
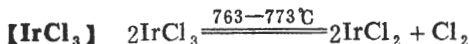
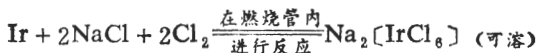
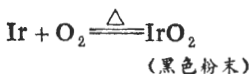
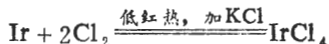
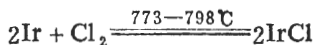
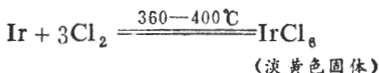
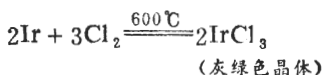
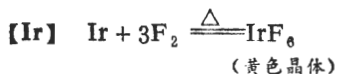
14.4 铱 $5d^6 6s^2$ Os = 190.2

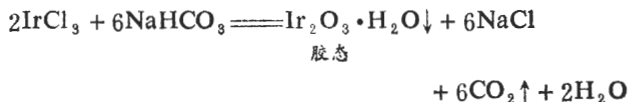
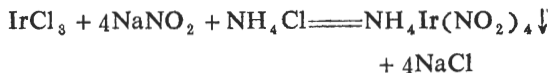
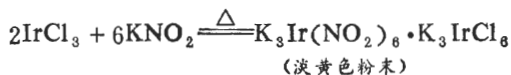
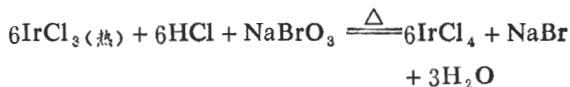
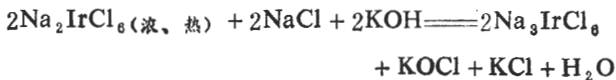
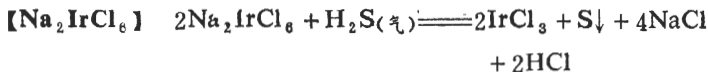
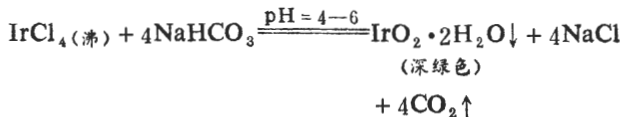
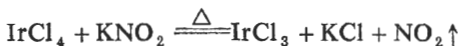
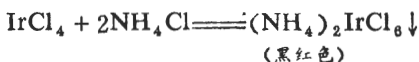
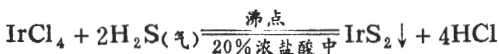
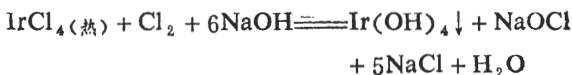


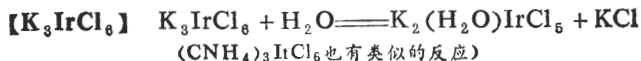
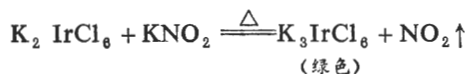
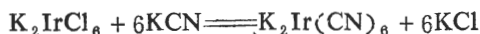
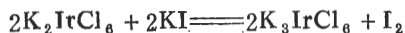
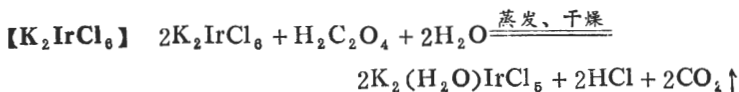
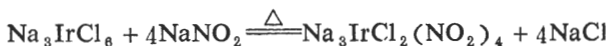
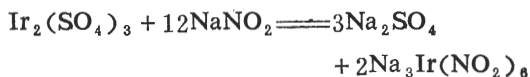
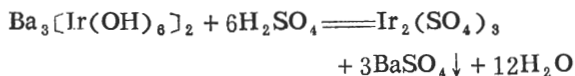
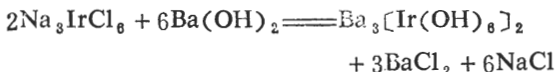
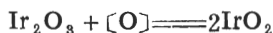
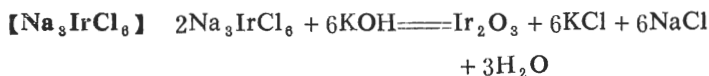
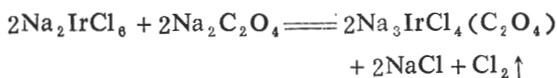
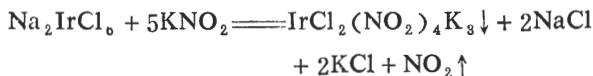
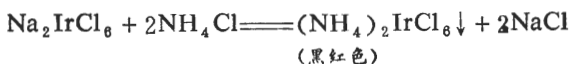
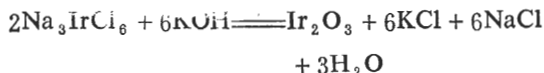


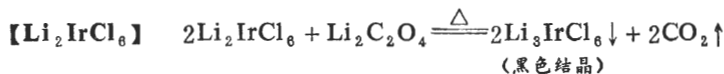
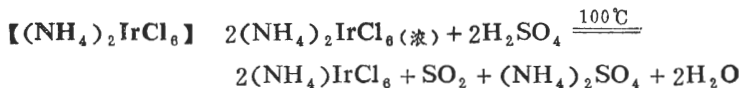
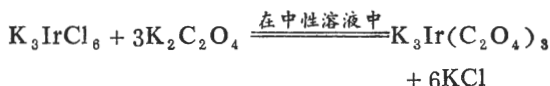
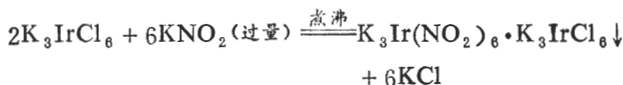
【其他含铱的化合物】



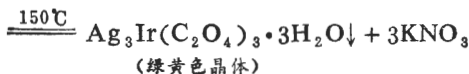
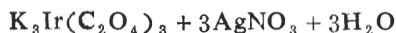
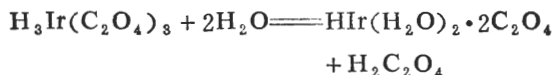
14. 5 铱 $5d^7 6s^2$ Ir = 192.22

【 IrCl_4 】

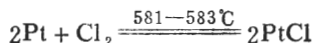
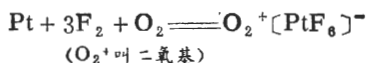


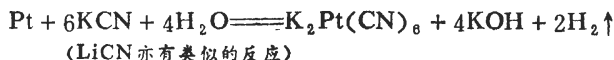
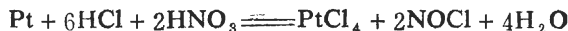
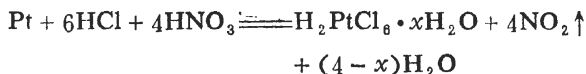
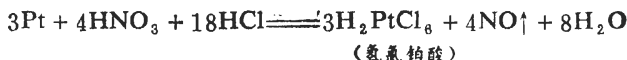
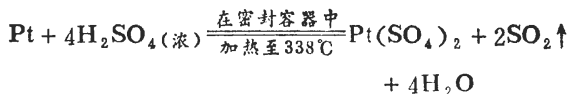
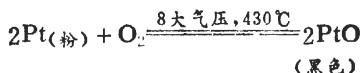
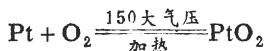
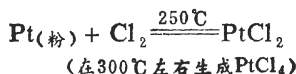
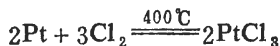


【其他含铱的化合物】

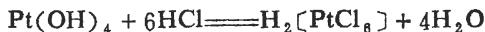
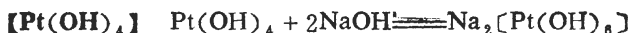
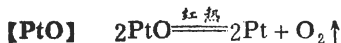
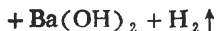
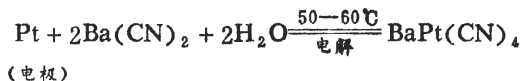


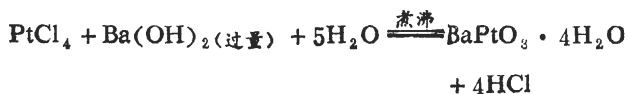
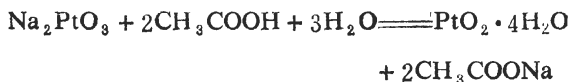
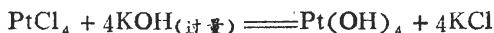
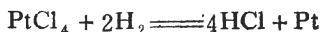
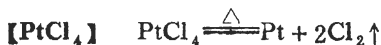
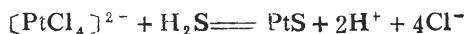
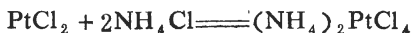
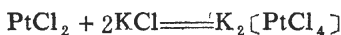
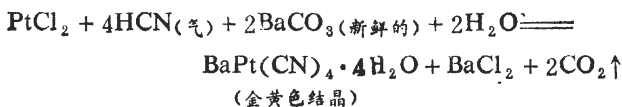
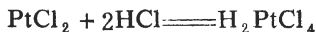
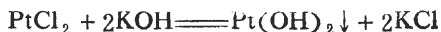
14.6 铂 $5d^8 6s^1$ Pt = 195.09

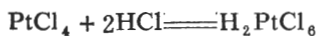
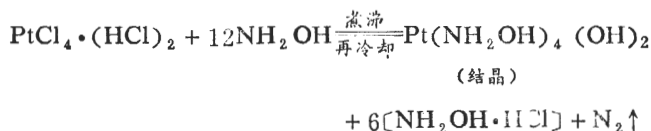




注：以Pt做电极，电解Ba(CN)₂溶液时的反应：



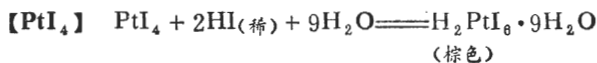
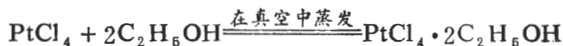
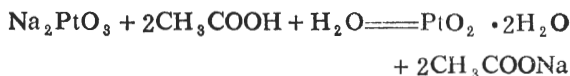
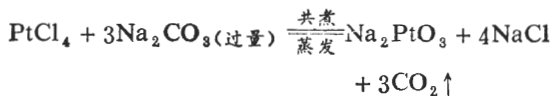
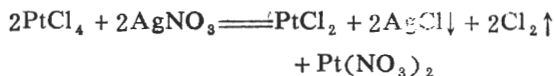
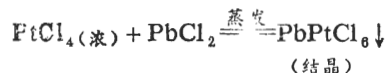
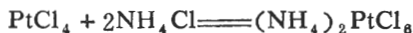
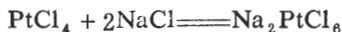




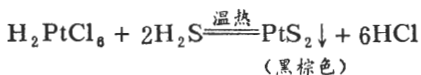
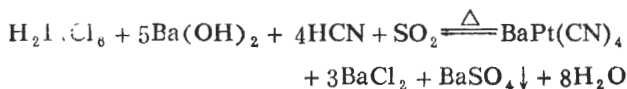
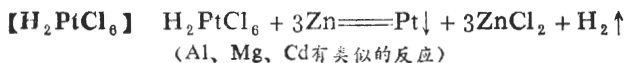
(反应在标准状态下进行)



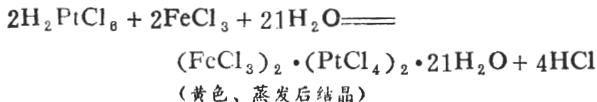
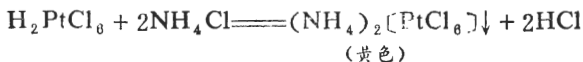
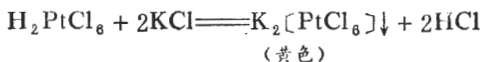
(其他碱金属盐、铵盐与PtCl₄均有类似的反应)



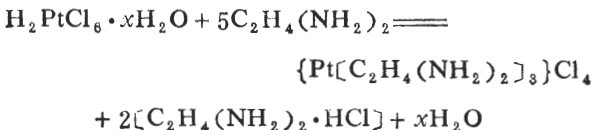
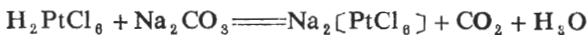
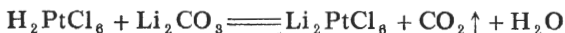
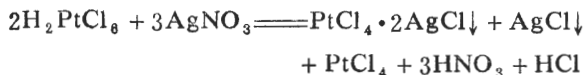
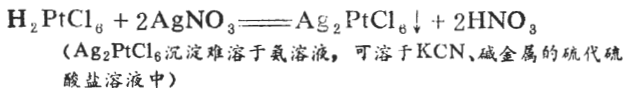
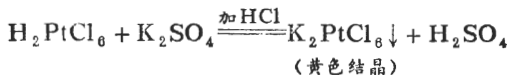
注：PtI₄能与NH₄⁺、Na⁺、Ca²⁺、Mg²⁺、Mn²⁺、Zn²⁺、Co²⁺、Ni²⁺、Fe²⁺等亦生成带结晶水的复盐。

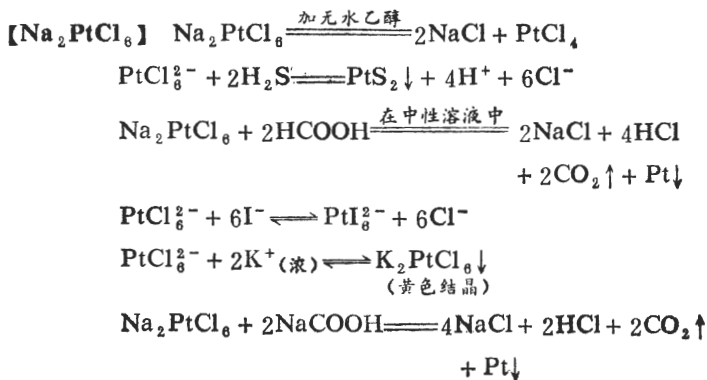
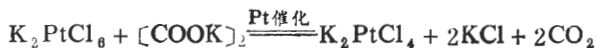
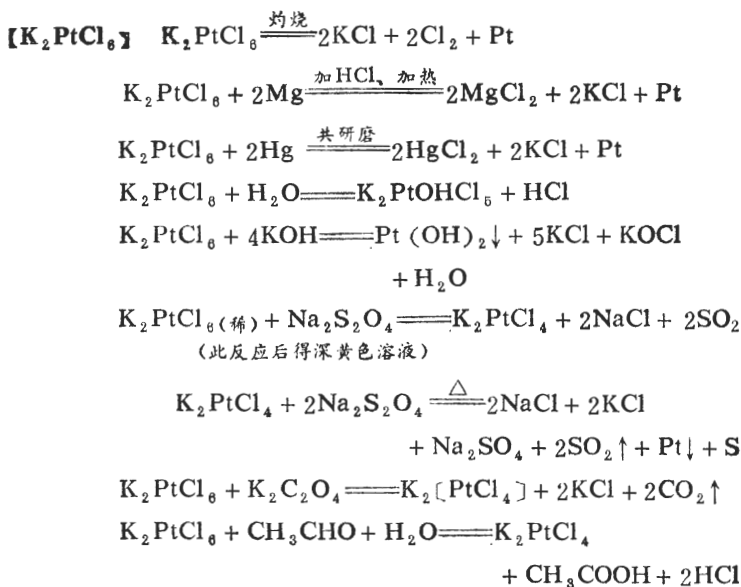
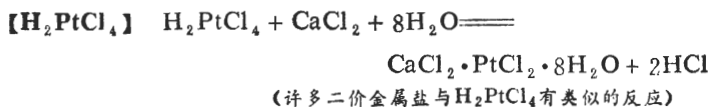


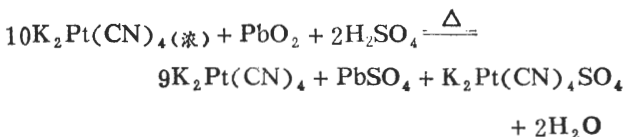
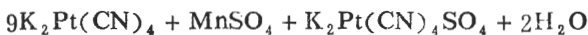
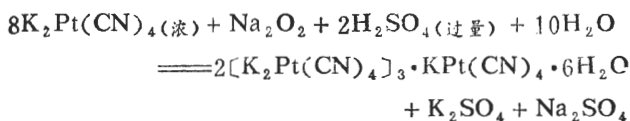
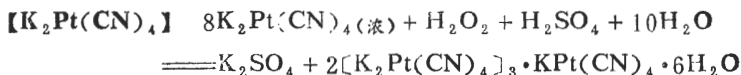
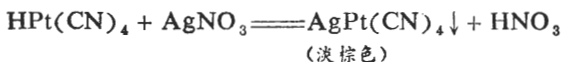
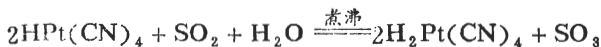
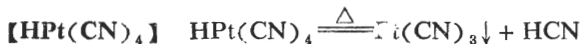
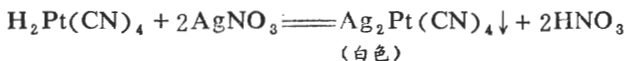
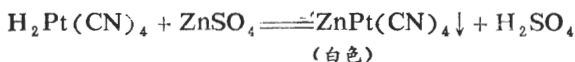
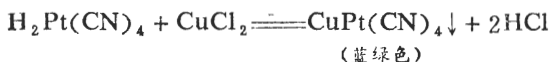
(PtS₂沉淀不溶于HNO₃, 而溶于王水中)



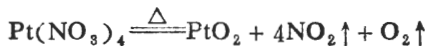
(同理, H₂PtCl₆与Cr³⁺、In³⁺、Sn⁴⁺、Zn²⁺的盐作用也有类似的反应)

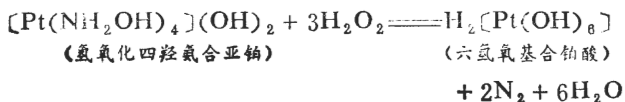
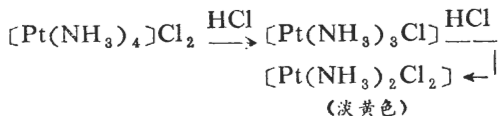
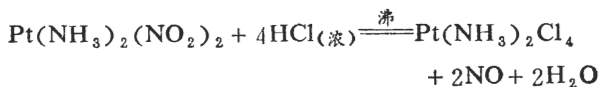
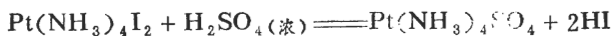
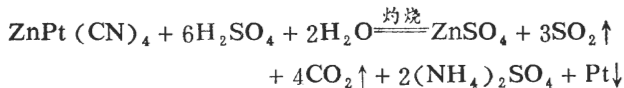
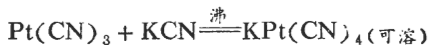
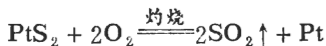
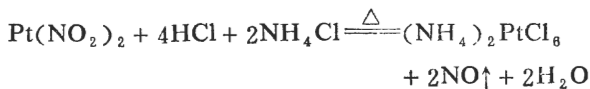






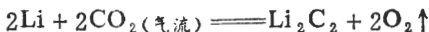
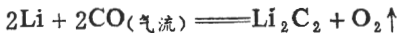
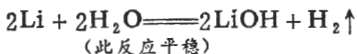
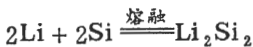
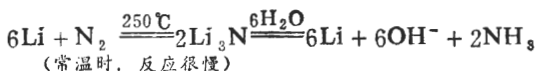
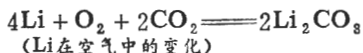
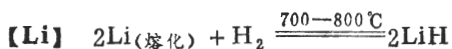
【其他含铂的化合物】

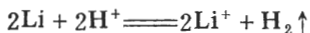
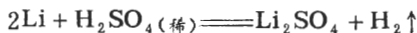




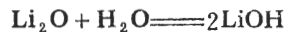
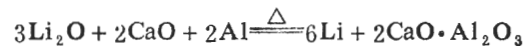
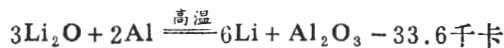
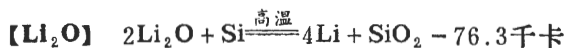
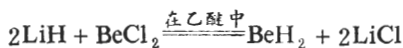
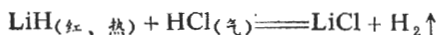
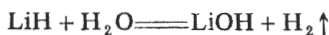
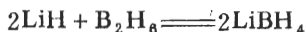
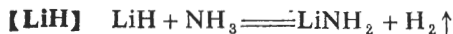
第十五章 碱金属

15.1 锂 $2s^1$ $\text{Li} = 6.941$

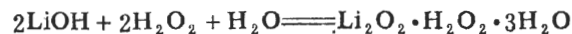
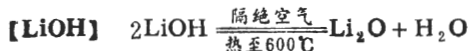




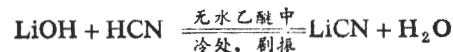
(是Li与无氧化性酸的反应)

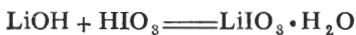
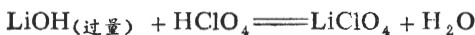


(反应较慢)

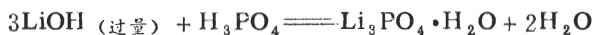
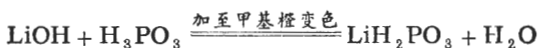


(把过氧化氢和乙醇加至氢氧化锂溶液中)

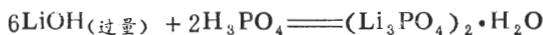




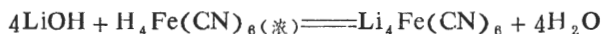
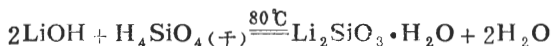
(针状结晶)



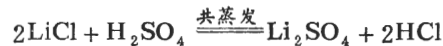
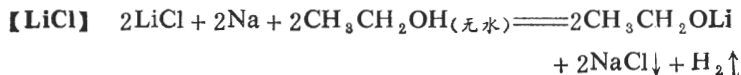
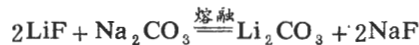
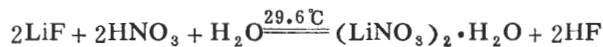
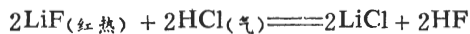
(在16℃时干燥)

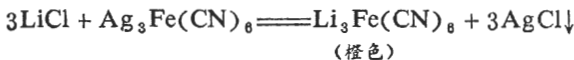
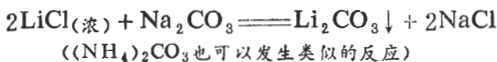
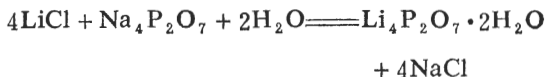
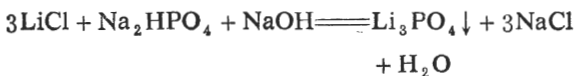
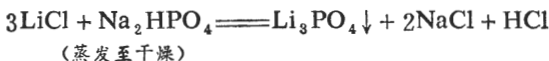
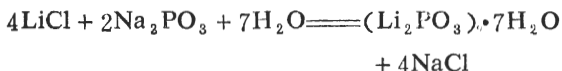
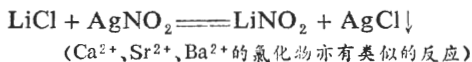
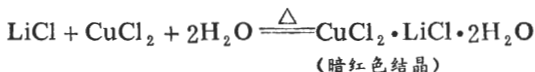
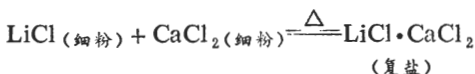
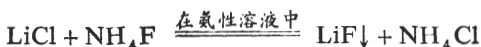


(在60℃时干燥)

