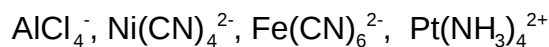
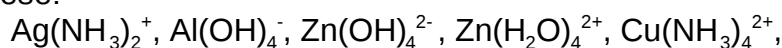


**Student Packet: 9.5: Various Reactions: Student Handout****Complex ions**

Complex ions are basically transition metals (Cu, Ag, Zn, Al, etc) attached to a lone pair of electrons made available by some friendly molecule or ion like  $\text{OH}^-$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$  or  $\text{CN}^-$ . The metal is called the central atom. The species which bond to it are called ligands. The type of bond is called a coordinate covalent bond. The best thing to do is memorize the popular complex ions and keep an eye out for metals which serve as control atoms and species which act as ligands.

Memorize these:

**Ammonia**

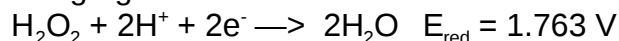
$\text{NH}_3$  acts as a Lewis base, forms complex ions and is a precipitating agent. In solution it produces  $\text{OH}^-$  ions and many hydroxides are insoluble.

**Hydrogen sulfide**

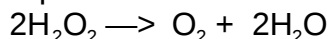
$\text{H}_2\text{S}$  acts as a Brönsted acid. It is also a precipitating agent as most sulfides are insoluble.

**Hydrogen peroxide**

$\text{H}_2\text{O}_2$  is a strong oxidizing agent.



It also spontaneously decomposes. This is called disproportionation.

**Carbonates**

If you add a carbonate (a molecule containing  $\text{CO}_3^{2-}$  or  $\text{HCO}_3^-$ ) to an acidic solution, you will get carbon dioxide gas and water — metal oxides will react with carbon dioxide gas to form the metal carbonate.

**Roasting**

The “roasting” of sulfide ores is part of the separation process of metals. When metal sulfides are roasted in oxygen, they produce the metal oxide and sulfur dioxide gas. The special case of this is copper. When copper (I) sulfide is roasted in oxygen, it produces copper metal and sulfur dioxide gas.

**Student Packet: 9.5: Various Reactions: AssessMe questions**

- 1) Mercury sulfide has a  $K_{sp}=1.6 \times 10^{-54}$ ; how many  $Hg^{2+}$  ions are present in one liter of a saturated  $HgS$  solution?
- A)  $7.6 \times 10^{-4}$  molecules/liter  
B)  $7.6 \times 10^4$  molecules/liter  
C)  $1.6 \times 10^{54}$  molecules/liter  
D)  $1.26 \times 10^{-27}$  molecules/liter  
E) I'm clueless
- 2) If lead phosphate has a  $K_{sp}=1 \times 10^{-54}$ , what is its solubility in water?
- A)  $1 \times 10^{-54}$  M  
B)  $6.2 \times 10^{-26}$  M  
C)  $7.74 \times 10^{-12}$  M  
D)  $1 \times 10^{-12}$  M  
E) I'm clueless
- 3) Given the following reaction:  $3NaBr + H_3PO_4 + O_2 \longrightarrow 3HBr + Na_3PO_4 + O_2$   
What is the limiting reagent if 200 gm of each reactant is used?
- A) NaBr  
B)  $H_3PO_4$   
C)  $O_2$   
D) both (A) and (B)  
E) I'm clueless
- 4) Given the following reaction:  $4Ag + 2H_2S + O_2 \longrightarrow 2Ag_2S + 2H_2O$   
How much  $Ag_2S$  can be made from 0.95 g Ag, 0.14 g  $H_2S$ , and 0.08 g  $O_2$ ?
- A) 9.92 g      B) 2.04 g      C) 0.51 g      D) 0.16 g      E) I'm clueless
- 5) What is the percent dissociation of a 1.0 M  $HClO$  solution if the  $pH = 3.7$ ?
- A) 20 %      B) 2.0 %      C) 0.2 %      D) 0.02 %      E) I'm clueless
6. What is the  $pH$  of a 0.05 M  $HCl$  solution?
- A) 5.0      B) 1.30      C) 7.34      D) 3.45      E) I'm clueless

**Student Packet: 9.5: Various Reactions: ShowMe questions**

Write the net ionic equation for each of the reactions.

- 1) Potassium hydroxide solution is added to a precipitate of aluminum hydroxide in water.