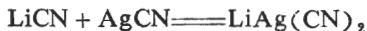


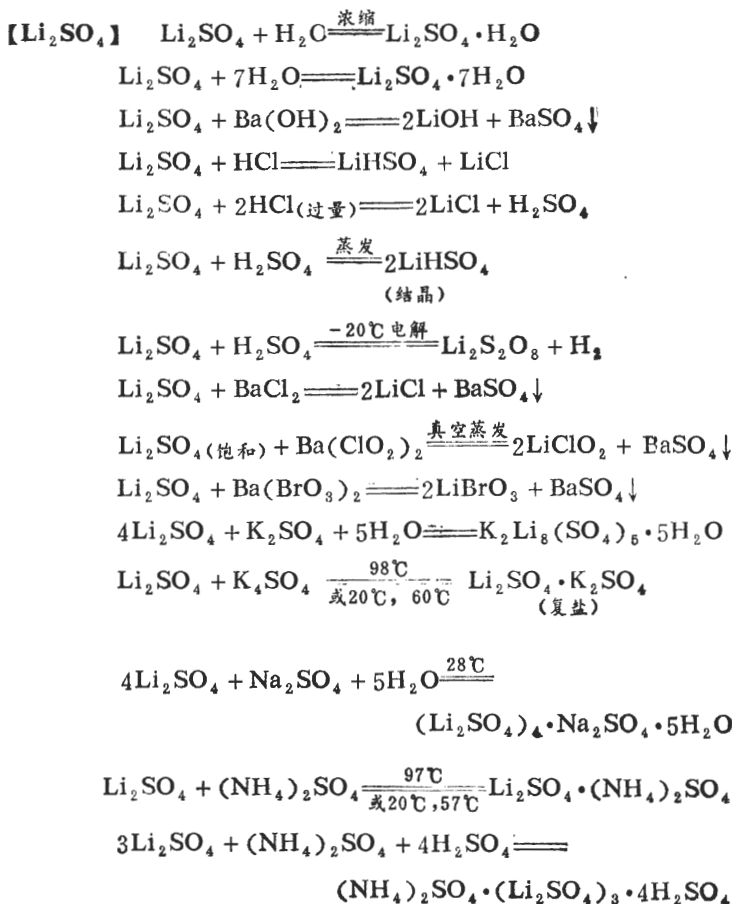
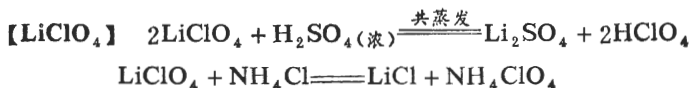
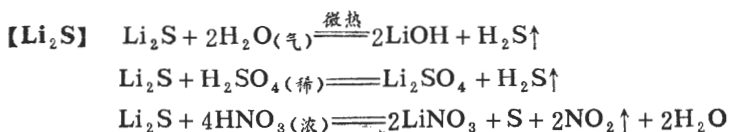
(固体)

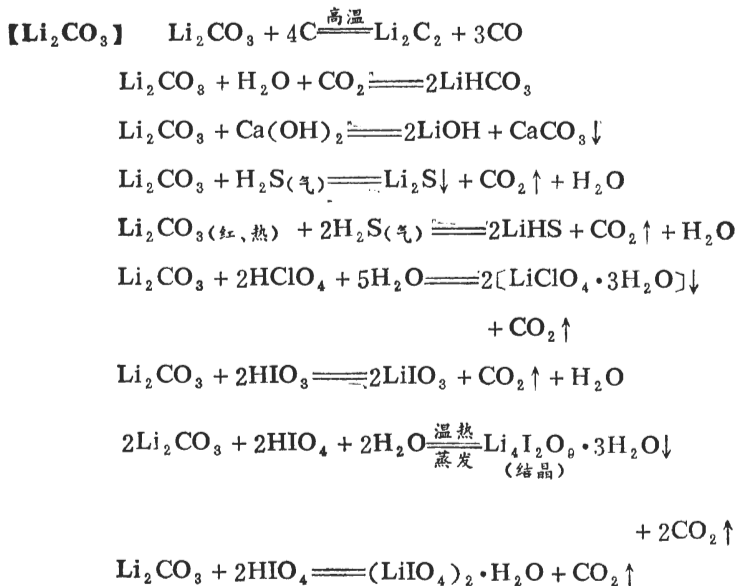
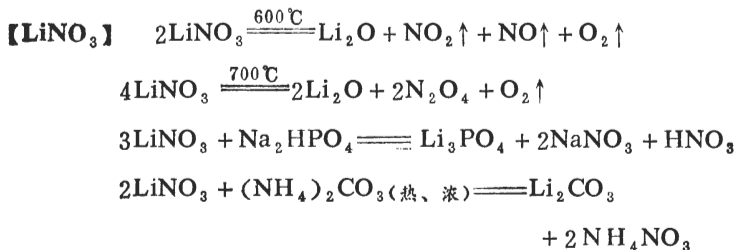
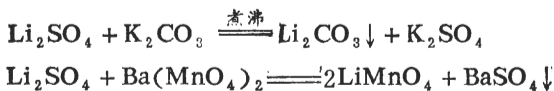
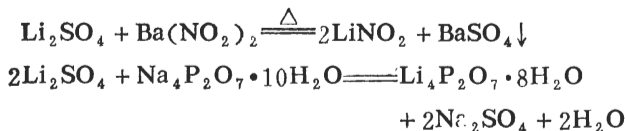




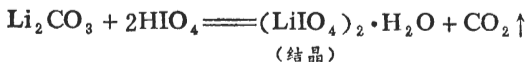
(产物在水溶液上浓缩)





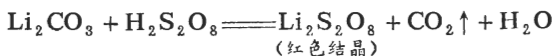


+ 2CO₂ ↑

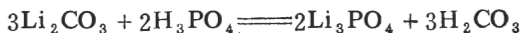
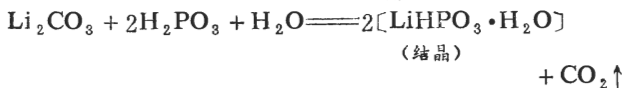
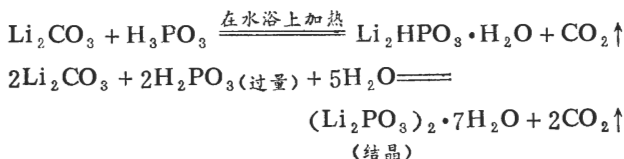
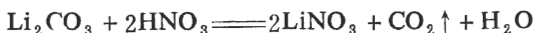


(结晶)

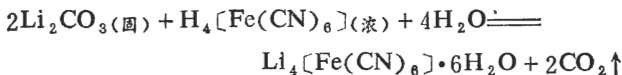
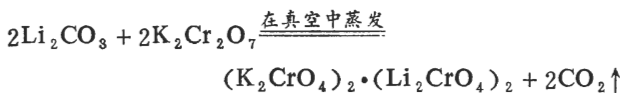
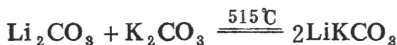
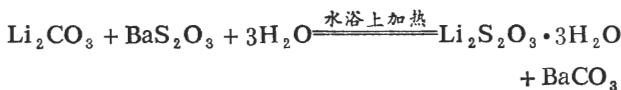
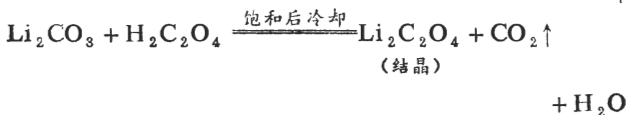
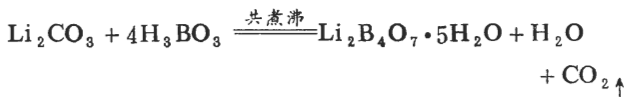
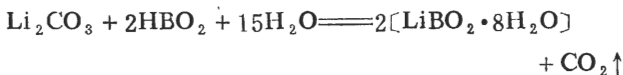
(反应产物在干燥器中蒸发得晶体)

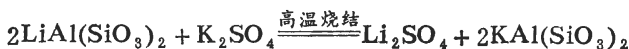
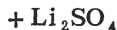
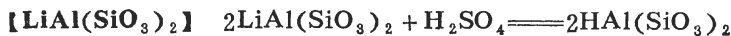
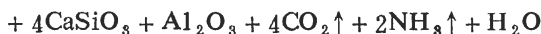
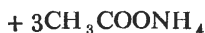
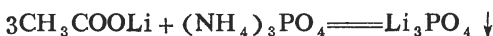
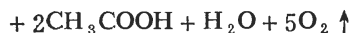
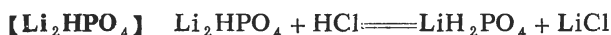


(反应产物在真空中蒸发结晶)

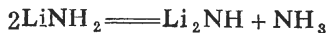


(用CO₂饱和溶液)

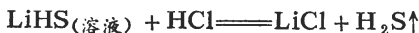


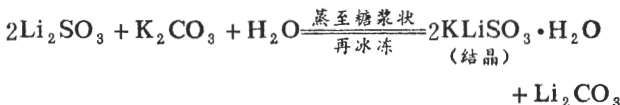
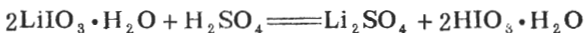
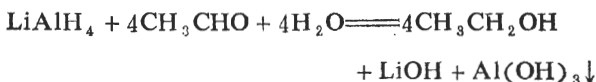
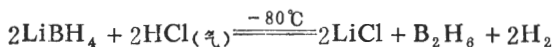
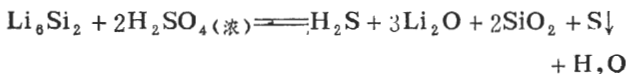


【其他含锂的化合物】

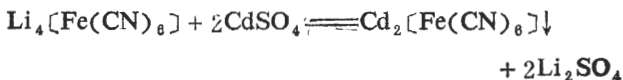
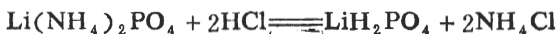
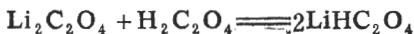
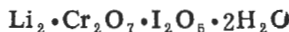
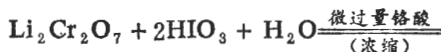
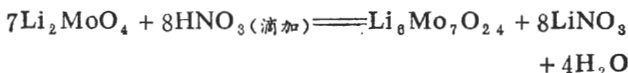


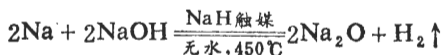
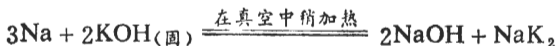
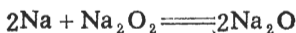
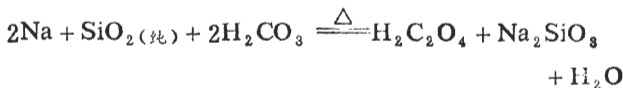
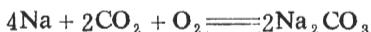
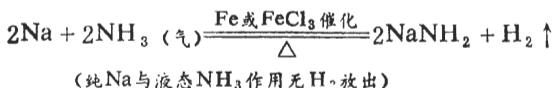
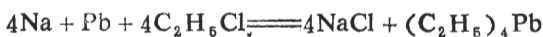
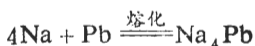
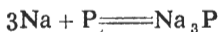
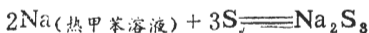
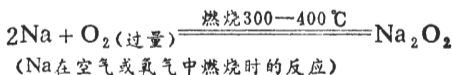
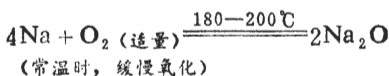
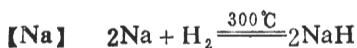
(在真空中加热至熔点) (亚氨基化锂)

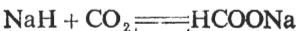
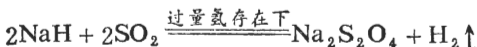
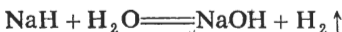
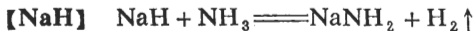
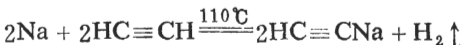
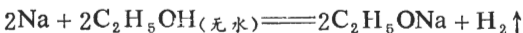
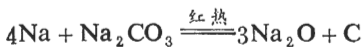
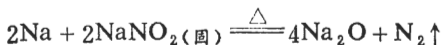
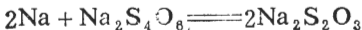
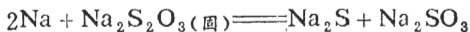
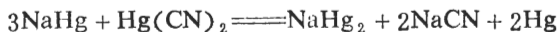
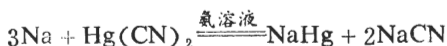
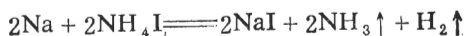
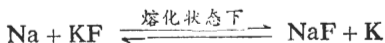
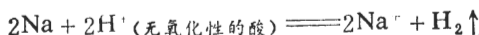
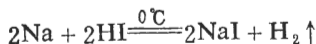
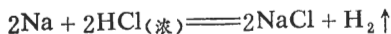


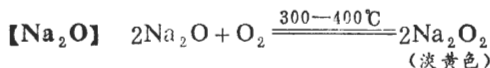
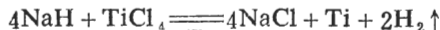
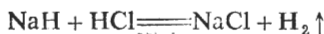


(产物蒸发冷却得结晶)

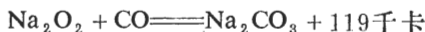
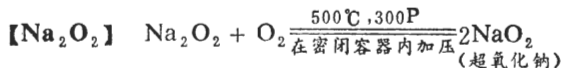
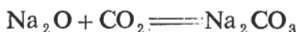
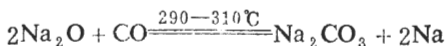
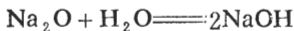


15.2 钠 $3s^1$ $Na = 22.9898$ 

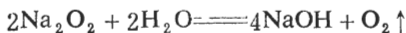
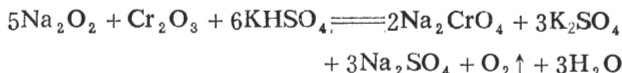
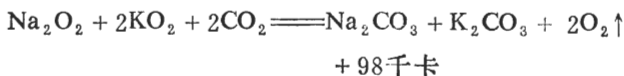




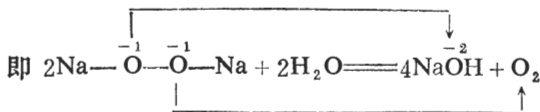
(使用不含 CO_2 的干燥空气与Na作用。 Na_2O 暴露在空气中也会继续氧化生成 Na_2O_2 。)



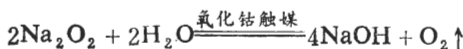
(用作防毒面具和潜艇中紧急时供氧)

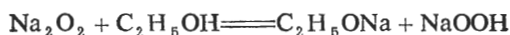
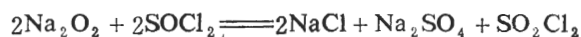
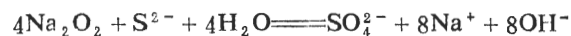
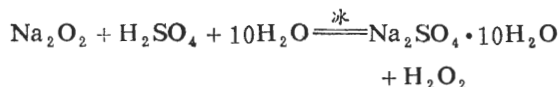
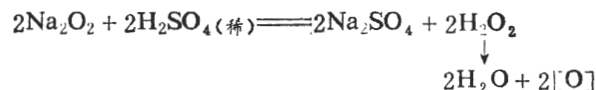
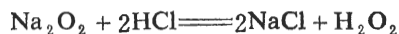
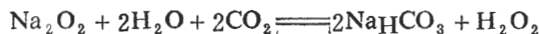
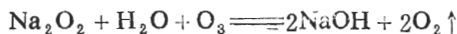


取得 $e \times 2$ (还原)

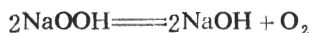


失去 $e \times 2$ (氧化)

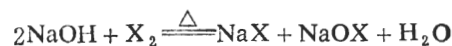
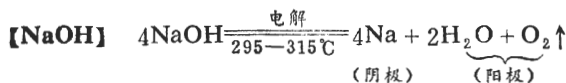
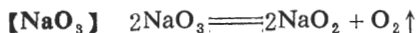
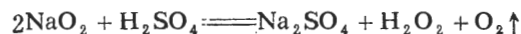
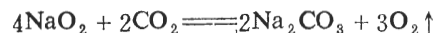
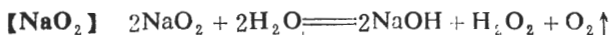




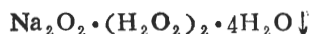
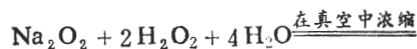
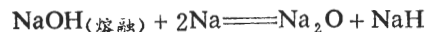
(冷却到0°C)

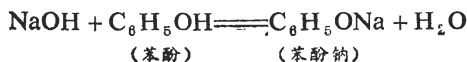
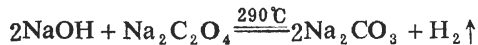
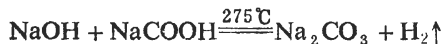
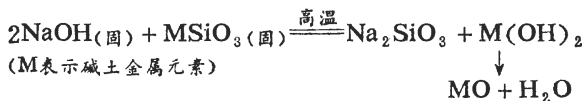
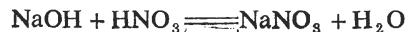
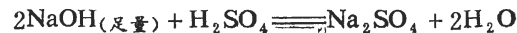
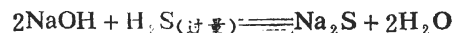
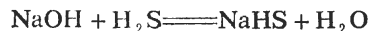
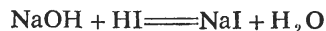
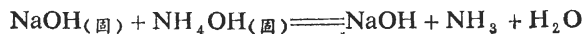
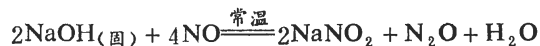
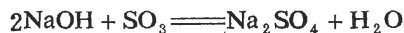
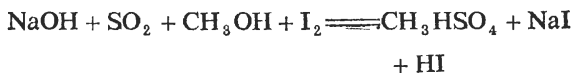
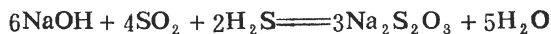
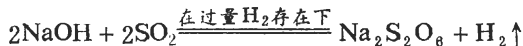
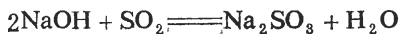


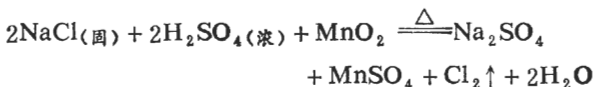
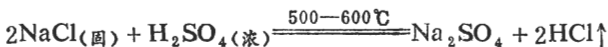
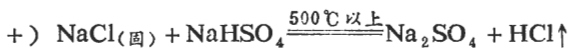
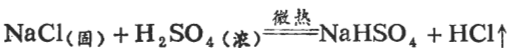
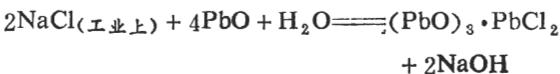
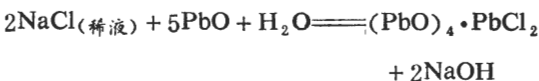
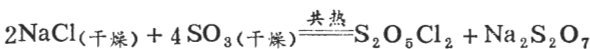
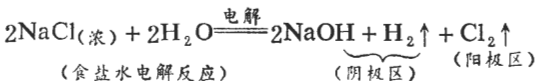
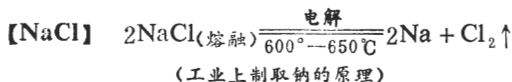
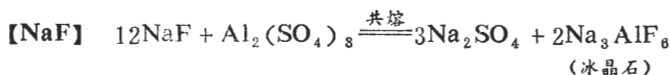
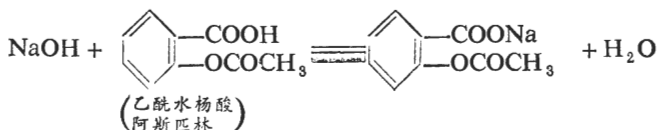
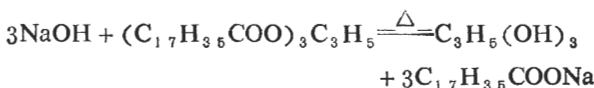
(极易进行的反应)

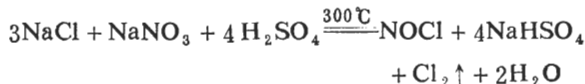


(X₂ = Cl₂、Br₂、I₂)

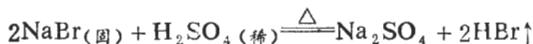
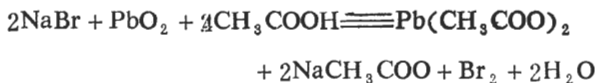
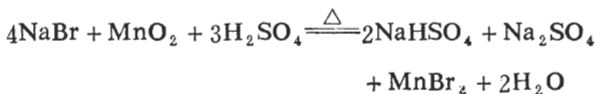
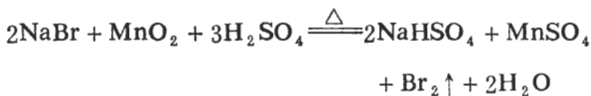
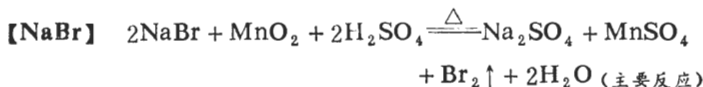
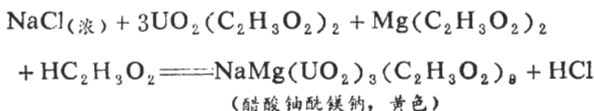
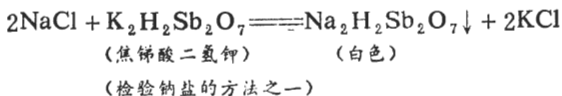
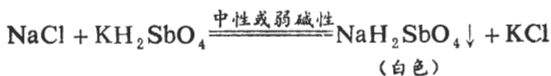


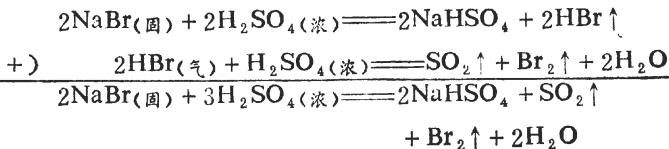




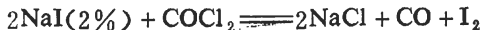
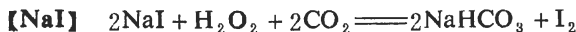
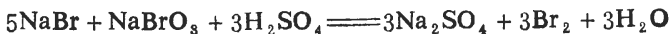
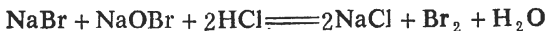
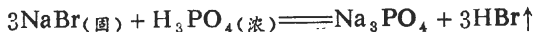
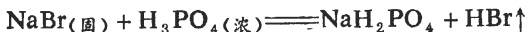


注：在含有氨的NaCl饱和溶液中通入CO₂时，则发生下反应：

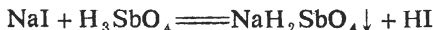
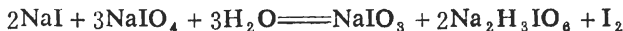
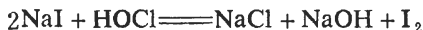




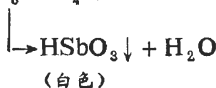
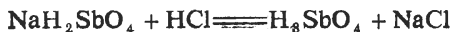
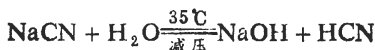
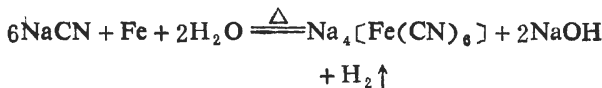
(制取溴的反应)

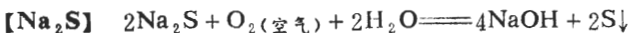
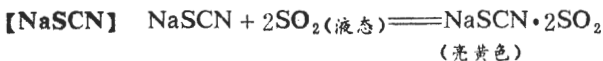
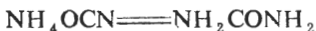
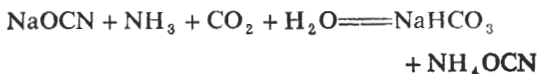
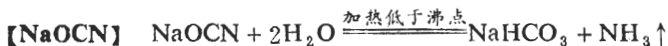
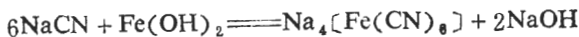
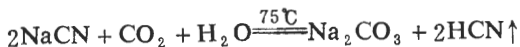


(溶于无水丙酮)



(白色结晶, 溶于酸)

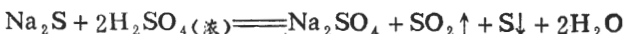
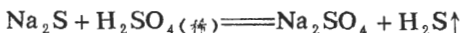
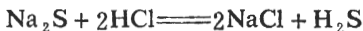
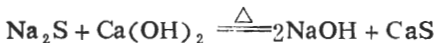
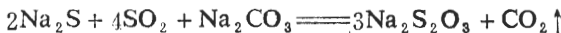
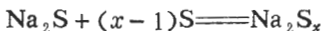
(与Cl₂作用有类似的反应)

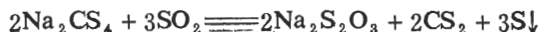
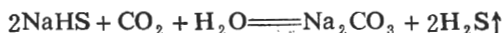
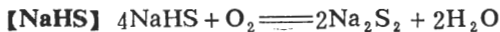
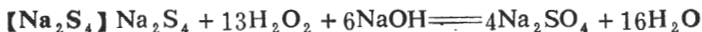
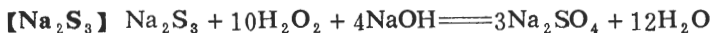
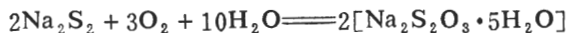
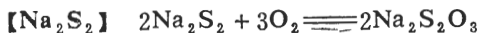
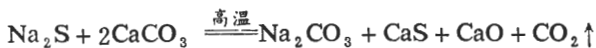
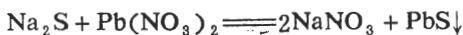
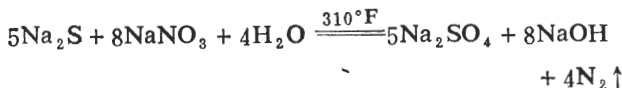
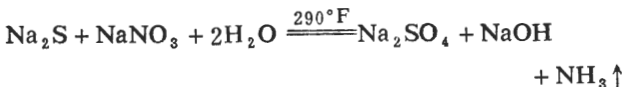


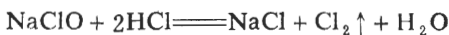
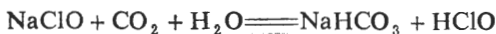
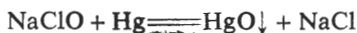
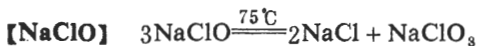
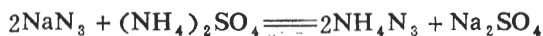
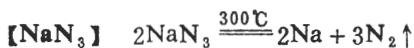
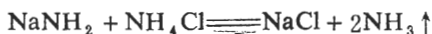
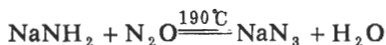
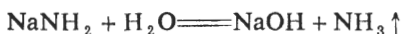
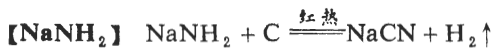
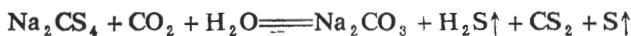
(溶液呈碱性)



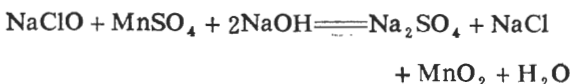
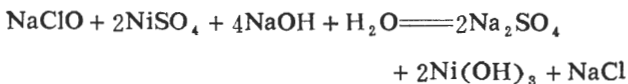
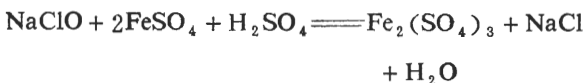
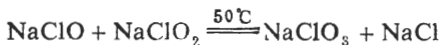
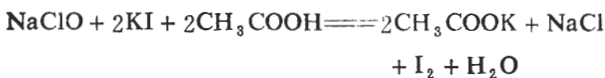
(M为碱金属元素)



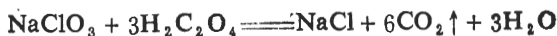
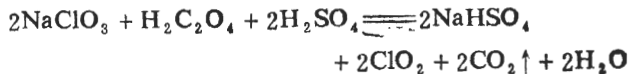
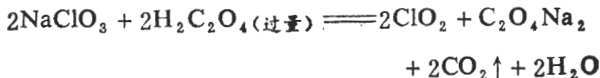
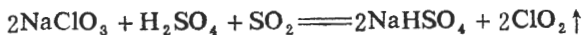
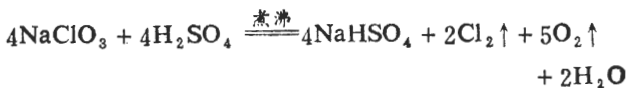
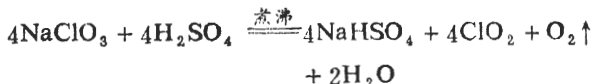
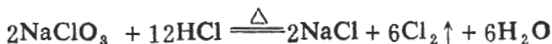
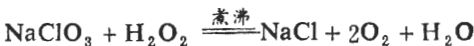
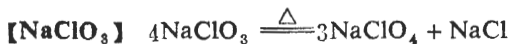
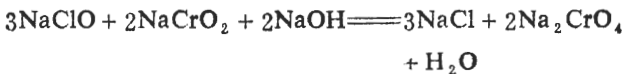
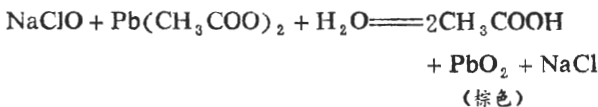
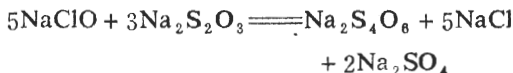
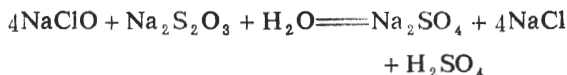
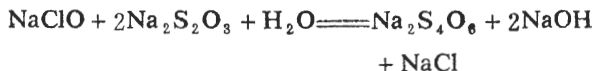


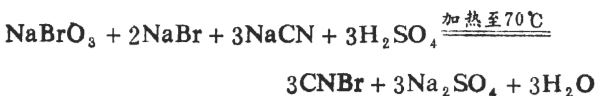
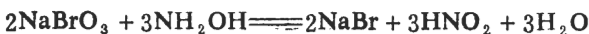
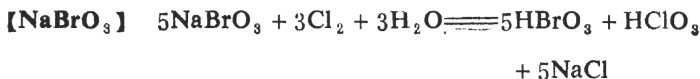
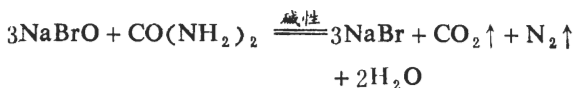
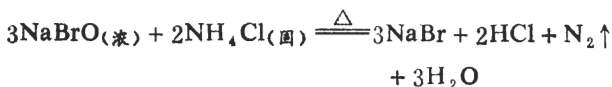
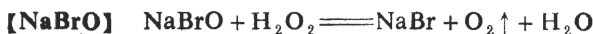
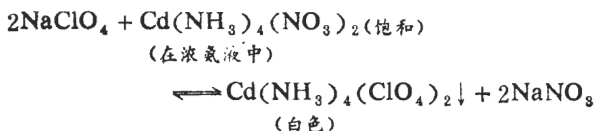
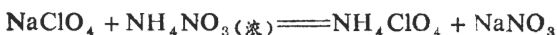
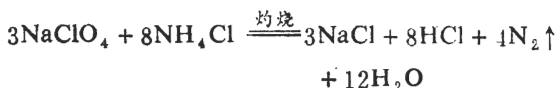
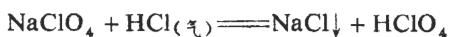
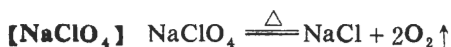
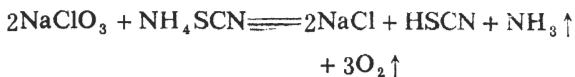
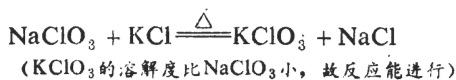


(KClO也有类似的反应)



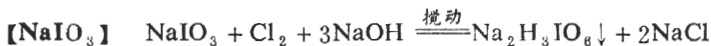
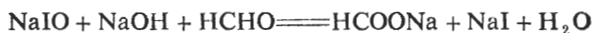
注 NaClO与Na₂S₂O₈作用，根据分子比例不同而有以下三个反应：



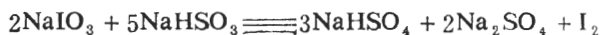




(在碱性条件下, 自动进行的反应)



(白色)

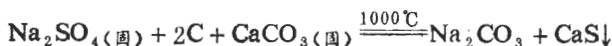
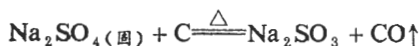
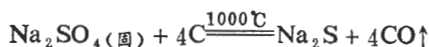
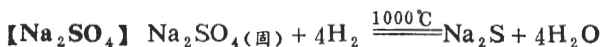
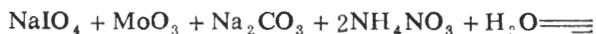
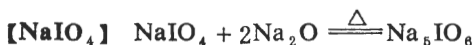


+ H₂O



(白色)

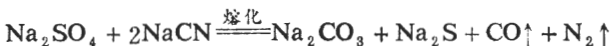
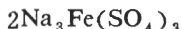
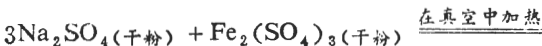
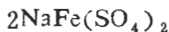
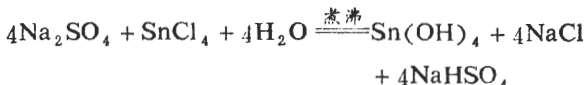
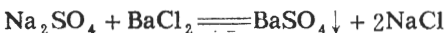
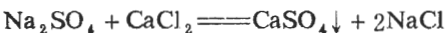
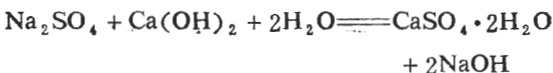
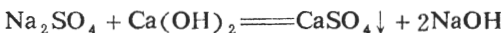
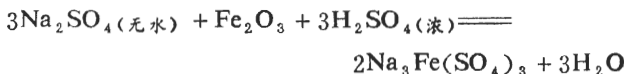
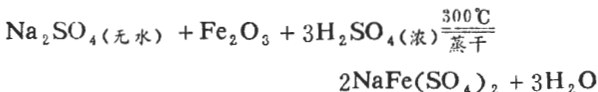
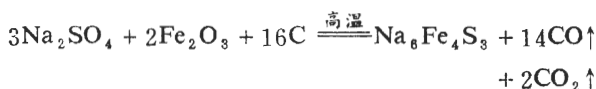
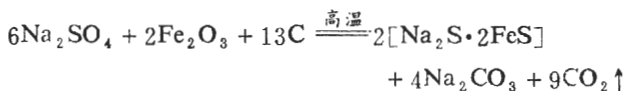
+ 2CH₃COONa

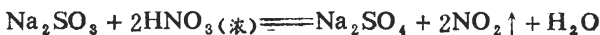
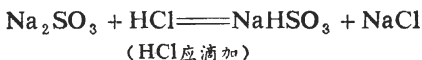
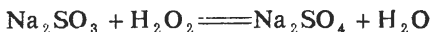
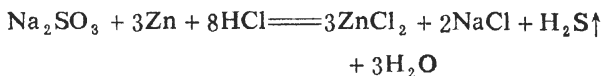
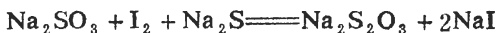
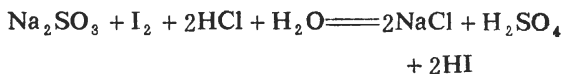
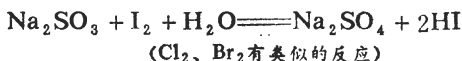
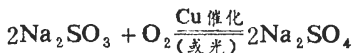
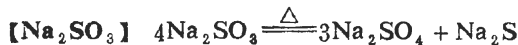
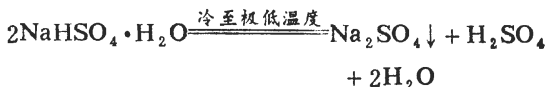
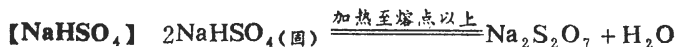
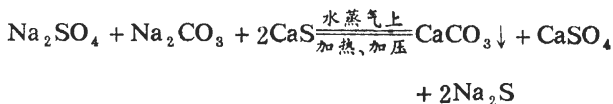


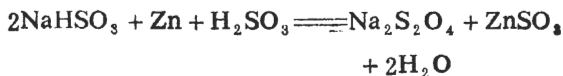
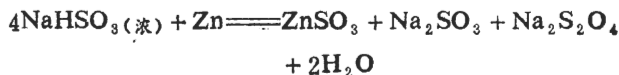
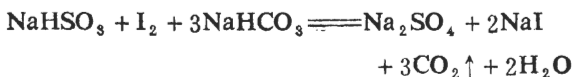
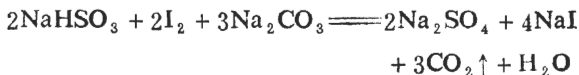
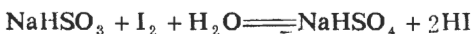
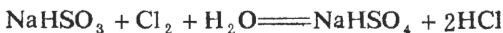
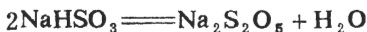
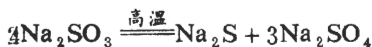
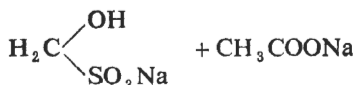
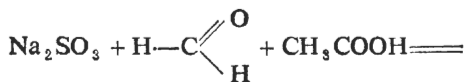
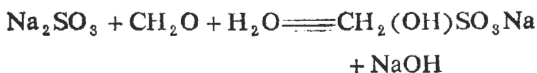
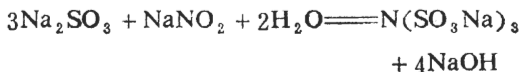
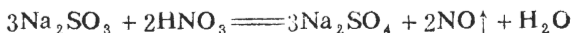
+ 2CO₂ ↑

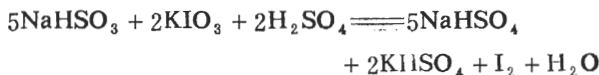
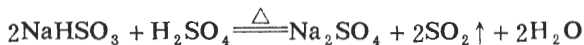


(温度低于硫酸钠熔点)

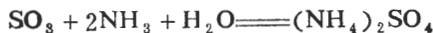
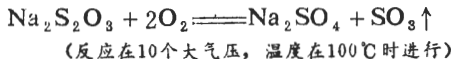
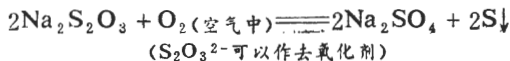
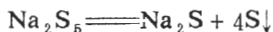
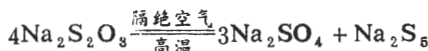
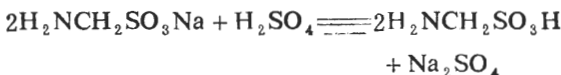
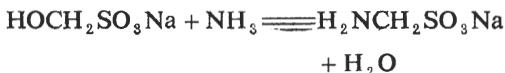




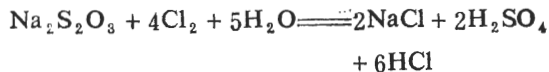
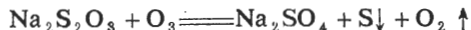


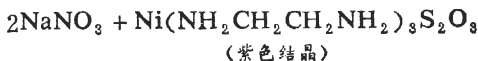
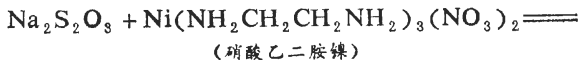


(羟基甲烷硫酸钠)

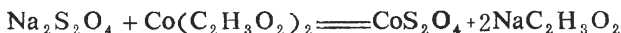
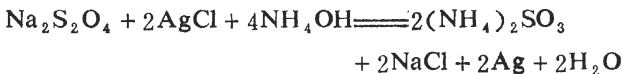
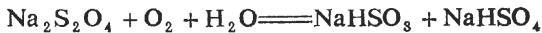
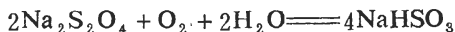
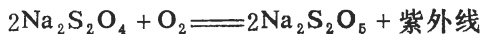
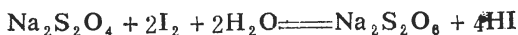
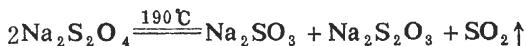


注: $\text{Na}_2\text{S}_2\text{O}_3$ 可被臭氧氧化为 Na_2SO_4

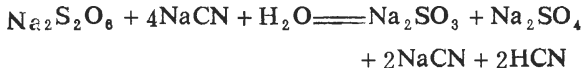




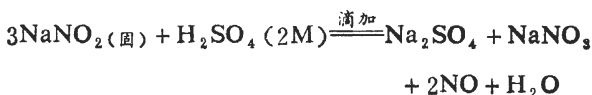
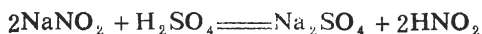
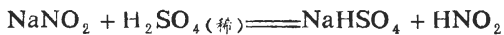
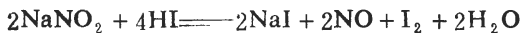
【Na₂S₂O₄】



【Na₂S₂O₆】 Na₂S₂O₆ + 2Na \rightleftharpoons 2Na₂S₂O₃

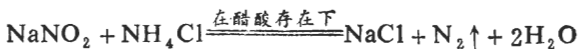


【NaNO₂】 4NaNO₂ $\xrightarrow{\Delta}$ 2Na₂O + 4NO + O₂ ↑

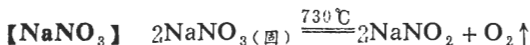
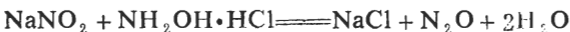
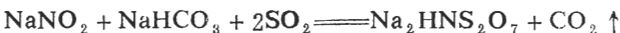
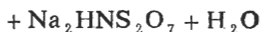
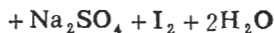
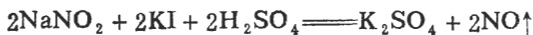
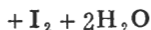




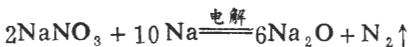
(常温溶液中的反应)



(实验室制取 N_2 的反应原理)



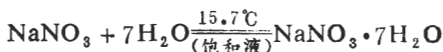
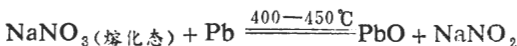
注：电解熔化的 NaNO_3 时，其阴极上的钠可与硝酸钠作用：



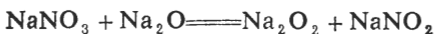
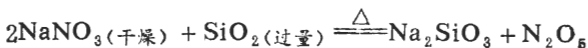
(在低温下进行的反应)



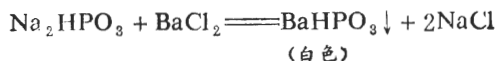
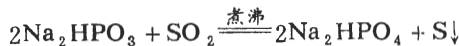
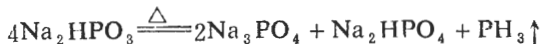
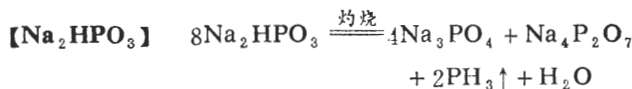
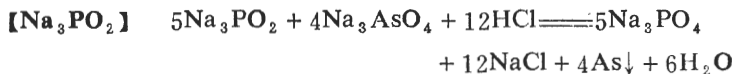
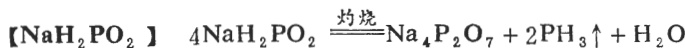
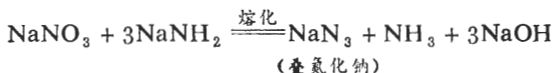
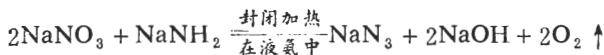
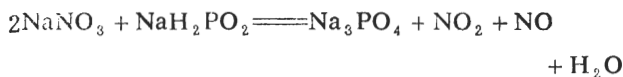
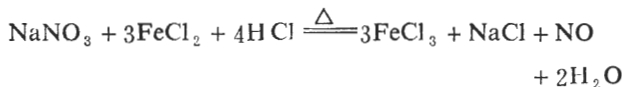
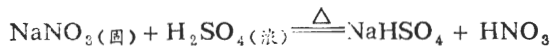
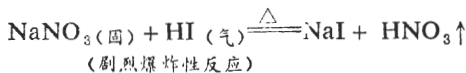
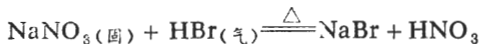
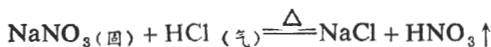
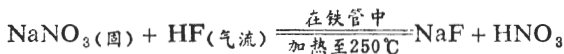
(在较高温度下进行的反应)



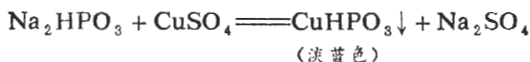
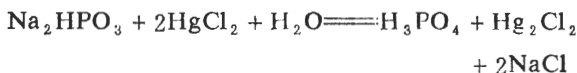
(饱和液)



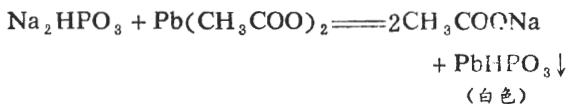
(在较高温度下进行的反应)



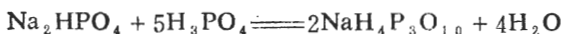
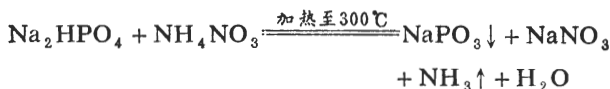
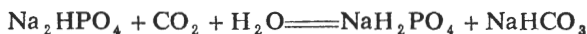
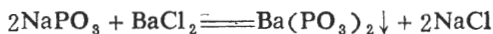
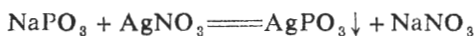
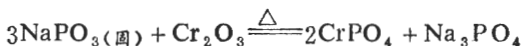
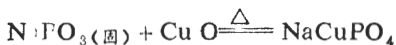
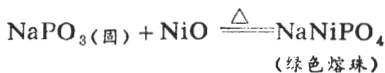
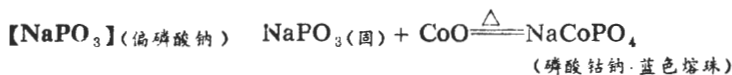
(BaHPO₃沉淀溶于酸)

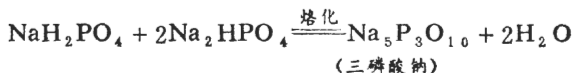
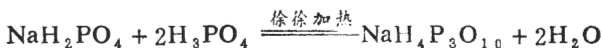
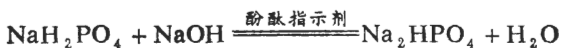
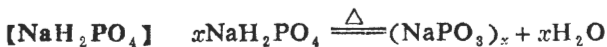
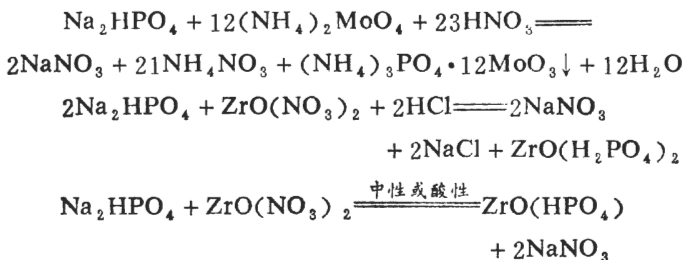


(CuHPO₃沉淀溶于热CH₃COOH中)

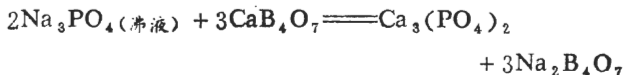
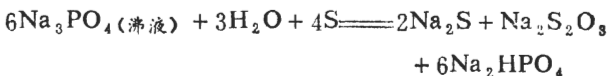
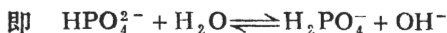


(PbHPO₃不溶于醋酸)

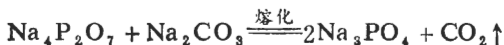
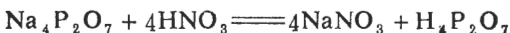
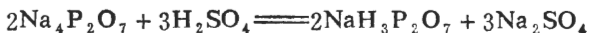


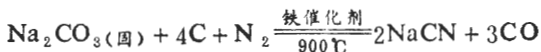
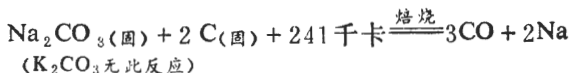
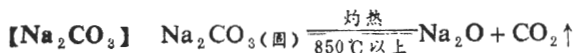
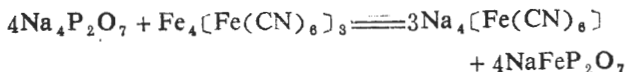
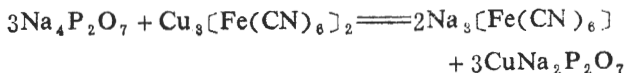
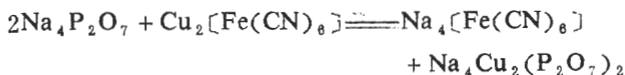


【 Na_3PO_4 】注： Na_3PO_4 的水解反应。

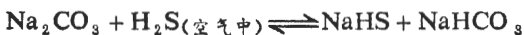
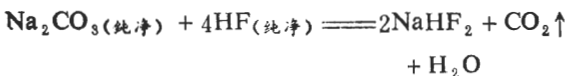
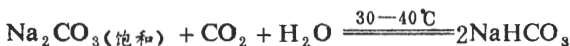
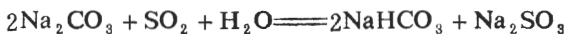
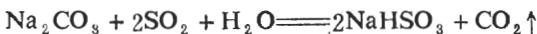
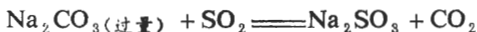
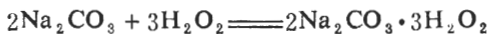