Excess concentrated sodium hydroxide is added to a precipitate of zinc hydroxide.

A concentrated solution of ammonia is added to a solution of copper (II) bromide.

- 2) Zinc sulfide is roasted in excess air.

Hydrogen sulfide gas is bubbled through a solution of iron (II) nitrate.

A solution of hydrogen peroxide is heated.

- 3) Gaseous boron trifluoride is mixed with gaseous ammonia.

Powdered magnesium oxide is added to a container of carbon dioxide gas.

A dilute solution of hydrobromic acid is added to a solution of hydrogen peroxide.

**Student Packet: 9.5: Various Reactions: TestMe questions**

- 1) Ammonia gas is bubbled through a saturated solution of silver chloride. Write the net ionic equation. (Don't balance the equation)
- A)  $\text{Ag}^+ + \text{NH}_3 + \text{H}_2\text{O} \longrightarrow \text{AgOH} + \text{N}_2 + \text{H}_2$   
 B)  $\text{Ag}^+ + \text{NH}_3 \longrightarrow \text{NH}_4^+ + \text{Ag}$   
 C)  $\text{Ag}^+ + \text{NH}_3 \longrightarrow \text{Ag}(\text{NH}_3)_2^+$   
 D)  $\text{Ag}^+ + \text{NH}_3 \longrightarrow \text{Ag}(\text{NH}_3)_4^+$   
 E) None of the above
- 2) A solution of ammonia is added to a solution of iron (II) chloride. Write the net ionic equation. (Don't balance the equation)
- A)  $\text{Fe}^{3+} + \text{NH}_3 \longrightarrow \text{Fe}(\text{NH}_3)_3^{3+}$   
 B)  $\text{Fe}^{3+} + \text{NH}_3 + \text{H}_2\text{O} \longrightarrow \text{Fe}(\text{OH})_3 + \text{NH}_4^+$   
 C)  $\text{Fe}^{3+} + \text{NH}_3 \longrightarrow \text{Fe}^{2+} + \text{NH}_4^+$   
 D)  $\text{Fe}^{3+} + \text{NH}_3 \longrightarrow \text{Fe}(\text{NH}_3)_2^{3+}$   
 E) None of the above
- 3) Hydrogen peroxide is added to a solution of iron (II) chloride. Write the net ionic equation. (Don't balance the reaction)
- A)  $\text{Fe}^{2+} + \text{H}_2\text{O}_2 \longrightarrow \text{Fe}^{3+} + \text{H}_2\text{O}$   
 B)  $\text{Cl}^- + \text{H}_2\text{O}_2 \longrightarrow \text{Cl}_2 + \text{H}_2\text{O}$   
 C)  $\text{Fe}^{2+} + \text{H}_2\text{O}_2 \longrightarrow \text{Fe} + \text{H}_2\text{O}$   
 D)  $\text{Fe}^{2+} + \text{H}_2\text{O}_2 \longrightarrow \text{Fe}^{3+} + \text{OH}^-$   
 E) None of the above
- 4) Hydrogen sulfide gas is bubbled through a solution of sodium hydroxide. Write the net ionic equation. (Don't balance the reaction)
- A)  $\text{H}_2\text{S} + \text{OH}^- \longrightarrow \text{S}^{2-} + \text{H}_2\text{O}$   
 B)  $\text{H}_2\text{S} + \text{Na}^+ \longrightarrow \text{NaS} + \text{H}_2$   
 C)  $\text{H}_2\text{S} + \text{OH}^- \longrightarrow \text{SO}_2 + \text{H}_2$   
 D)  $\text{H}_2\text{S} + \text{OH}^- \longrightarrow \text{HSO}_3^-$   
 E) None of the above
- 5) Copper (I) sulfide is roasted in excess air. Write the net ionic equation. (Don't balance)
- A)  $\text{Cu}_2\text{S} + \text{O}_2 \longrightarrow \text{Cu} + \text{SO}_2$   
 B)  $\text{Cu}_2\text{S} + \text{O}_2 \longrightarrow \text{CuO} + \text{SO}_2$   
 C)  $\text{Cu}_2\text{S} + \text{O}_2 \longrightarrow \text{CuO} + \text{SO}_3$   
 D)  $\text{Cu}_2\text{S} + \text{O}_2 \longrightarrow \text{Cu} + \text{S} + \text{O}_2$   
 E) None of the above