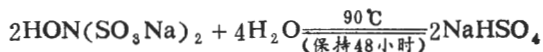
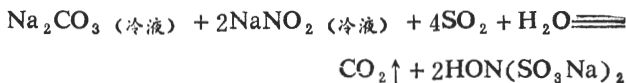
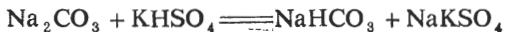
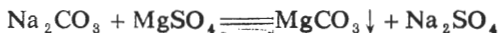
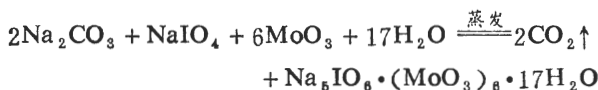
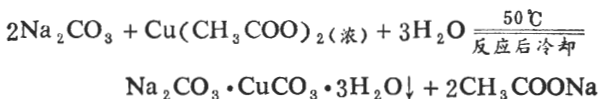
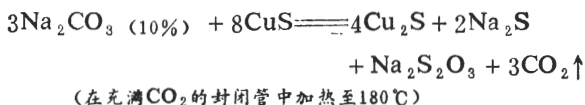
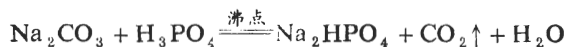
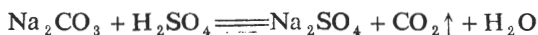
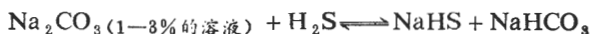
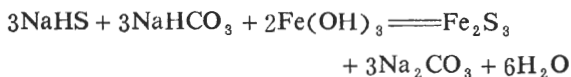
【 $\text{Na}_4\text{P}_2\text{O}_7$ 】

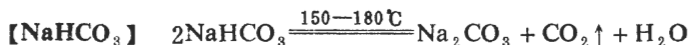
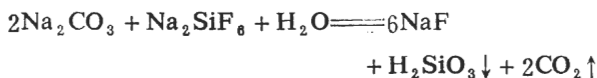




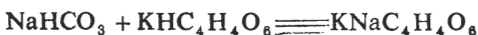
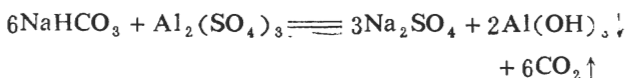
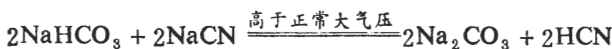
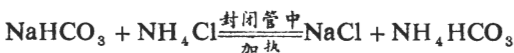
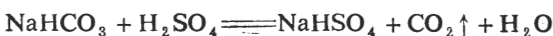
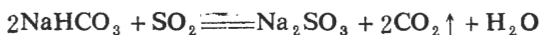
- 138.5 千卡



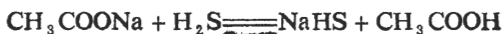
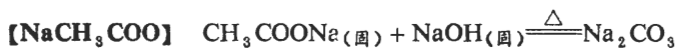
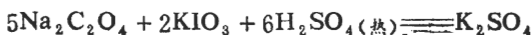
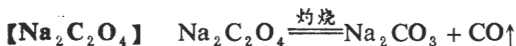
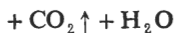


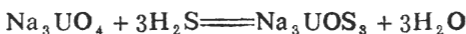
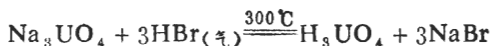
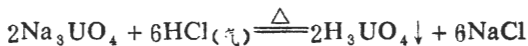
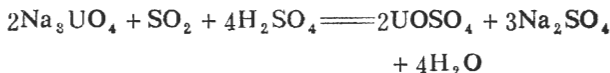
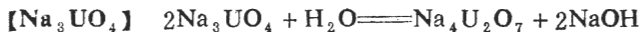


(水解后其溶液呈碱性)

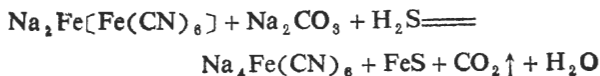
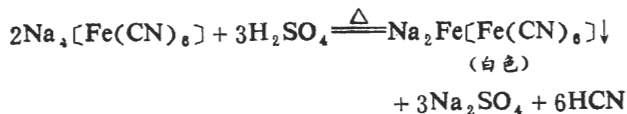
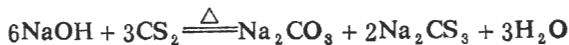
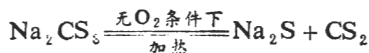
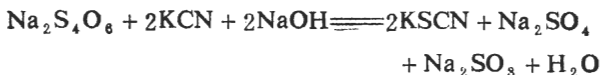
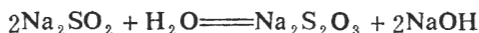
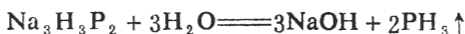


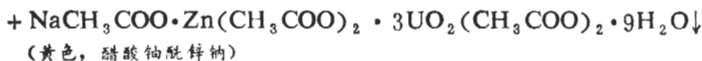
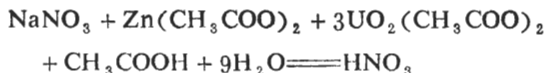
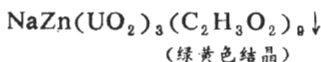
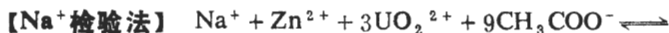
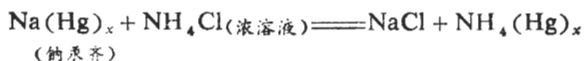
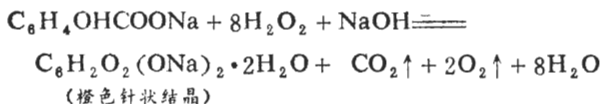
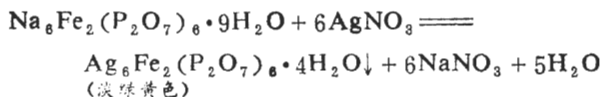
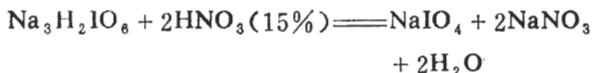
(酒石酸氢钾)



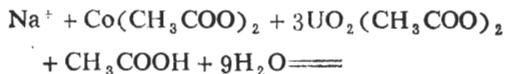


【其他含钠的化合物】

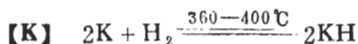


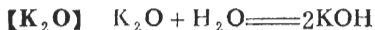
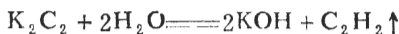
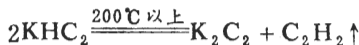
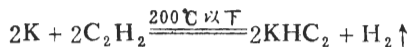
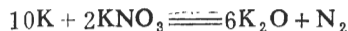
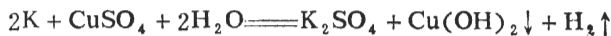
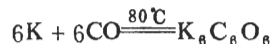
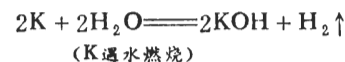
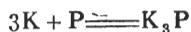
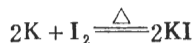


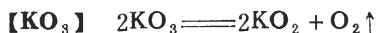
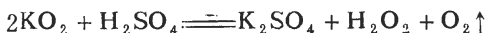
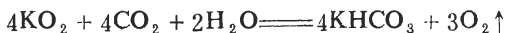
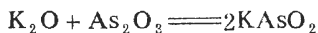
(反应在中性或CH₃COOH酸性中进行)



15.3 钾 4s¹ K = 39.102

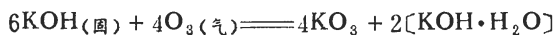




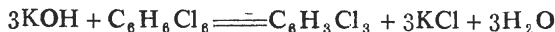
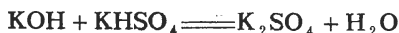
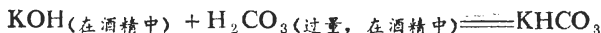
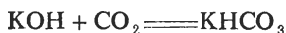
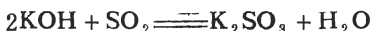
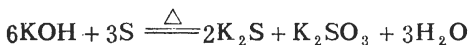
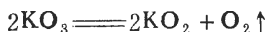
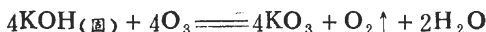


(臭氧化钾)

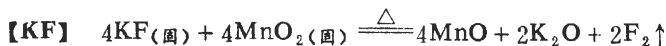
【KOH】 注：与NaOH相类似。



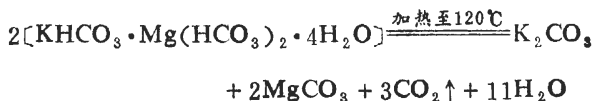
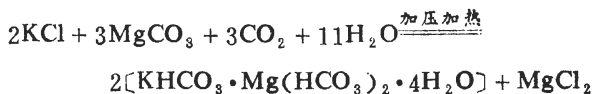
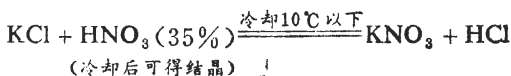
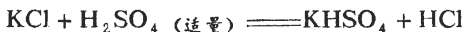
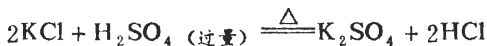
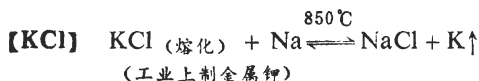
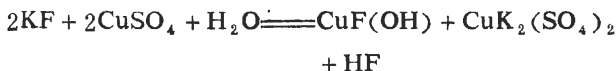
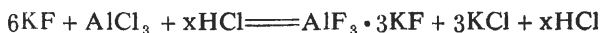
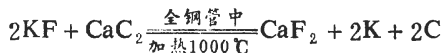
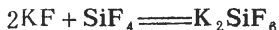
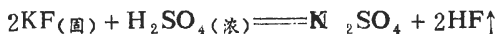
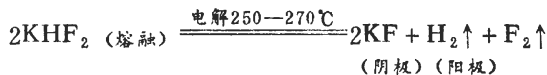
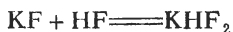
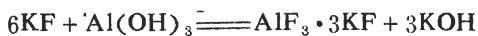
(固体, 桔红色) (固体)

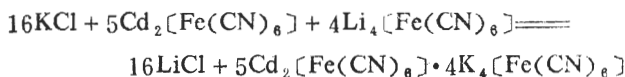
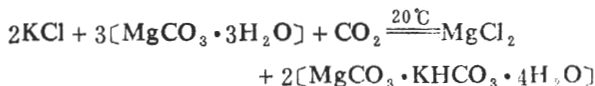


(六六六遇碱分解的反应)

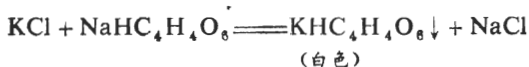


(反应需在铂金曲颈中进行)



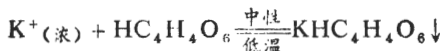


(可溶)

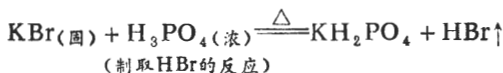
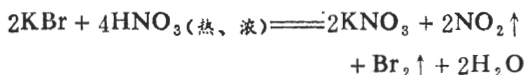
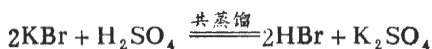
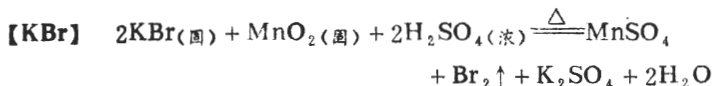
(此反应可用来检验K⁺)

(白色)

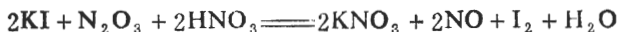
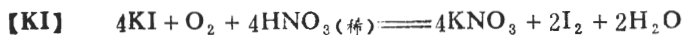
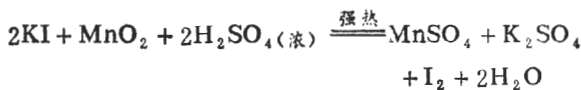
(其他钾盐也有类似的反应)

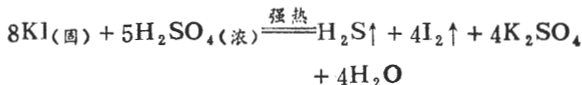
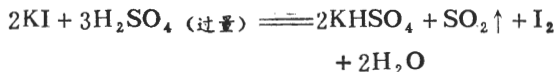
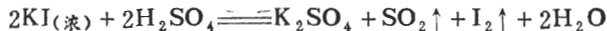
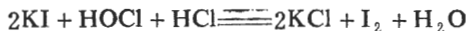
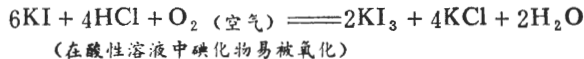
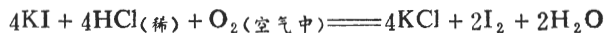
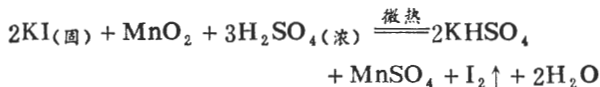


(反应后所生沉淀溶于强酸、强碱中)

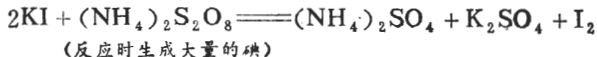
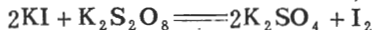
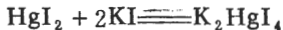
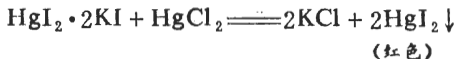
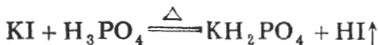
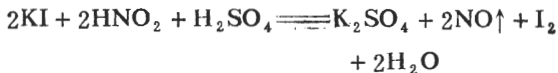
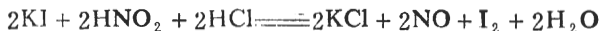


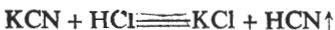
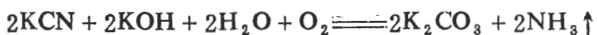
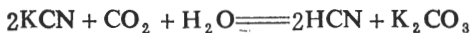
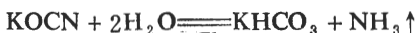
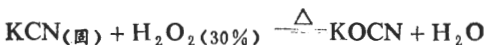
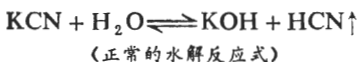
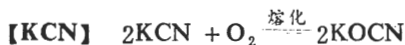
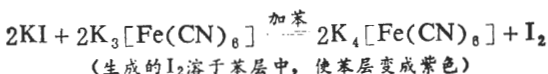
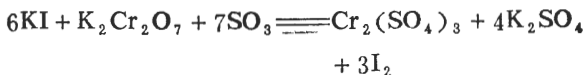
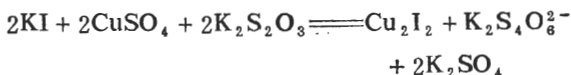
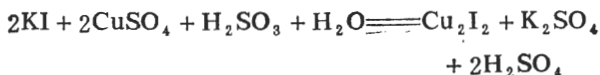
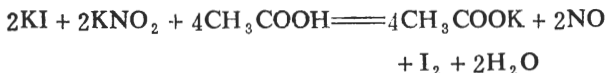
(制取HBr的反应)

(因为 $2\text{HNO}_3 \xrightarrow{\text{日光}} \text{N}_2\text{O}_3 + \text{O}_2 \uparrow + \text{H}_2\text{O}$)

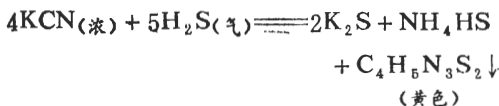


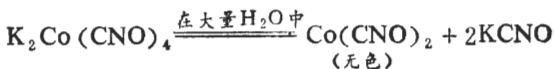
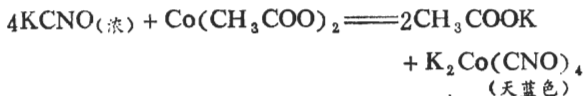
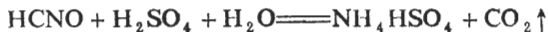
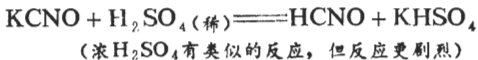
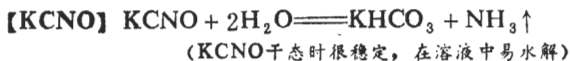
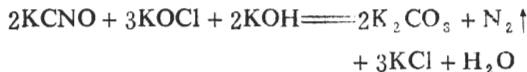
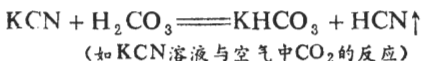
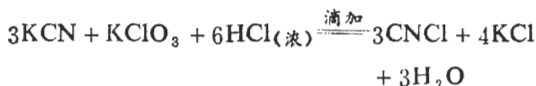
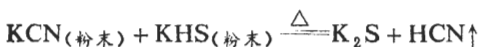
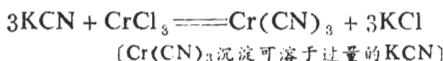
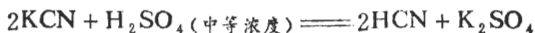
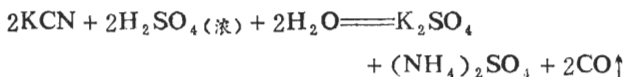
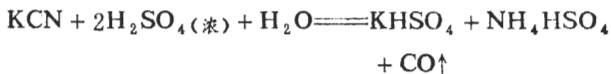
(NaI也有类似的反应)

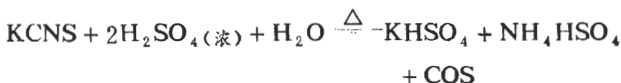
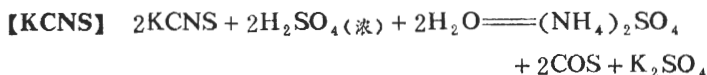




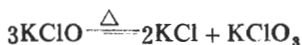
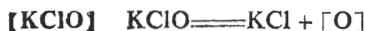
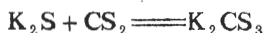
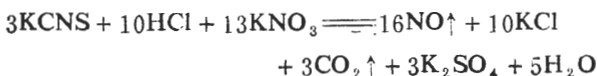
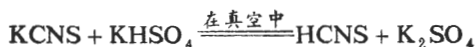
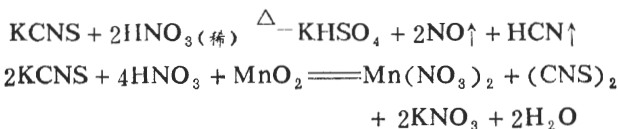
(NaCN 有类似的反应。冷的稀酸与可溶性氰化物均可发生此反应)



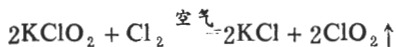
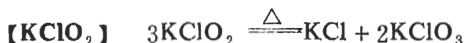
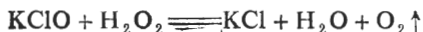




(若 H_2SO_4 的浓度很高, 则有 HCOOH 、 CO_2 、 SO_2 等生成, 同时有 $\text{S}\uparrow$)



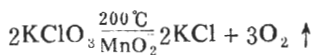
(在溶液中进行的反应)



(反应时, Cl_2 用空气稀释)

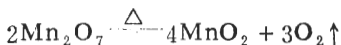


(纯 KClO_3 单独加热)

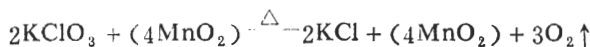


(实验室制氧法)

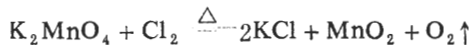
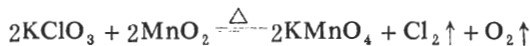
注: KClO_3 和 MnO_2 的反应机理有两种可能的情况:



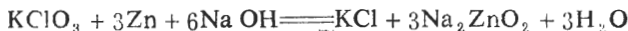
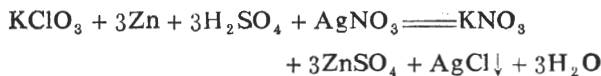
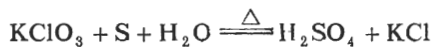
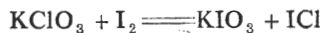
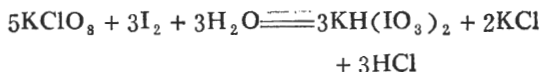
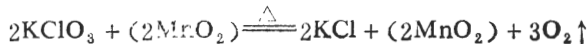
+)

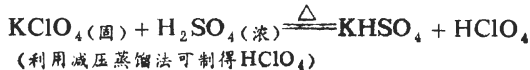
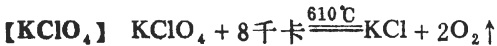
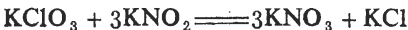
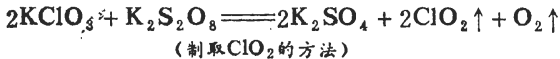
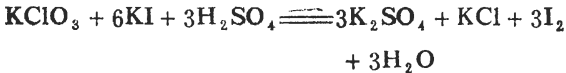
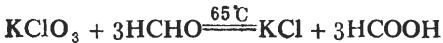
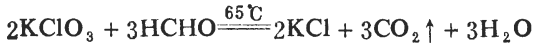
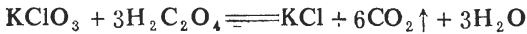
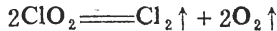
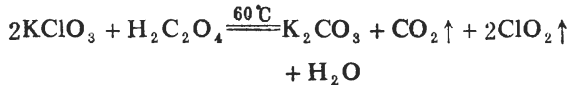
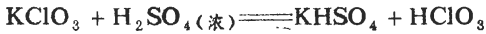
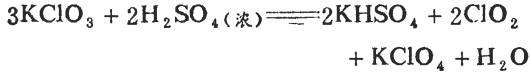
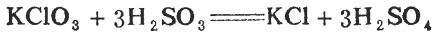
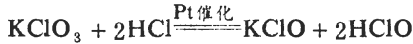
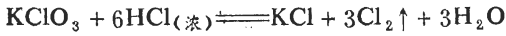
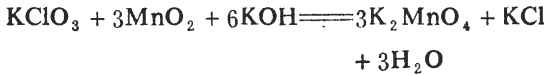
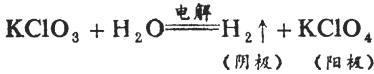


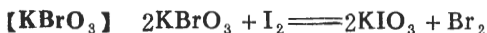
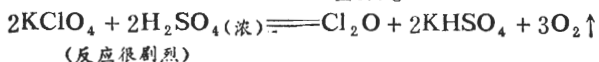
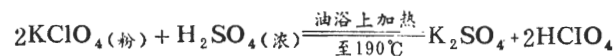
或:



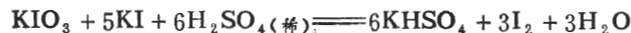
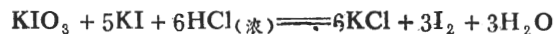
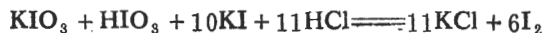
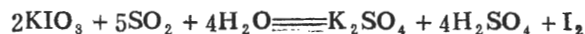
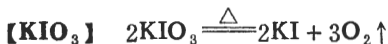
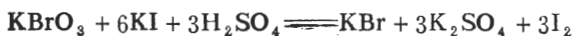
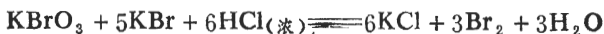
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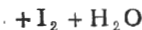


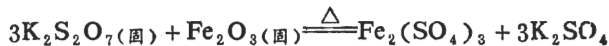
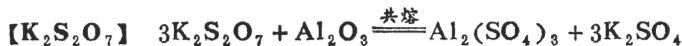
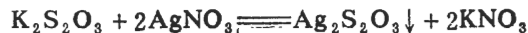
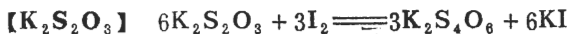
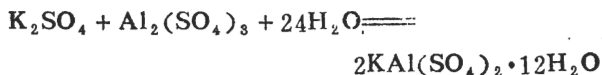
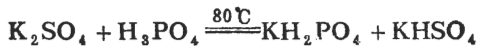
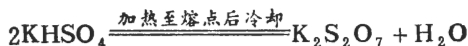
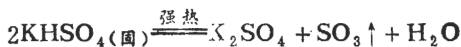
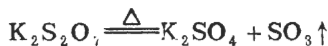
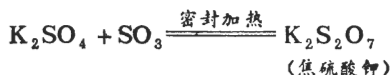
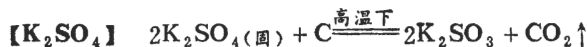
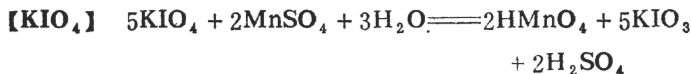
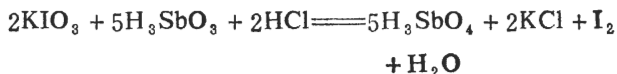
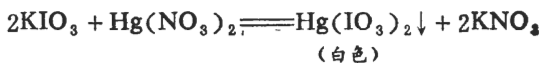


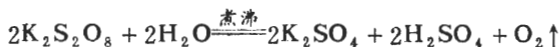
(NaBrO₃也可发生类似的反应)



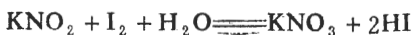
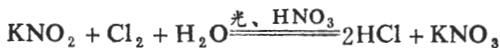
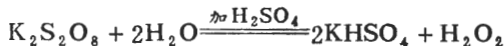
(KBrO₃也有类似的反应)



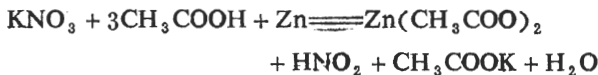
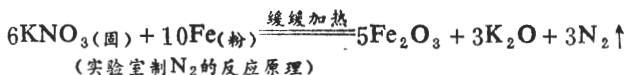
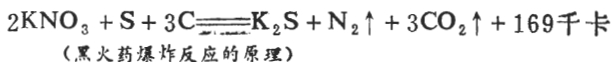
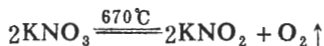
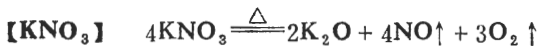
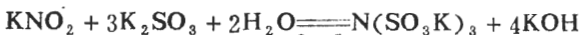
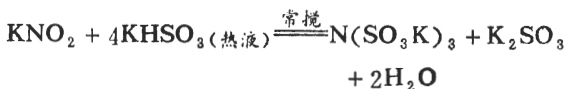


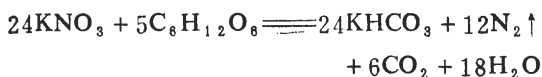
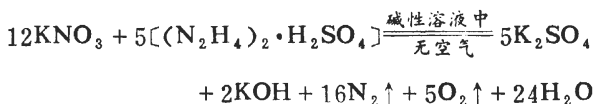
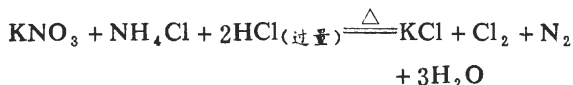
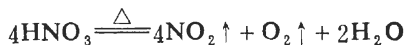
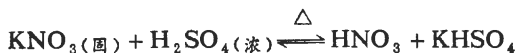


(所有可溶性的过二硫酸盐均有此类反应发生)

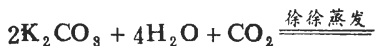
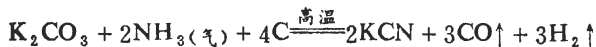
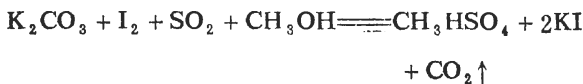
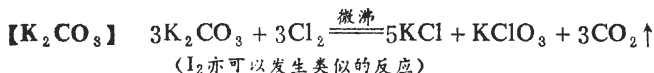
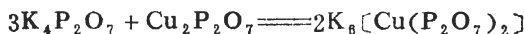
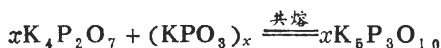
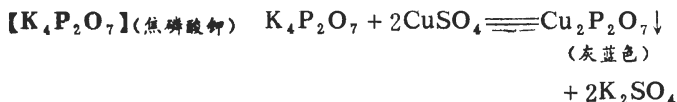


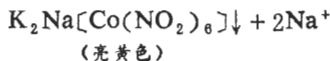
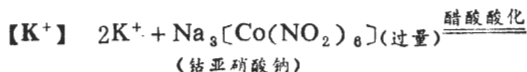
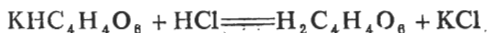
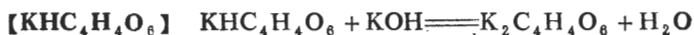
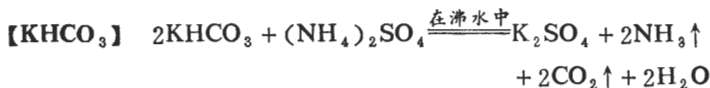
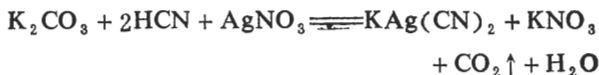
(石榴红色)



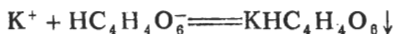


(土壤中反硝化菌的作用)



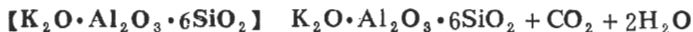


(用来鉴定 K^+ 的反应)

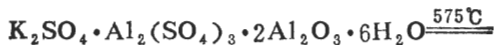
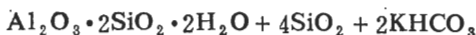
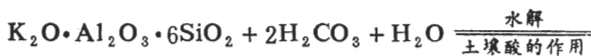
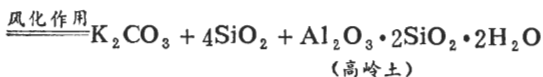


(酒石酸氢根) (白色)

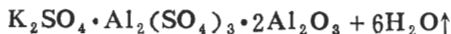
(KHC₄H₄O₆沉淀溶于酸或碱)



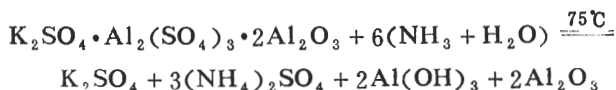
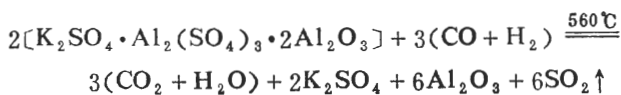
(正长石)



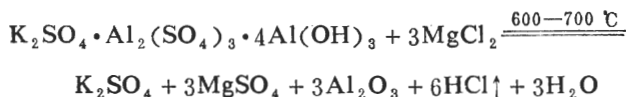
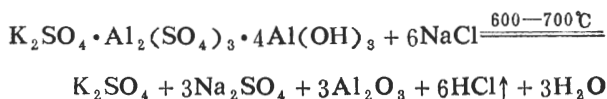
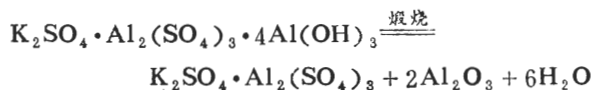
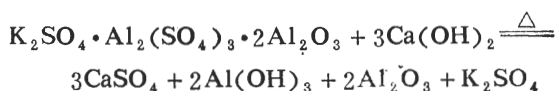
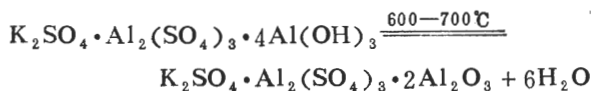
(明矾石)



(蒸明矾石)



【 $\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 4\text{Al}(\text{OH})_3$ 】

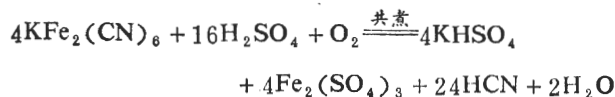
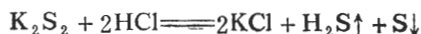
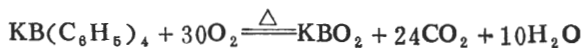


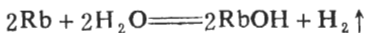
【其他含钾的化合物】



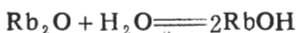
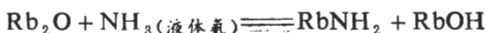
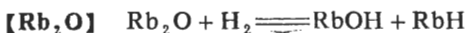
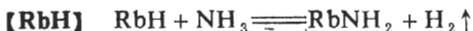
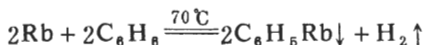
(四苯硼钠) (白色)

(检验 K^+ 的反应)

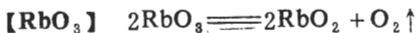
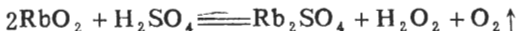
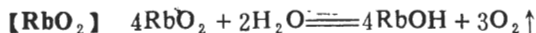
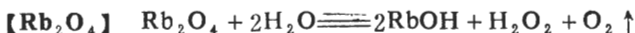
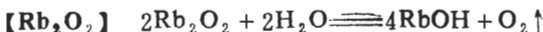




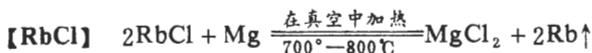
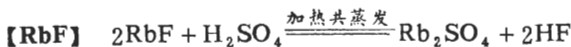
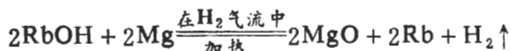
(爆炸性的反应)



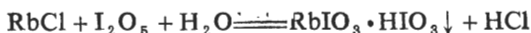
(反应剧烈, 能燃烧)



【RbOH】 RbOH的化学性质与KOH相似。



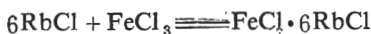
(工业上制取Rb)



(无色结晶)



(浓盐酸液)(浓盐酸液)



(浓盐酸溶液)

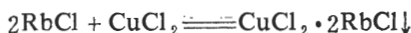
(反应后将溶液蒸发可得结晶)



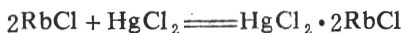
(浓盐酸液)(浓盐酸液)



(浓盐酸液)(浓盐酸液)



(浓盐酸液)(浓盐酸液) (红色)

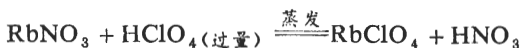
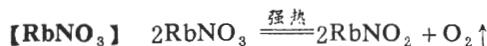
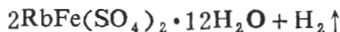
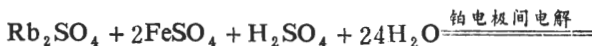
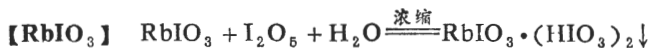
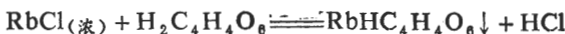


(浓盐酸液)

(反应后将溶液蒸发可得结晶)



(黄色)

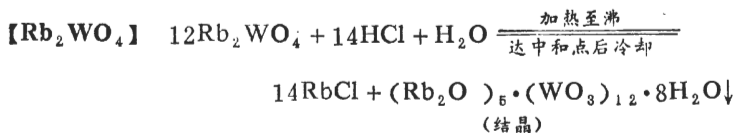
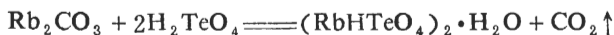
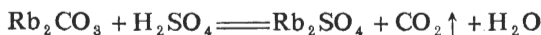
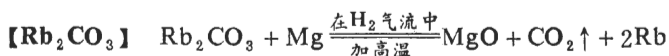


(结晶)

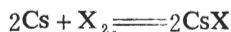
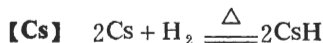


(比重1.5)

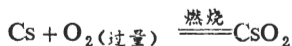
(反应后, 进行冰冻得结晶体)



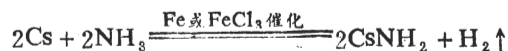
15.5 铯 $6s^1$ $\text{Cs} = 132.9055$



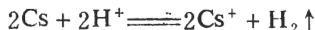
(X代表卤素元素)



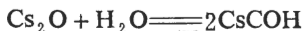
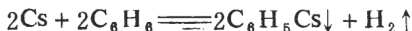
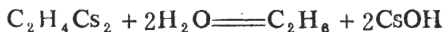
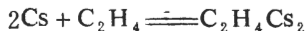
(反应剧烈)



(发生爆炸性的反应)



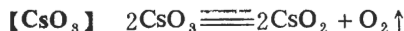
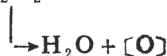
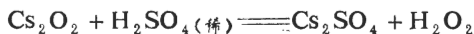
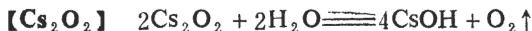
(在无氧化性能酸的作用下)



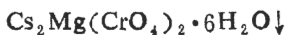
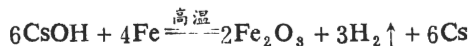
(反应剧烈)



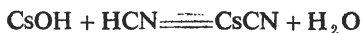
(醇溶液)



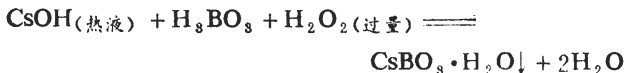
(用Ca代Mg亦可有类似的反应)



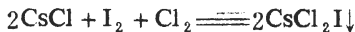
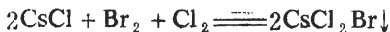
(结晶)



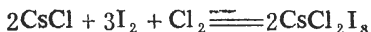
(结晶)



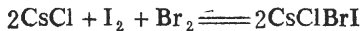
(冷却加入过氧化氢, 放置一夜, 加入大量36%的乙醇)



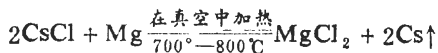
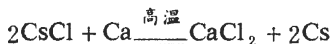
(二氯化碘, 黄色结晶)



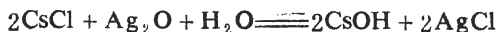
(黄色结晶)



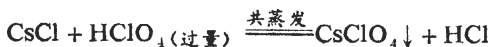
(黄色结晶)



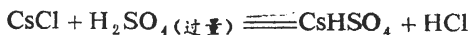
(工业上制取Cs)



(AgCl比Ag₂O更难溶)

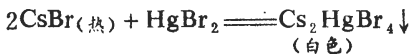
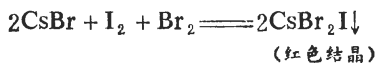
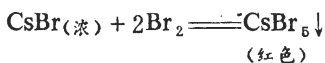
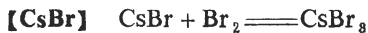
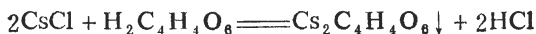
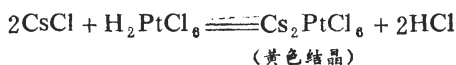
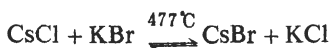
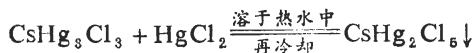
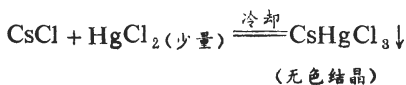
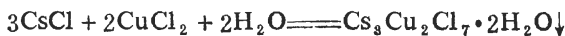
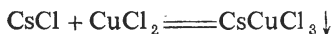
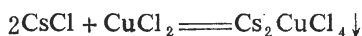
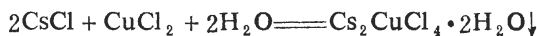
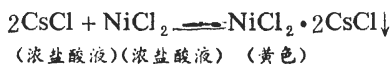
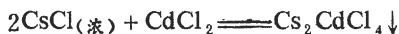
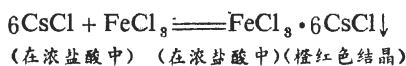


(结晶)

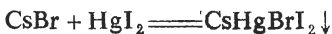
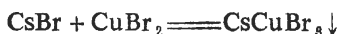
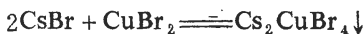


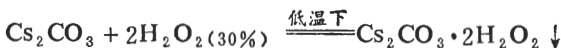
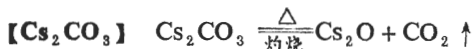
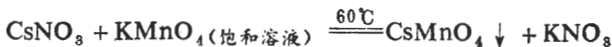
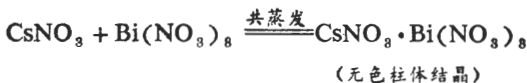
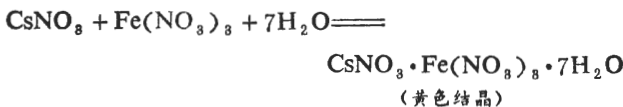
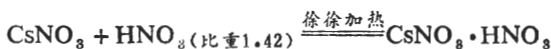
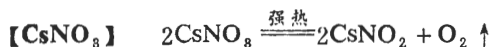
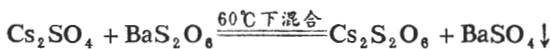
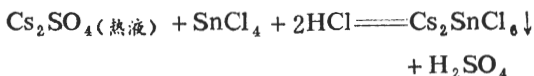
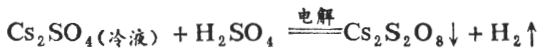
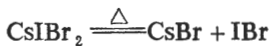
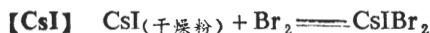
+ H₂O

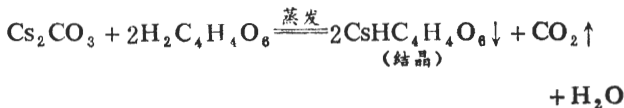
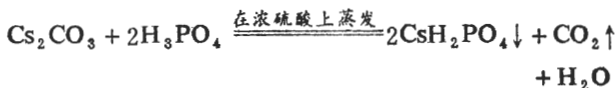
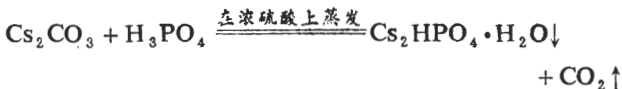
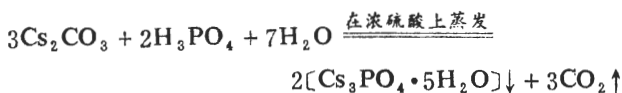
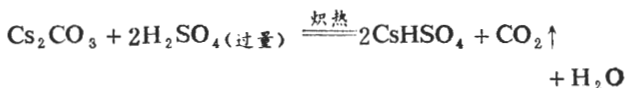
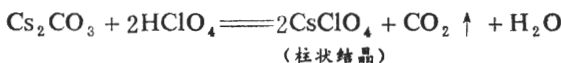
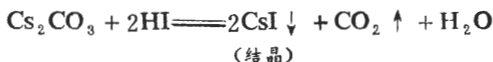
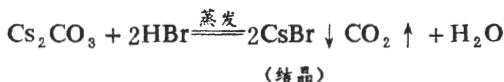
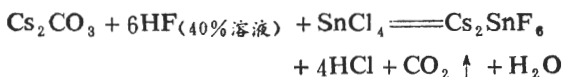
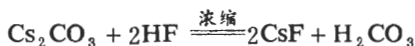
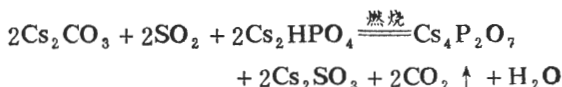
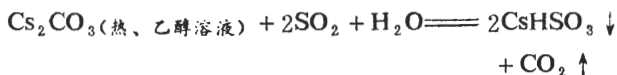




(反应冷却后结晶)

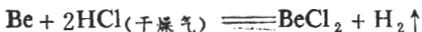
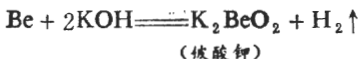
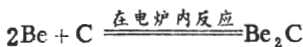
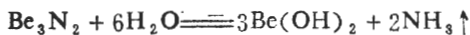
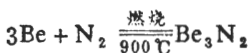
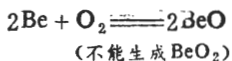
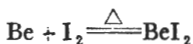
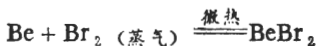
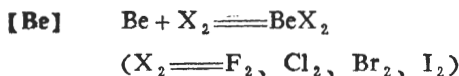


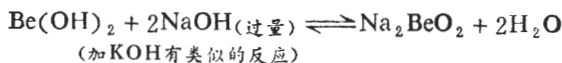
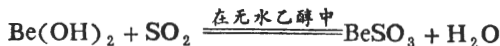
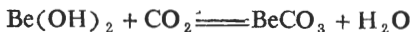
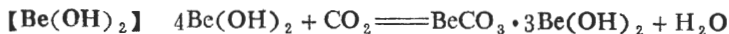
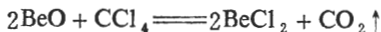
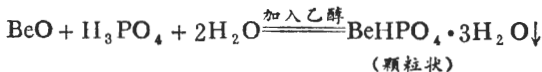
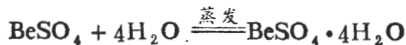
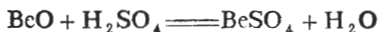
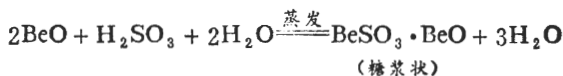
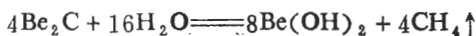
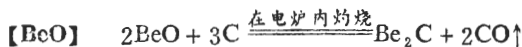
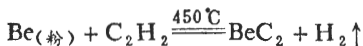
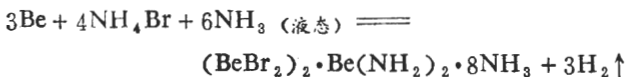
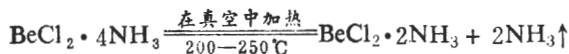


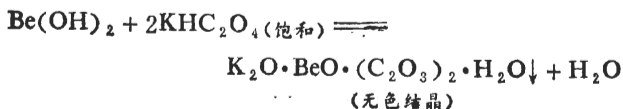
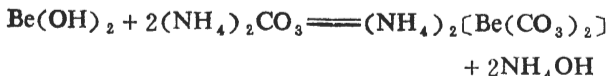
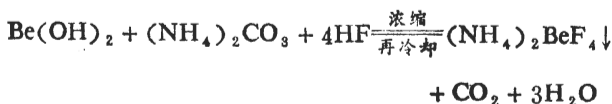
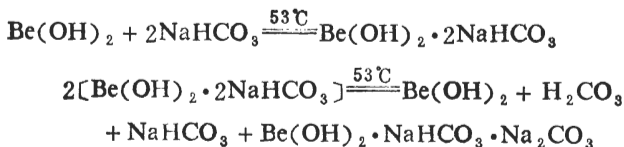
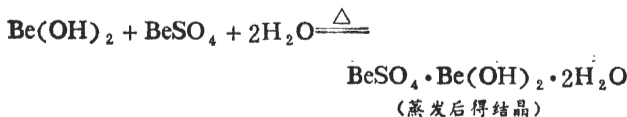
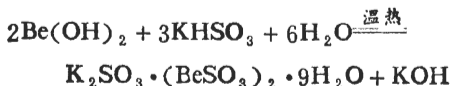
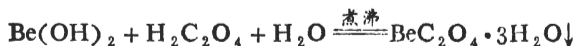
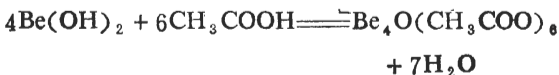
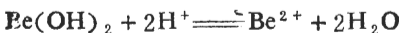
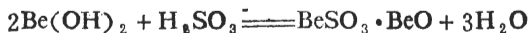
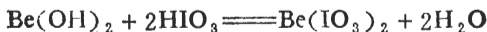


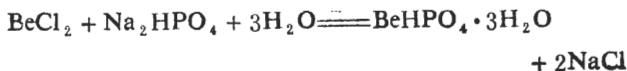
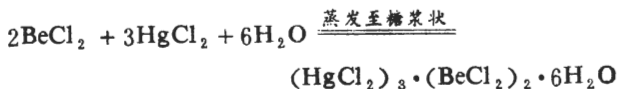
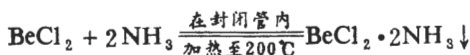
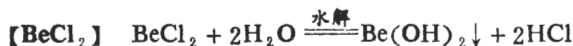
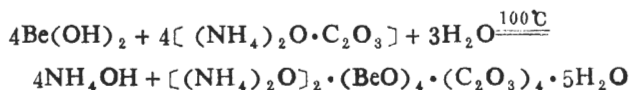
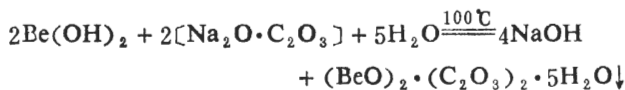
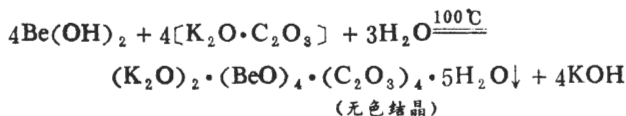
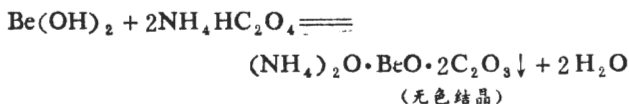
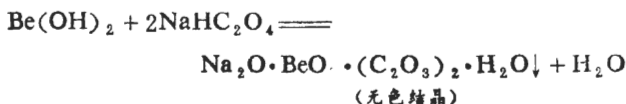
第十六章 碱土金属

16.1 铍 $2s^2$ $\text{Be} = 9.0122$

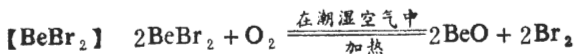


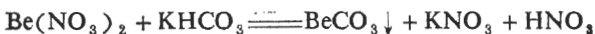
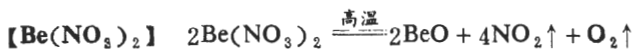
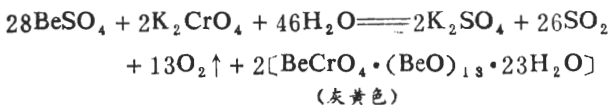
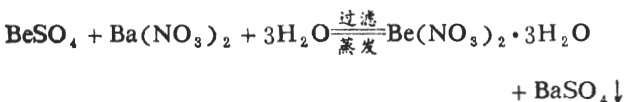
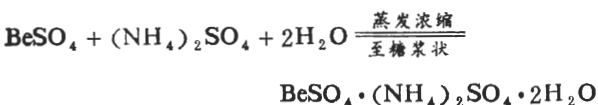
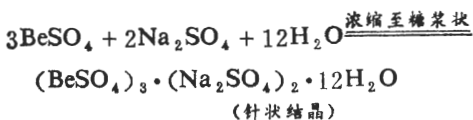
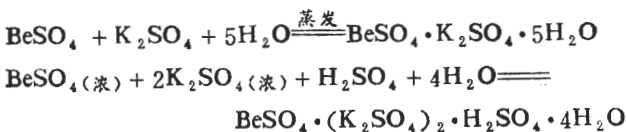
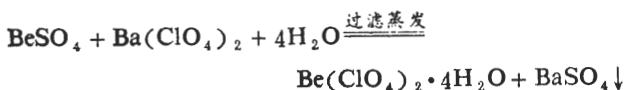
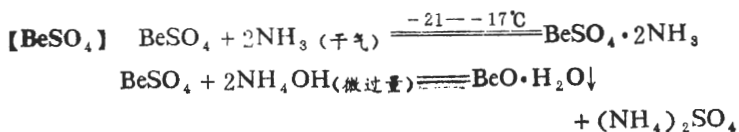


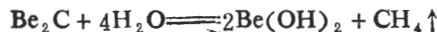
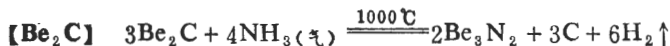
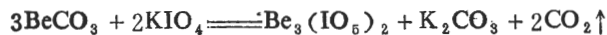
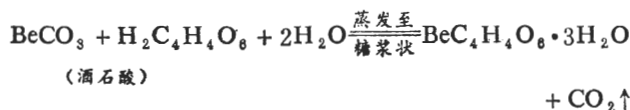
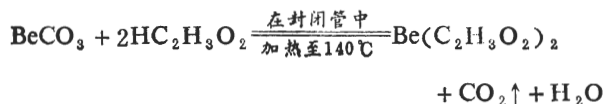
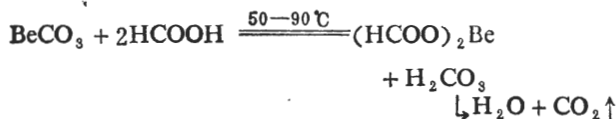
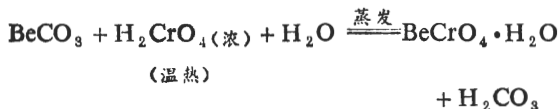
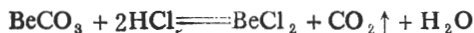
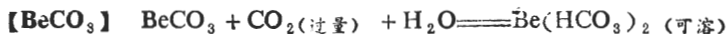
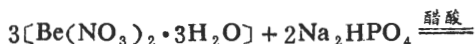
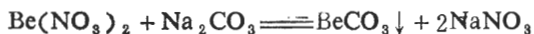




(浓缩后得结晶)

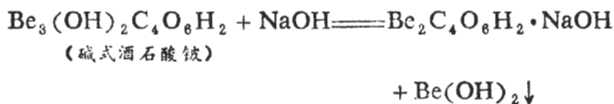
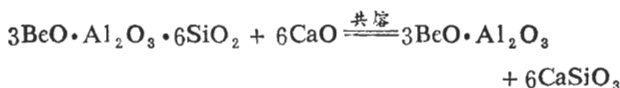
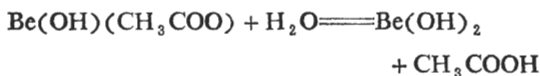
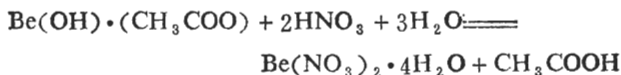
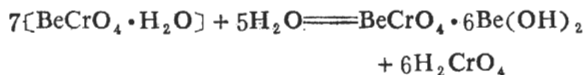
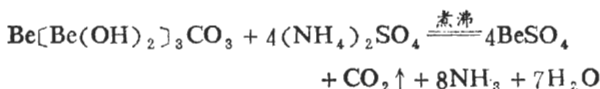




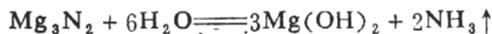
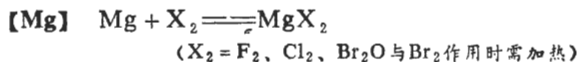


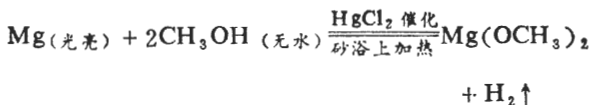
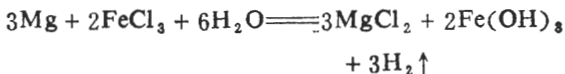
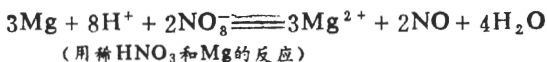
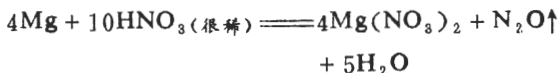
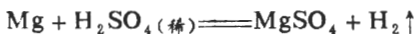
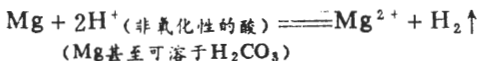
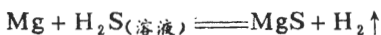
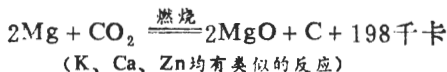
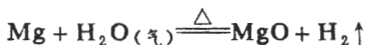
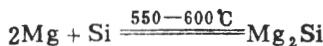
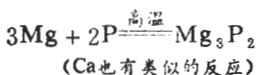
【其他含铍的化合物】

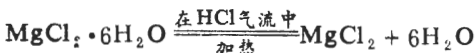
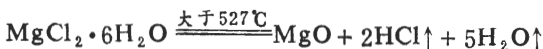
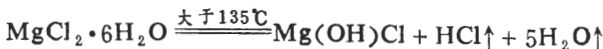
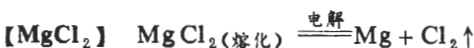
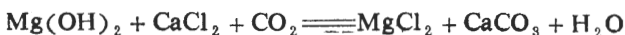
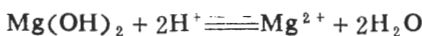
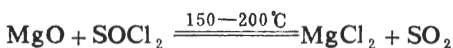
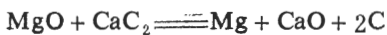
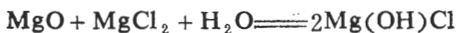
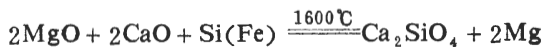
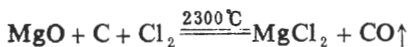
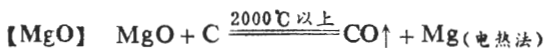
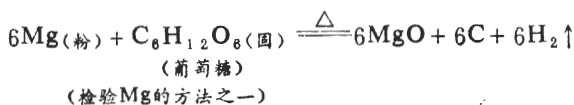




16. 2 镁 $3s^2$ $\text{Mg} = 24.305$

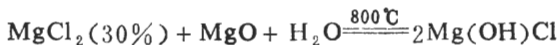








(将溶液蒸干得沉淀物)



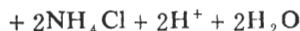
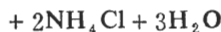
(镁氧水泥)



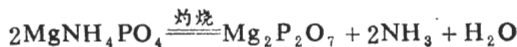
(白色胶状)



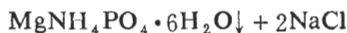
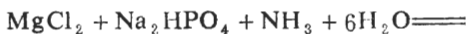
(白色)



(白色)



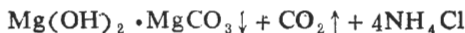
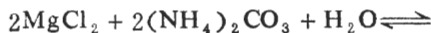
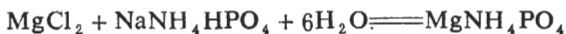
(镁盐的检验方法之一)

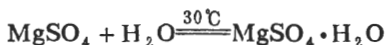
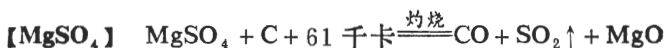
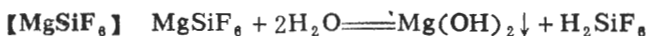
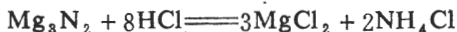
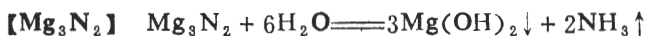
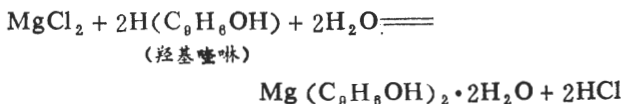
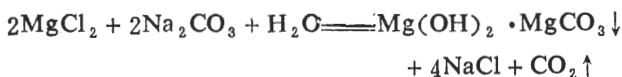


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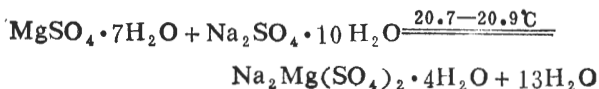
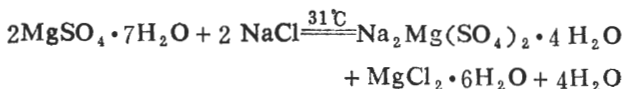
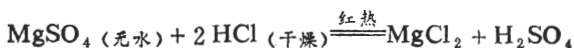
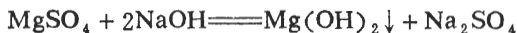
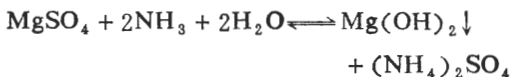


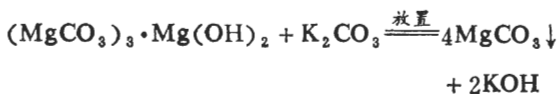
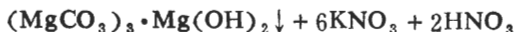
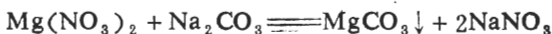
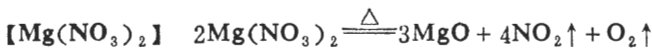
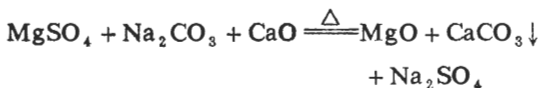
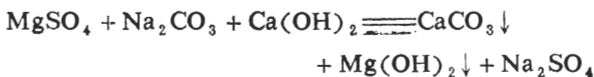
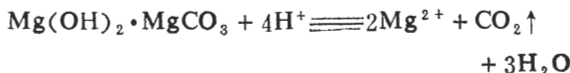
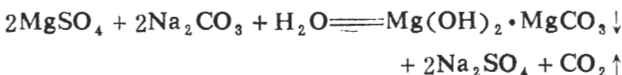
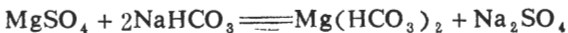
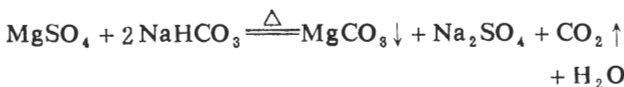
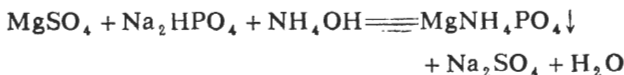
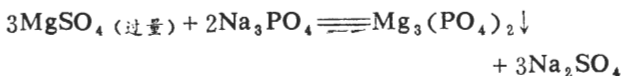
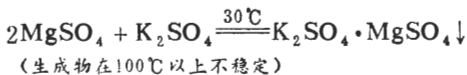
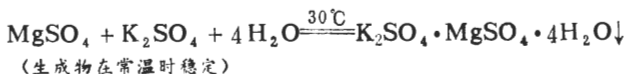
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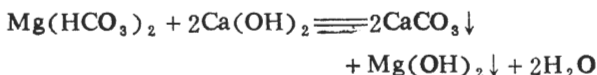
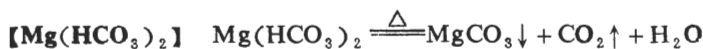
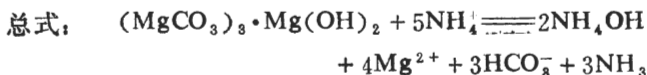
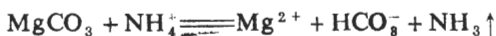
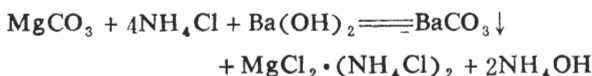
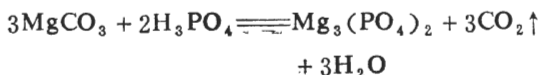
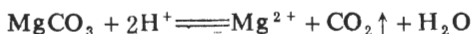
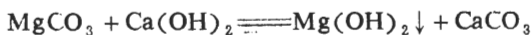
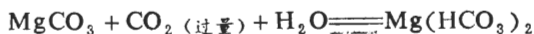
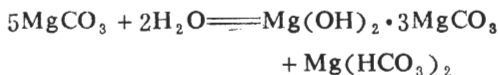
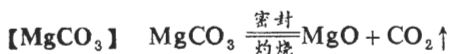
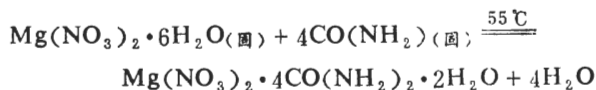




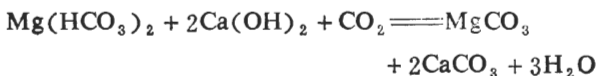
(生成物在常温时稳定)

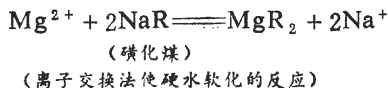
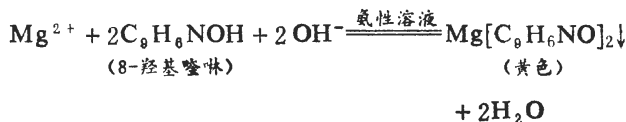
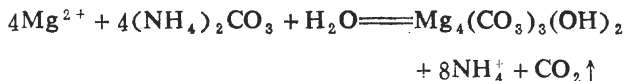
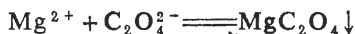
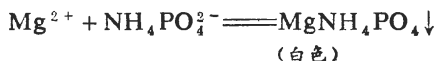
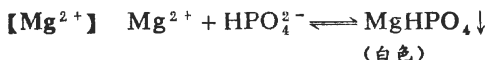
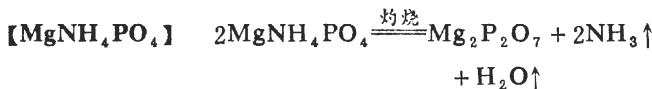
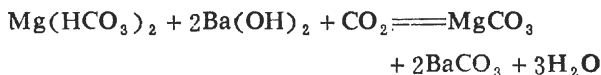






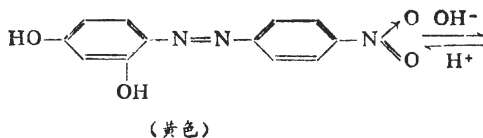
(软化暂时硬水的反应)

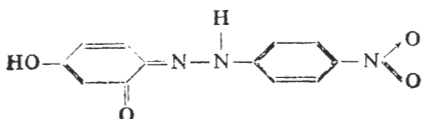




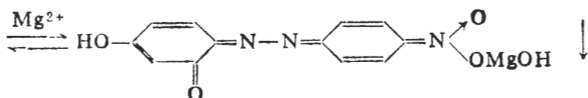
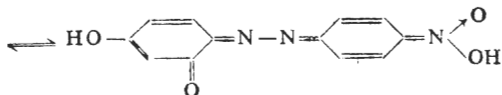
Mg²⁺的检验法:

Mg²⁺与镁试剂(对硝基偶氮间苯二酚)在碱性溶液中生成天蓝色沉淀。镁试剂在酸性溶液中呈黄色,在碱性溶液中显紫色或红色。





(紫色)



(天蓝色沉淀)

Mg^{2+} 与 EDTA 反应 (用铬黑 T 作指示剂)



(铬黑 T, 蓝色) (酒红色)

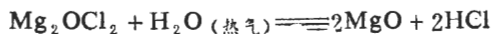
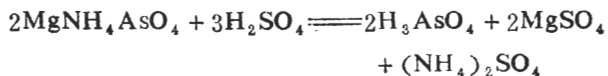
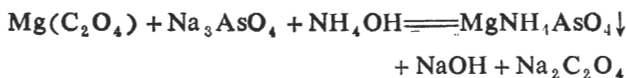
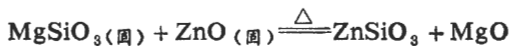
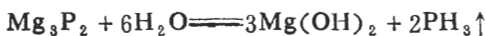
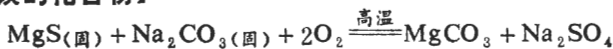


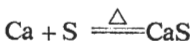
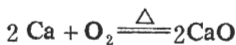
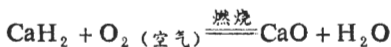
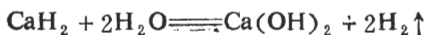
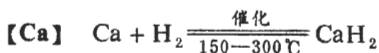
(EDTA)

(蓝色)

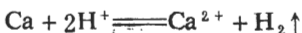
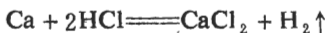
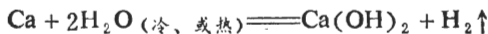
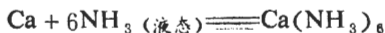
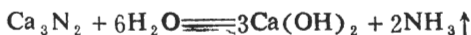
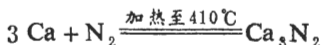
(EDTA 即 乙二胺四乙酸)

【其他含镁的化合物】



16.3 钙 $4s^2$ $\text{Ca} = 40.08$ 

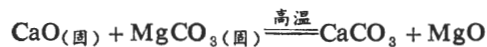
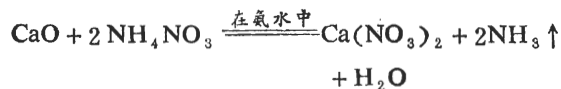
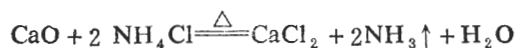
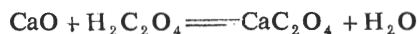
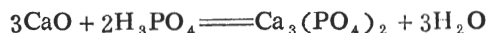
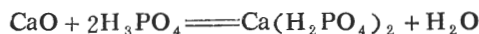
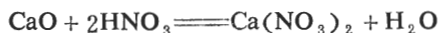
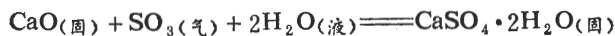
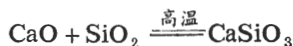
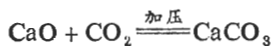
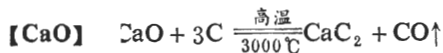
(与Se、Te也有类似的反应)

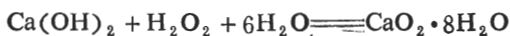
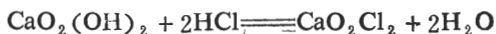
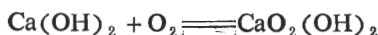
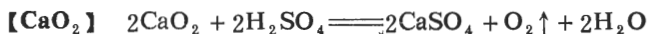
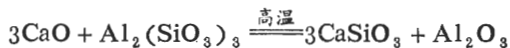


(Ca与非氧化性的酸反应放出氢气)

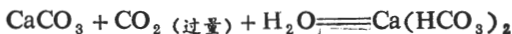
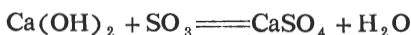
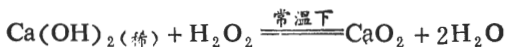


(Ca与浓硝酸作用时,使钙呈“钝态”)

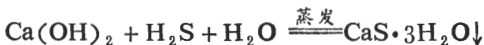
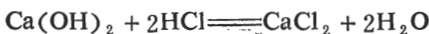




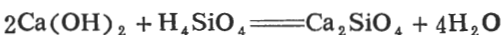
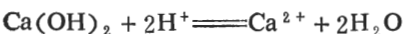
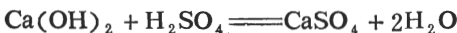
(防止过量)



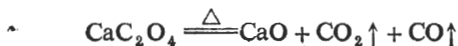
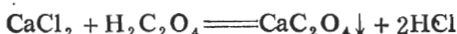
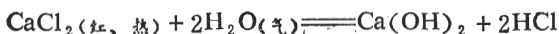
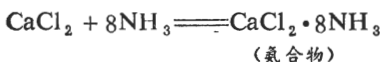
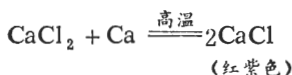
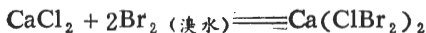
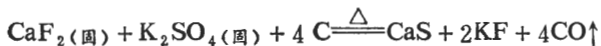
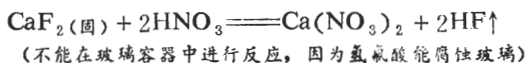
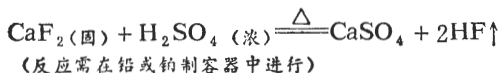
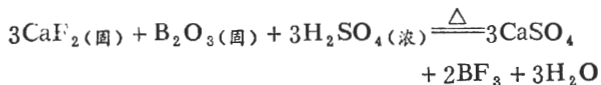
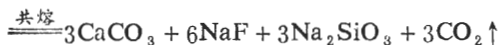
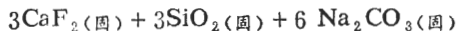
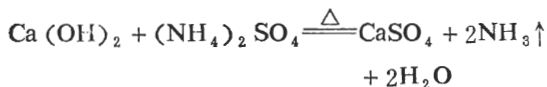
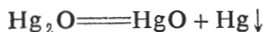
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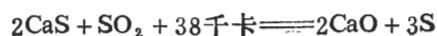
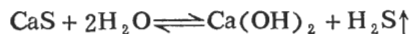
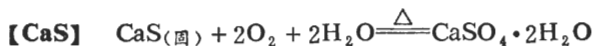
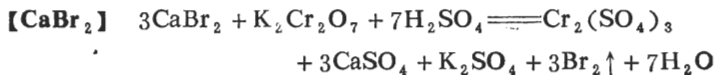
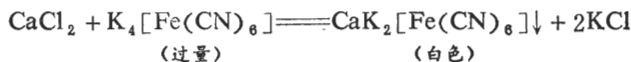
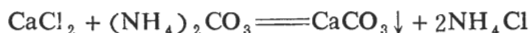
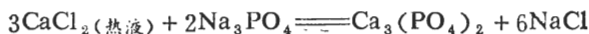
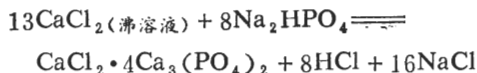
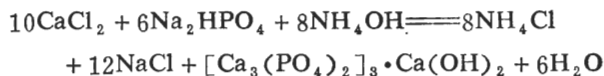
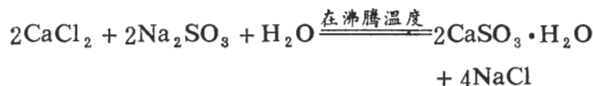
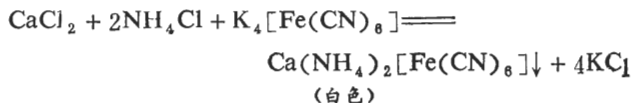
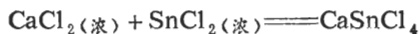
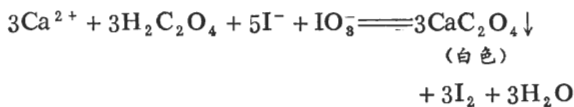
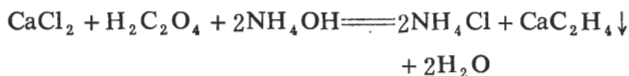


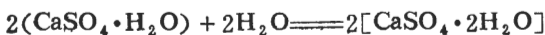
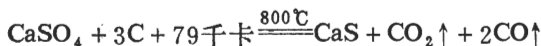
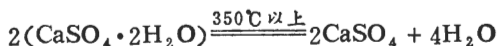
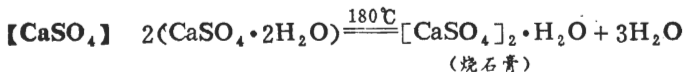
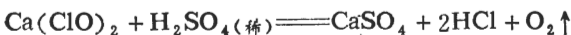
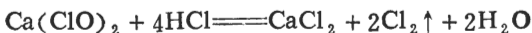
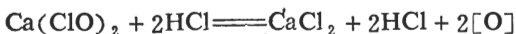
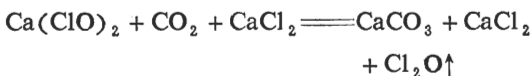
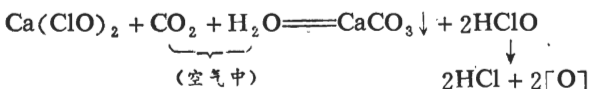
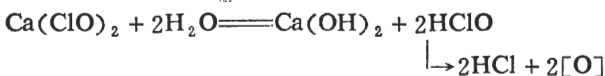
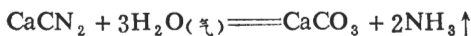
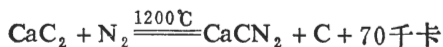
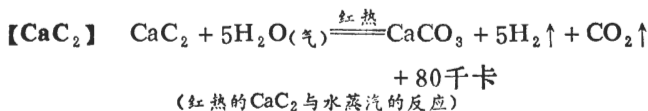
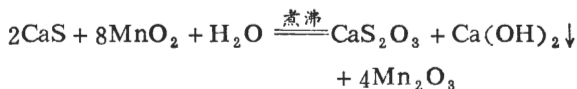
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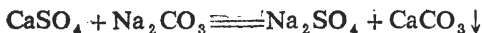
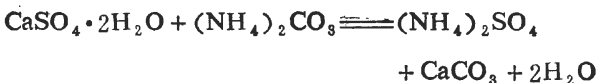
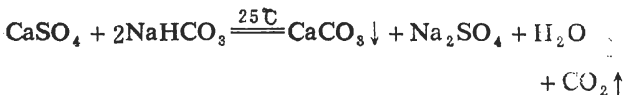
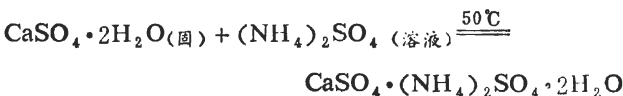
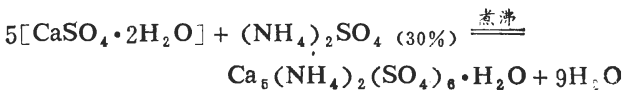
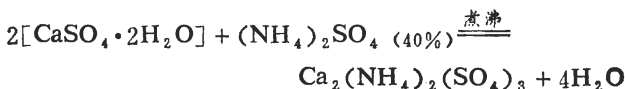
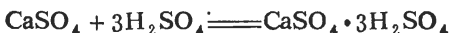
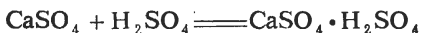
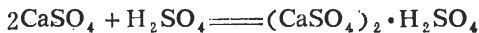
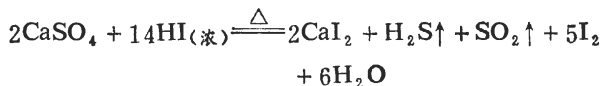
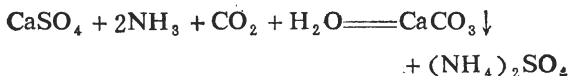
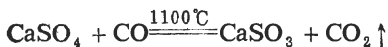


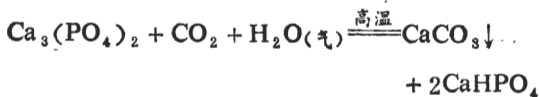
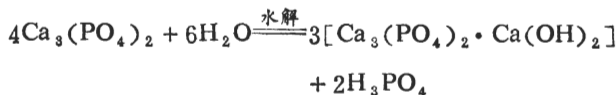
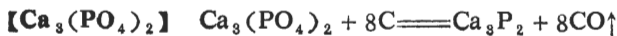
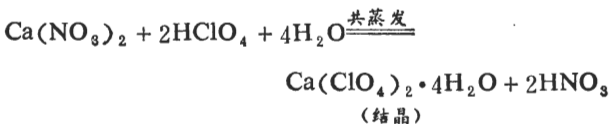
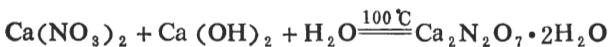
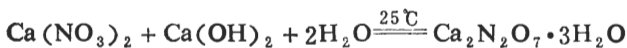
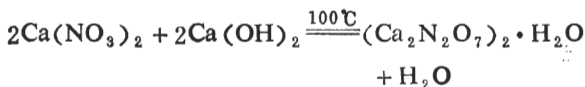
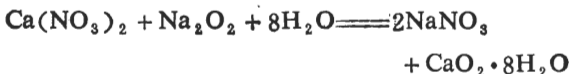
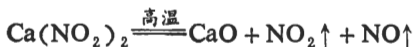
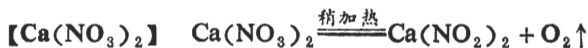
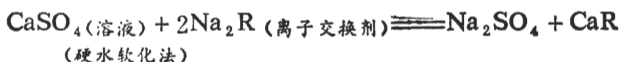
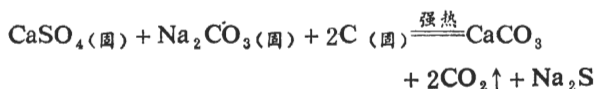
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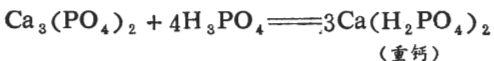
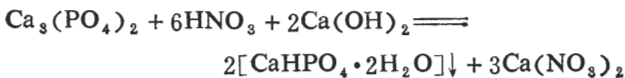
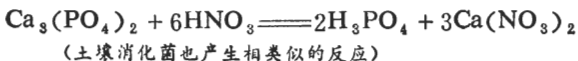
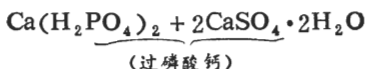
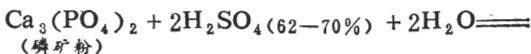
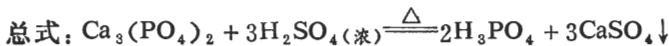
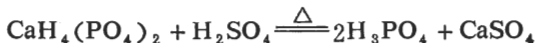
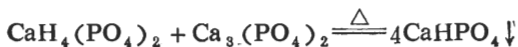
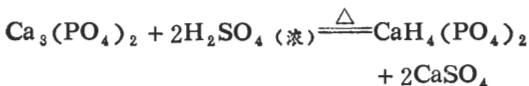
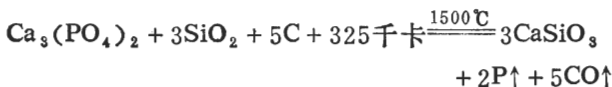
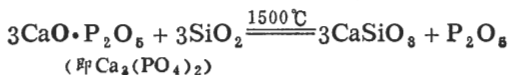




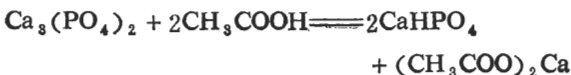
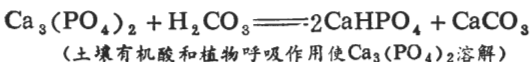


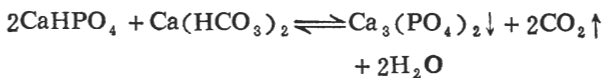
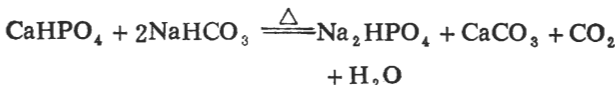
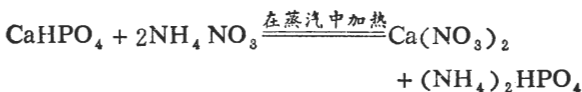
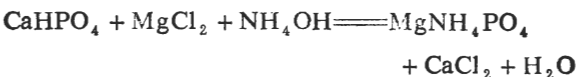
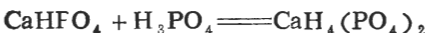
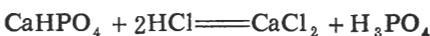
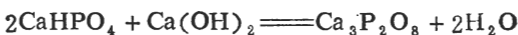
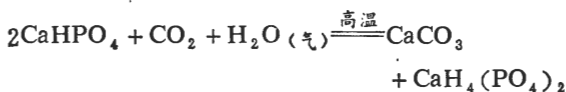
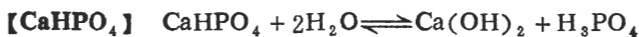
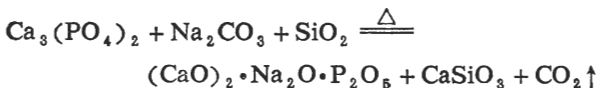
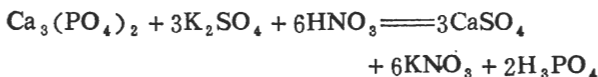
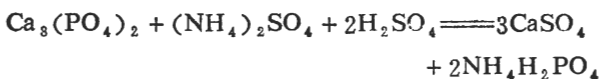




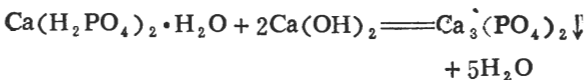
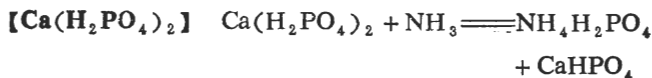


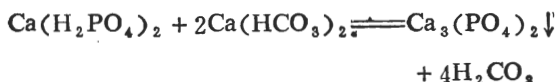
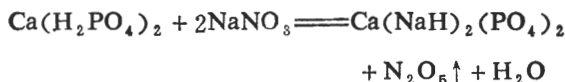
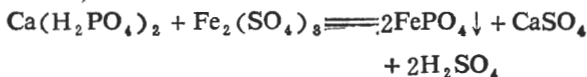
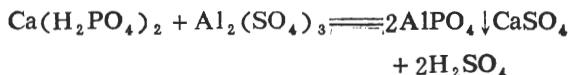
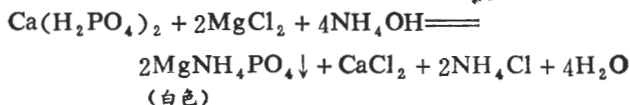
(土壤有机酸和生理酸性肥料也产生相类似的效果)



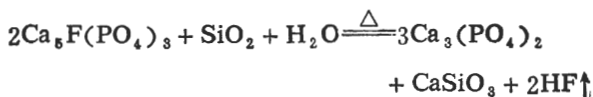
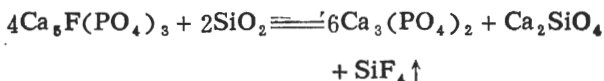
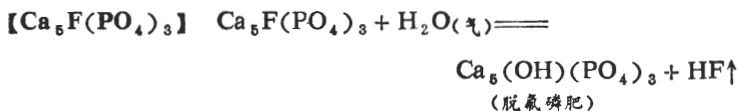
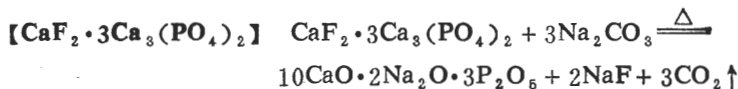
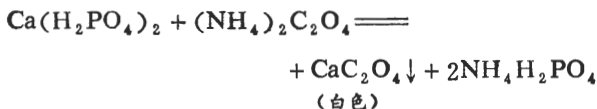


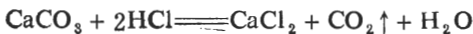
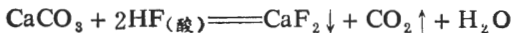
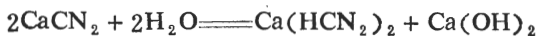
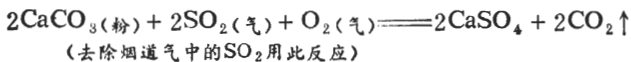
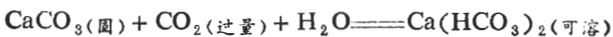
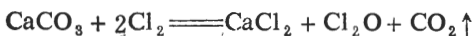
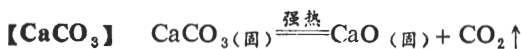
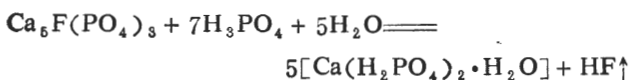
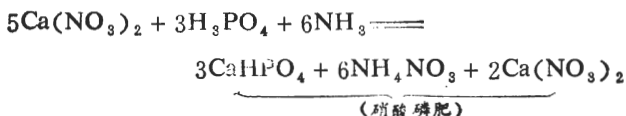
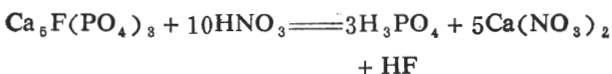
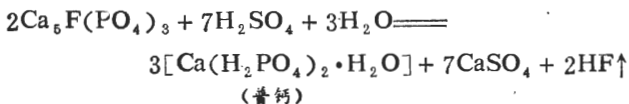
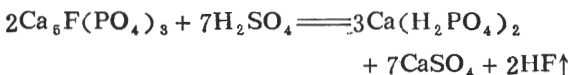
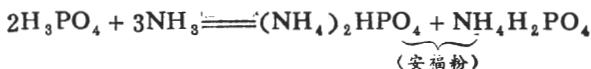
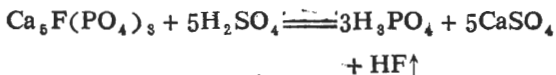
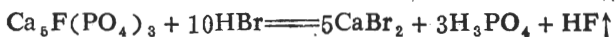
(土壤中发生的反应)

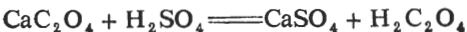
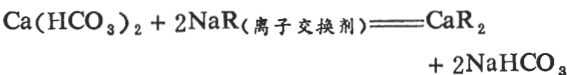
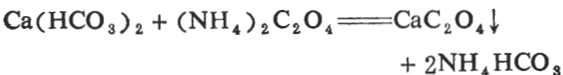
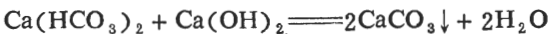
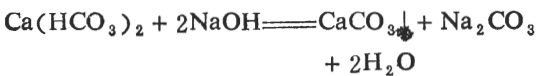
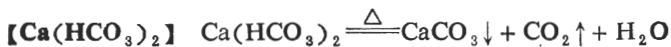
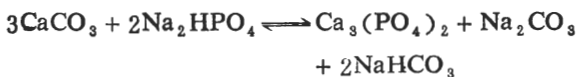
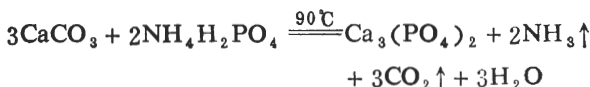
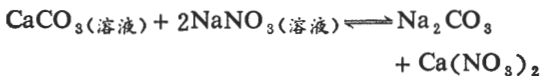
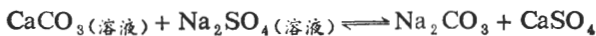
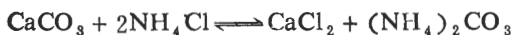
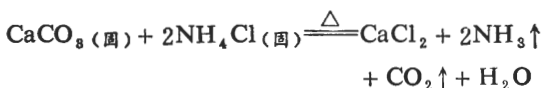
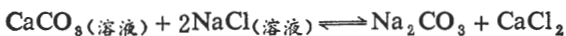
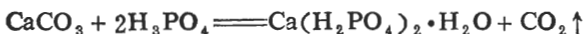


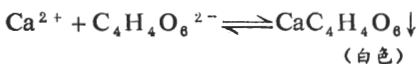
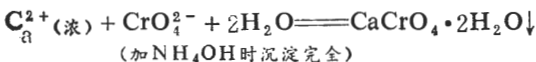
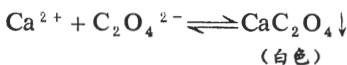
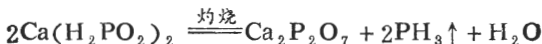
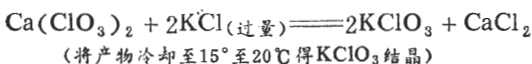
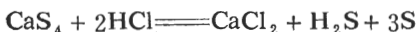
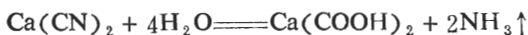
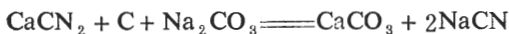
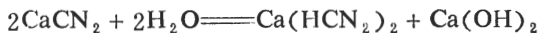
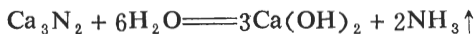
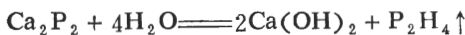
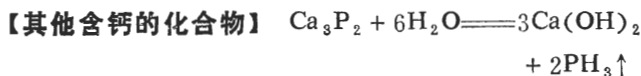
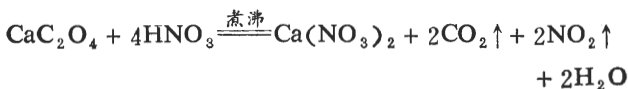


(石灰性土壤对磷的固定作用)

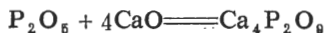
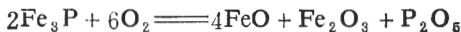


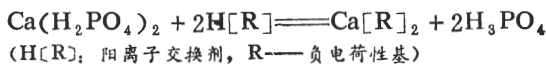
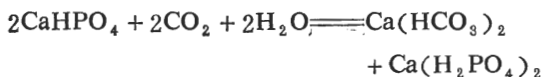
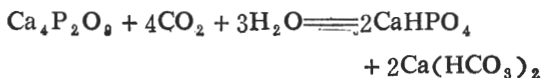
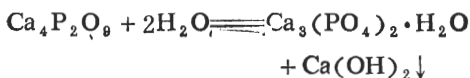




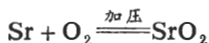
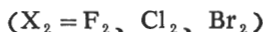
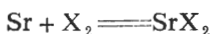
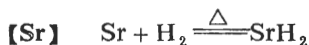


【含磷炉渣及汤姆斯磷肥】

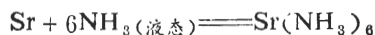
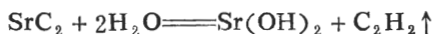
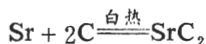
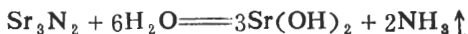




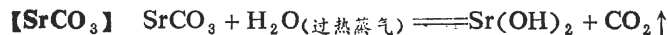
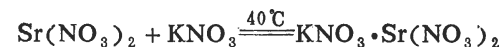
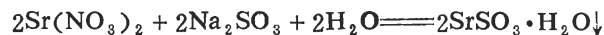
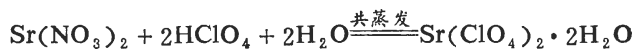
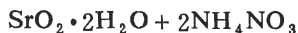
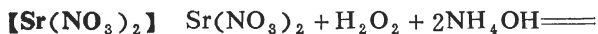
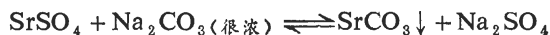
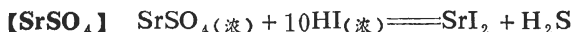
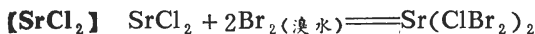
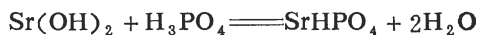
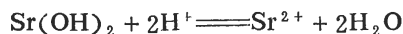
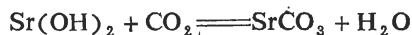
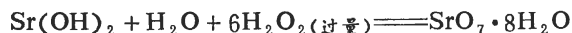
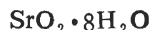
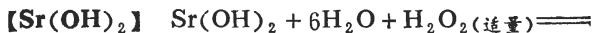
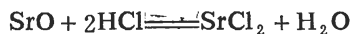
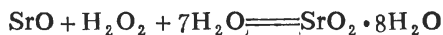
16.4 锶 $5s^2$ $\text{Sr} = 87.62$

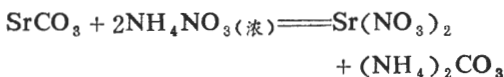
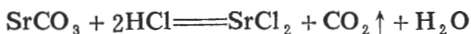
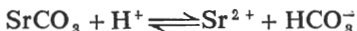


(Sr与Se、Te有相类似的反应)

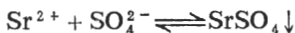


(Sr与无氧化性能的酸反应)

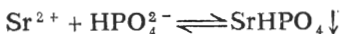




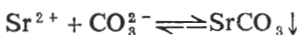
(白色)

(Sr(OH)₂溶于酸,难溶于水)

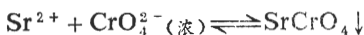
(白色)



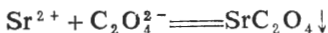
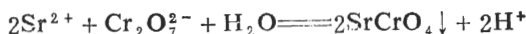
(白色)

(Sr₃(PO₄)₂溶于酸,不溶于水)

(白色)

(SrCO₃沉淀溶于酸,难溶于水)

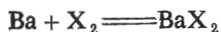
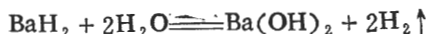
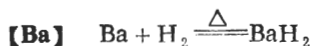
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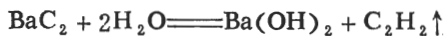
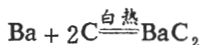
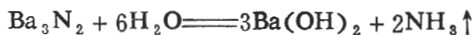
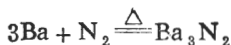
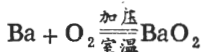
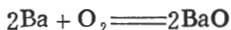
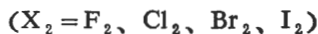


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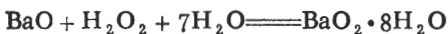
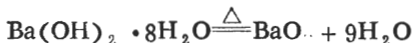
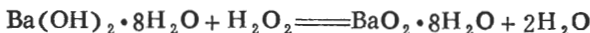
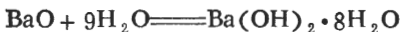
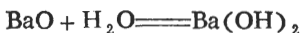
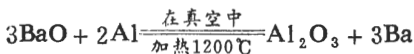
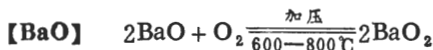
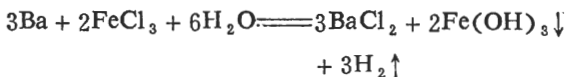
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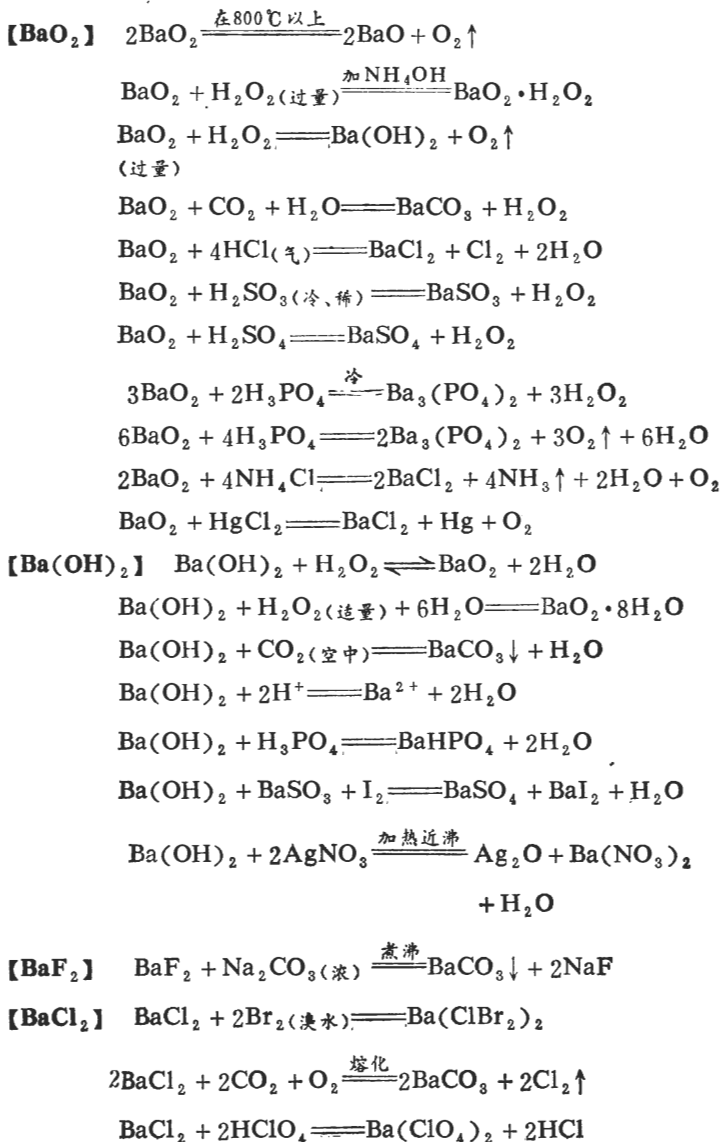
16.5 钡 6s² Ba = 137.34

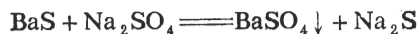
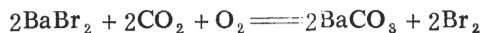
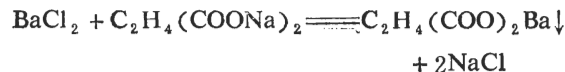
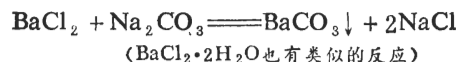
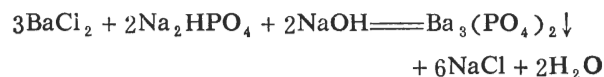
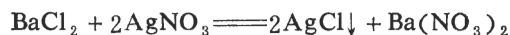
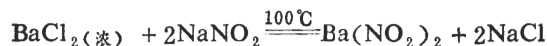
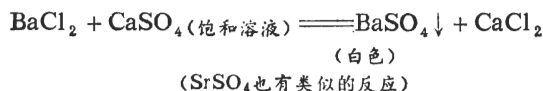
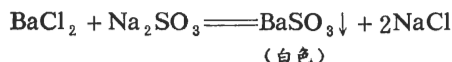
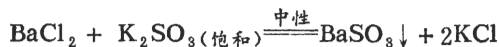
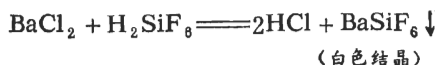
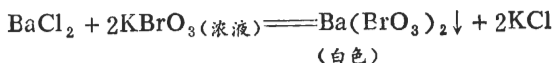


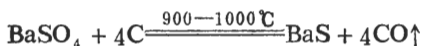
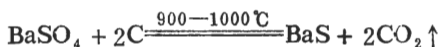
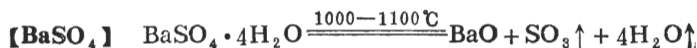
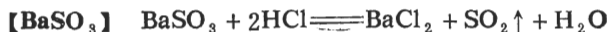
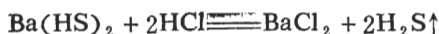
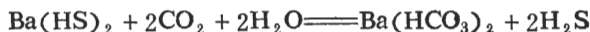
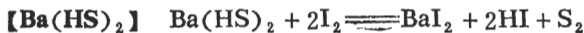
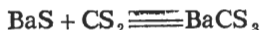


(Ba与非氧化性能的反应)

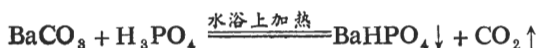
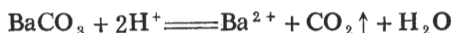
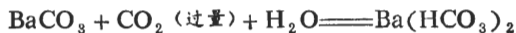
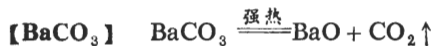
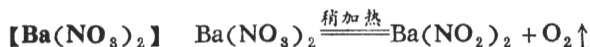


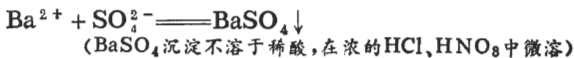
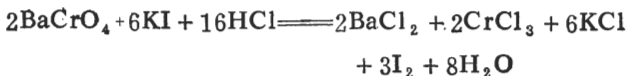
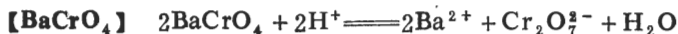
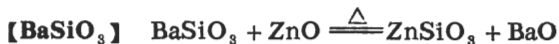
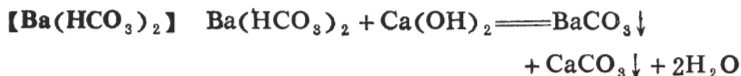
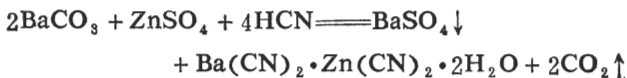
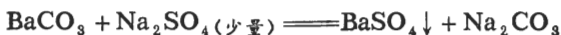
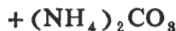
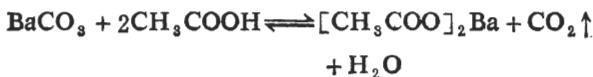
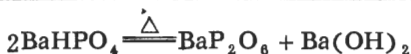


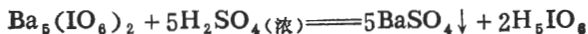
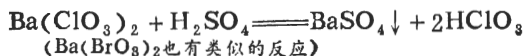
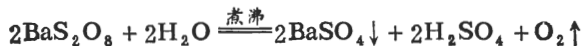
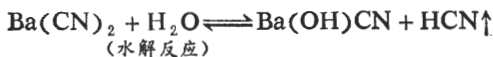
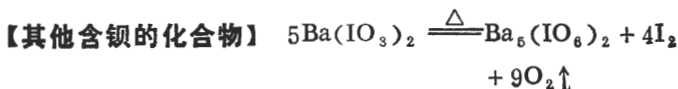
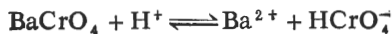
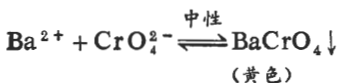
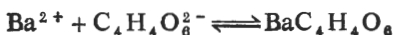
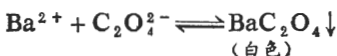
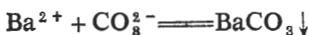
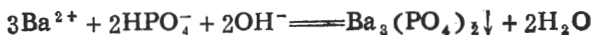
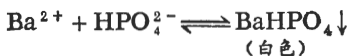


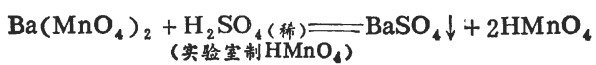
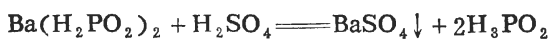


(此反应很不完全)









常见阴离子与常见试剂的反应

离子	试剂	BaCl ₂	钡盐沉淀 加	AgNO ₃	酸的作用	氧化剂	还原剂
SO ₄ ²⁻		BaSO ₄ ↓ (白)	不溶	Ag ₂ SO ₄ ↓(白), (浓溶液中)	—	—	—
SO ₃ ²⁻		BaSO ₃ ↓ (白)	溶解 SO ₂ ↑	Ag ₂ SO ₃ ↓(白) 溶于强酸及硝酸 NH ₃ ·H ₂ O	SO ₂ ↑	酸性KMnO ₄ 溶液褪色 I ₂ 淀粉液褪色	被Zn、Al、 Mg、还原成 H ₂ S↑
S ₂ O ₃ ²⁻		BaS ₂ O ₃ ↓ (白色) (浓溶液中)	溶解 SO ₂ ↑ + S↓	Ag ₂ S ₂ O ₃ ↓ → Ag ₂ S↓ (肉黄) (棕黑) Ag ₂ S ₂ O ₃ 溶于HNO ₃ NH ₃ ·H ₂ O	SO ₂ ↑ + S↓	同上	同上
CO ₃ ²⁻		BaCO ₃ ↓ (白色)	溶解 CO ₂ ↑	Ag ₂ CO ₃ ↓(白色) 溶于HNO ₃ 、CH ₃ COOH NH ₃ ·H ₂ O	CO ₂ ↑	—	—
BO ₂ ⁻		Ba(BO ₂) ₂ ↓ (白色) (浓溶液中)	溶解	AgBO ₂ ↓(白色), 溶于 HNO ₃ 、CH ₃ COOH及 NH ₃ ·H ₂ O	—	—	—

续表一

试剂 离子	BaCl ₂	钼盐沉淀 加酸	AgNO ₃	酸的作用	氧化剂	还原剂
PO ₄ ³⁻	Ba ₃ (PO ₄) ₂ ↓ (白色)	溶解	Ag ₃ PO ₄ ↓(黄色), 溶于强 酸及CH ₃ COOH, NH ₃ ·H ₂ O	—	—	—
AsO ₄ ³⁻	Ba ₃ (AsO ₄) ₂ ↓ (白色)	溶解	Ag ₃ AsO ₄ ↓(棕色), 溶于强 酸及CH ₃ COOH, NH ₃ ·H ₂ O	—	—	KI溶液中析 出I ₂ (酸性溶 液中)
AsO ₃ ³⁻	Ba ₃ (AsO ₃) ₂ ↓ (白色)	溶解	Ag ₃ AsO ₃ ↓(黄色), 溶于 HNO ₃ , CH ₃ COOH 及 NH ₃ , H ₂ O	—	酸性KMnO ₄ 溶液褪色, 在 NaHCO ₃ 存 在下, I ₂ 淀粉 溶液褪色。	—
C ₂ O ₄ ²⁻	BaC ₂ O ₄ ↓ (白色)	溶解	Ag ₂ C ₂ O ₄ 溶于HNO ₃ , NH ₃ ·H ₂ O	—	酸性KMnO ₄ 溶液褪色(加热)	—
SiO ₃ ²⁻	BaSiO ₃ ↓ (白色)	H ₂ SiO ₃ ↓	Ag ₂ SiO ₃ ↓(黄色), 溶于 酸析出H ₂ SiO ₃ ↓	H ₂ SiO ₃ ↓ (白色) 凝胶状	—	—

续表二

试剂 离子	BaCl ₂	钡盐沉淀 加酸	AgNO ₃	酸的作用	氧化剂	还原剂
F ⁻	BaF ₂ ↓ (白色)	溶解浓酸 中析出HF↑	—	HF↑ (浓H ₂ SO ₄)	—	—
CN ⁻	—	—	AgCN↓(白色)	HCN↑ (稀酸) NH ₄ ⁺ +CO (浓H ₂ SO ₄)	不与KMnO ₄ 作用, I ₂ 淀粉 液褪色。	—
SCN ⁻	—	—	AgSCN↓(白色), 溶于 NH ₃ ·H ₂ O	NH ₄ ⁺ +COS↑ (浓H ₂ SO ₄)	酸性KMnO ₄ 溶液褪色	—
Cl ⁻	—	—	AgCl↓(白色), 溶于 NH ₃ ·H ₂ O	HCl (浓H ₂ SO ₄) HCl (稀H ₂ SO ₄)	同上	—
Br ⁻	—	—	AgBr↓(淡黄)	HBr (稀H ₂ SO ₄) HBr+Br ₂ (浓H ₂ SO ₄) ₂	同上	—
I ⁻	—	—	AgI↓(黄色), 不溶于 NH ₃ ·H ₂ O	HI (稀H ₂ SO ₄) I ₂ (浓H ₂ SO ₄)	同上	—

续表三

试剂 离子	$D:Cl_2$	钡盐沉淀 加酸	$AgNO_3$	酸的作用	氧化剂	还原剂
S^{2-}	—	—	$Ag_2S \downarrow$ (黑色), 溶于热 HNO_3	$H_2S \uparrow$ (稀 H_2SO_4) H_2S, SO_2 (浓 H_2SO_4)	同上 I_2 淀粉液褪色	—
NO_3^-	—	—	—	$NO_2 \uparrow + O_2 \uparrow$ (浓 H_2SO_4)	—	$NO_2, NO,$ N_2, NH_3
NO_2^-	—	—	$AgNO_2 \downarrow$ (白色) (浓 NO_2^-)	$NO_2 \uparrow + NO \uparrow$ (浓 H_2SO_4)	酸性 $KMnO_4$ 溶液褪色	同上 KI 析出 I_2 (酸性溶液中)
ClO_3^-	—	—	—	ClO_2 (浓 H_2SO_4)	—	液时, 析出 I_2 (KI)
ClO^-	—	—	—	$HCl + O_2 \uparrow$ (浓 H_2SO_4) Cl_2 (HCl)	—	KI 酸性溶 液中 I_2 放出。
CH_3COO^-	—	—	$CH_3COOAg \downarrow$ (浓时)	CH_3COOH (浓 H_2SO_4)	—	—

常见阳离子与常

	HCl	H ₂ SO ₄	NH ₃ (适量)	NH ₃ (过量)
Ag ⁺	AgCl ↓ (白)	Ag ₂ SO ₄ ↓ (白)	Ag ₂ O ↓ (褐)	[Ag(NH ₃) ₂] ⁺
Hg ₂ ²⁺	Hg ₂ Cl ₂ ↓ (白)	Hg ₂ SO ₄ ↓ (白)	NH ₂ HgNO ₃ ↓ (白) + Hg ↓ (黑)	同左
Pb ²⁺	PbCl ₂ ↓ (白)	PbSO ₄ ↓ (白)	Pb(OH) ₂ ↓ (白)	同左
Cu ²⁺			Cu(OH)NO ₃ ↓ (蓝绿)	[Cu(NH ₃) ₄] ²⁺ (蓝)
Cd ²⁺			Cd(OH) ₂ ↓ (白色)	[Cd(NH ₃) ₄] ²⁺ (无色)
Bi ³⁺			Bi(OH) ₃ NO ₃ ↓ (白)	同左
Hg ²⁺			HgNH ₂ NO ₃ ↓ (白)	同左
Sn ²⁺			Sn(OH) ₂ ↓ (白)	同左
Sn ⁴⁺			Sn(OH) ₄ ↓ (白)	同左
Sb ³⁺			HSbO ₂ ↓ (白)	同左
Sb ⁵⁺			HSbO ₃ ↓ (白)	同左
As ³⁺				
As ⁵⁺				
Fe ²⁺			Fe(OH) ₂ ↓ (灰绿)	同左

用试剂的反应表

NaOH (适量)	NaOH (过量)	$(\text{NH}_4)_2\text{CO}_3$	H_2S (0.3M HCl)	$(\text{NH}_4)_2\text{S}$
$\text{Ag}_2\text{O} \downarrow$ (褐)	同左	$\text{Ag}_2\text{CO}_3 \downarrow$ (白)	$\text{Ag}_2\text{S} \downarrow$ (黑)	同左
$\text{Hg}_2\text{O} \downarrow$ (黑)	同左	$\text{HgO} \downarrow + \text{Hg} \downarrow$ (灰) (黑)	$\text{HgS} \downarrow + \text{Hg} \downarrow$ (黑)	同左
同左	PbO_2^-	$\text{Pb}_2(\text{OH})_2\text{CO}_3 \downarrow$ (白)	$\text{PbS} \downarrow$ (黑)	同左
$\text{Cu}(\text{OH})_2 \downarrow$ (淡蓝色)	同左 部分 CuO_2^-	$\text{Cu}_2(\text{OH})_2\text{CO}_3 \downarrow$ (蓝绿)	$\text{CuS} \downarrow$ (黑)	同左
$\text{Cd}(\text{OH})_2 \downarrow$ (白)	同左	$\text{Cd}_2(\text{OH})_2\text{CO}_3 \downarrow$ (白)	$\text{CdS} \downarrow$ (黄)	同左
$\text{Bi}(\text{OH})_3 \downarrow$ (白)	同左	$\text{Bi}(\text{OH})\text{CO}_3 \downarrow$ (白)	$\text{Bi}_2\text{S}_3 \downarrow$ (暗褐)	同左
$\text{HgO} \downarrow$ (黄)	同左	$\text{HgCO}_3 \cdot 3\text{HgO} \downarrow$ (红棕)	$\text{HgS} \downarrow$ (黑)	同左
同左	SnO_2^-	$\text{Sn}(\text{OH})_2 \downarrow$ (白色)	$\text{SnS} \downarrow$ (棕)	同左
同左	SnO_4^-	$\text{Sn}(\text{OH})_4 \downarrow$ (白)	$\text{SnS}_2 \downarrow$ (黄)	同左
同左	SbO_2^-	$\text{HSbO}_2 \downarrow$ (白)	$\text{Sb}_2\text{S}_3 \downarrow$ (橙红)	同左
同左	SbO_3^-	$\text{HSbO}_3 \downarrow$ (白)	$\text{Sb}_2\text{S}_5 \downarrow$ (橙红)	同左
			$\text{As}_2\text{S}_3 \downarrow$ 淡黄	同左
			$\text{As}_2\text{S}_5 \downarrow$ 淡黄	同左
同左	同左	$\text{Fe}_2(\text{OH})_2\text{CO}_3 \downarrow$ (棕绿)		$\text{FeS} \downarrow$ (黑)

续表

	HCl	H ₂ SO ₄	NH ₃ (适量)	NH ₃ (过量)
Fe ³⁺			Fe(OH) ₃ ↓ (红棕)	同左
Co ²⁺			Co(OH)NO ₃ ↓ (蓝)	[Co(NH ₃) ₆] ²⁺ (红)
Ni ²⁺			Ni(OH)NO ₃ ↓ (浅绿)	[Ni(NH ₃) ₆] ²⁺ (蓝)
Mn ²⁺			Mn(OH) ₂ ↓ (白)	同左
Al ³⁺			Al(OH) ₃ ↓ (白)	同左
Cr ³⁺			Cr(OH) ₃ ↓ (灰绿)	同左
Zn ²⁺			Zn(OH) ₂ ↓ (白)	[Zn(NH ₃) ₆] ²⁺ (无色)
Ca ²⁺		CaSO ₄ ↓ (白)		
Sr ²⁺		SrSO ₄ ↓ (白)		
Ba ²⁺		BaSO ₄ ↓ (白)		
Mg ²⁺			部分Mg(OH) ₂ ↓ (白)	同左
K ⁺				
Na ⁺				
NH ₄ ⁺				

NaOH (适 量)	NaOH (过 量)	$(\text{NH}_4)_2\text{CO}_3$	H_2S (0.3MHCl)	$(\text{NH}_4)_2\text{S}$
同左	同左	$\text{Fe}(\text{OH})\text{CO}_3 \downarrow$ (红棕)		$\text{Fe}_2\text{S}_3 \downarrow$ (黑)
$\text{Co}(\text{OH})\text{NO}_3 \downarrow$ (蓝)	同左	$\text{Co}_2(\text{OH})_2\text{CO}_3 \downarrow$ (红)		$\text{CoS} \downarrow$ (黑)
$\text{Ni}(\text{OH})_2 \downarrow$ (绿色)	同左	$\text{Ni}_2(\text{OH})_2\text{CO}_3 \downarrow$ (浅绿)		$\text{NiS} \downarrow$ (黑)
同左	同左	$\text{MnCO}_3 \downarrow$ (白)		$\text{MnS} \downarrow$ (肉色)
同左	AlO_2^-	$\text{Al}(\text{OH})_3 \downarrow$ (白)		$\text{Al}(\text{OH})_3 \downarrow$ (白)
同左	CrO_2^-	$\text{Cr}(\text{OH})_3 \downarrow$ (灰绿)		$\text{Cr}(\text{OH})_3 \downarrow$ (灰绿)
$\text{Zn}(\text{OH})_2 \downarrow$ (白)	ZnO_2^-	$\text{Zn}_2(\text{OH})_2\text{CO}_3 \downarrow$ (白)		$\text{ZnS} \downarrow$ (白)
		$\text{CaCO}_3 \downarrow$ (白)		
		$\text{SrCO}_3 \downarrow$ (白)		
		$\text{BaCO}_3 \downarrow$ (白)		
$\text{Mg}(\text{OH})_2 \downarrow$ (白)	同左			

各 种 盐 类 的 溶

	Ag ⁺ ①	Hg ₂ ²⁺ ①	Pb ²⁺ ①	Hg ²⁺	Bi ³⁺ ②	Cu ²⁺	Cd ²⁺	As ³⁺	Sb ³⁺ ②	Sn ²⁺	Sn ⁴⁺	Al ³⁺	Cr ³⁺
碳酸盐 CO ₃ ²⁻	HNO ₃	HNO ₃	HNO ₃	HCl	HCl	HCl	HCl	—	—	—	—	—	—
草酸盐 C ₂ O ₄ ²⁻ ③	HNO ₃	HNO ₃	HNO ₃	HCl	HCl	HCl	HCl	—	HCl	HCl	水	HCl	HCl
氟化物 F ⁻	水	水	水略溶 HNO ₃	水	HCl	水略溶 HCl	水略溶 HCl	—	水略溶 HCl	水	水	水	水
亚硫酸盐 SO ₃ ²⁻	HNO ₃	HNO ₃	HNO ₃	HCl	—	HCl	HCl	—	—	HCl	—	HCl	—
亚砷酸盐 AsO ₃ ³⁻	HNO ₃	HNO ₃	HNO ₃	HCl	HCl	HCl	HCl	—	—	HCl	—	—	—
砷酸盐 AsO ₄ ³⁻	HNO ₃	HNO ₃	HNO ₃	HCl	HCl	HCl	HCl	—	—	HCl	HCl	HCl	HCl
磷酸盐 PO ₄ ³⁻	HNO ₃	HNO ₃	HNO ₃	HCl	HCl	HCl	HCl	—	HCl	HCl	HCl	HCl	HCl
硼酸盐 BO ₂ ⁻	HNO ₃	—	HNO ₃	—	HCl	HCl	HCl	—	—	HCl	—	HCl	HCl
硅酸盐 SiO ₃ ²⁻ ④	HNO ₃	—	HNO ₃	—	HCl	HCl	HCl	—	—	—	—	HCl	HCl
酒石酸盐 C ₄ H ₄ O ₆ ²⁻ ③	HNO ₃	水略溶 HNO ₃	HNO ₃	HCl	HCl	水	HCl	—	HCl	HCl	水	水	水
硫酸盐 SO ₄ ²⁻	水略溶	水略溶	不溶	水略溶	水略溶	水	水	—	HCl	水	—	水	水
铬酸盐 CrO ₄ ²⁻	HNO ₃	HNO ₃	HNO ₃	HCl	HCl	水	HCl	—	—	HCl	—	—	HCl
硫化物 S ²⁻	HNO ₃	王水	HNO ₃	王水	HNO ₃	HNO ₃	HNO ₃	HNO ₃	浓HCl	浓HCl	浓HCl	水解 HCl	水解 HCl
氰化物 CN ⁻	不溶	—	HNO ₃	水	—	HCl	HCl	—	—	—	—	—	HCl
亚铁氰化物 [Fe(CN) ₆] ⁴⁻	不溶	—	不溶	—	—	不溶	不溶	—	—	—	不溶	—	—
铁氰化物 [Fe(CN) ₆] ³⁻	不溶	—	不溶	不溶	—	不溶	不溶	—	—	不溶	—	—	—
硫代硫酸盐 S ₂ O ₃ ²⁻	HNO ₃	—	HNO ₃	—	—	—	水	—	—	水	水	水	—
硫代氰酸盐 SCN ⁻	不溶	HNO ₃	HNO ₃	水	—	HNO ₃	HCl	—	—	—	水	水	水
碘化物 I ⁻	不溶	HNO ₃	水略溶 HNO ₃	HCl	HCl	水略溶	水	水	水解 HCl	水	水解 HCl	水	水
溴化物 Br ⁻	不溶	HNO ₃	不溶	水	水解 HCl	水	水	水	水解 HCl	水	水	水	水
氯化物 Cl ⁻	不溶	HNO ₃	沸水	水	水解 HCl	水	水	水	水解 HCl	水	水	水	水
醋酸盐 CH ₃ COO ⁻	水略溶	水	水	水	水	水	水	—	—	水	水	水	水
亚硝酸盐 NO ₂ ⁻	热水	水	水	水	—	水	水	—	—	—	—	—	—
硝酸盐 NO ₃ ⁻	水	水略溶 HNO ₃	水	水	水略溶 HNO ₃	水	水	—	—	—	—	水	水
氧化物 (O ²⁻)	HNO ₃	HNO ₃	HNO ₃	HCl	HNO ₃	HCl	HCl	HCl	HCl	HCl	HCl略溶	HCl	HCl
氢氧化物 OH ⁻	HNO ₃	—	HNO ₃	—	HCl	HCl	HCl	—	HCl	HCl	不溶	HCl	HCl

注：①加入盐酸时，能使银、亚汞及铅之多数盐变成不溶之氯化物；②多种铋和铋之盐类能水解而析出沉淀；③多种草酸盐及酒石酸盐能和过量之弱胶状硅酸。

解 情 况 表

Fe ³⁺	Fe ²⁺	Mn ²⁺	Ni ²⁺	Co ²⁺	Zn ²⁺	Ba ²⁺	Sr ²⁺	Ca ²⁺	Mg ²⁺	K ⁺	Na ⁺	NH ₄ ⁺
—	HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	水略溶 HCl	水	水	水
HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	水	水	水	水
水略溶 HCl	水略溶 HCl	HCl	HCl	HCl	HCl	水略溶 HCl	HCl	不溶	HCl	水	水	水
—	HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	水	水	水	水
HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	水	水	水
HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	水	水	水
HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	水	水	水
HCl	HCl	HCl	HCl	HCl	HCl	HCl	水略溶 HCl	水微溶 HCl	HCl	水	水	水
HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	水	水	水
水	HCl	水略溶 HCl	HCl	水	HCl	HCl	HCl	HCl	水	水	水	水
水	水	水	水	水	水	不溶	不溶	水微溶	水	水	水	水
水	—	水略溶 HCl	HCl	HCl	水	HCl	水略溶	水	水	水	水	水
HCl	HCl	HCl	HNO ₃	HNO ₃	HCl	水	水	水	水	水	水	水
—	不溶	HCl	HNO ₃	HNO ₃	HCl	水略溶 HCl	水	水	水	水	水	水
不溶	不溶	HCl	不溶	不溶	不溶	水	水	水	水	水	水	水
水	不溶	不溶	不溶	不溶	HCl	水	水	水	水	水	水	水
—	水	水	水	水	水	HCl	水	水	水	水	水	水
水	水	水	水	水	水	水	水	水	水	水	水	水
水	水	水	水	水	水	水	水	水	水	水	水	水
水	水	水	水	水	水	水	水	水	水	水	水	水
水	水	水	水	水	水	水	水	水	水	水	水	水
水	水	水	水	水	水	水	水	水	水	水	水	水
水	—	水	水	水	水	水	水	水	水	水	水	水
水	水	水	水	水	水	水	水	水	水	水	水	水
HCl	HCl	HCl	HCl	HCl	HCl	HCl	HCl	水略溶 HCl	HCl	水	水	—
HCl	HCl	HCl	HCl	HCl	HCl	水	水略溶 HCl	水略溶 HCl	HCl	水	水	水

①酸离子或酒石酸离子生成络离子而溶解；④此处之溶解度系指新沉淀之硅酸盐，并非矿产者而言，加酸使其分解后，即析出