Chemistry 30 – Solubility Equilibrium – Unit Homework

Topic	Textbook Reading	Textbook Questions
Solutions and Solubility of Ionic Compounds	Section 15.1 (452-459) Section 10.3 (292-294)	#33-37
Solubility Equilibrium	Section 18.3 (577-581)	#17, 18
Ion Product Constant	Section 18.3 (581-583)	#19

Solutions and Solubility of Ionic Compounds

1. Indicate if each substance is soluble or has low solubility. Write the dissociation equation for each, using the proper arrow (→ or ⇌)
   a. aluminum hydroxide
   b. potassium hydroxide
   c. sodium sulfate
   d. lead(II) chloride
   e. iron(III) phosphate
   f. barium nitrate
   g. ammonium phosphate
   h. magnesium bromide
   i. tin(IV) nitrate
   j. copper(II) carbonate

2. For each, write the molecular, total ionic and net ionic equations for the reaction. Remember that a complete equation includes coefficients, ion charges and states. Be sure to balance each reaction.
   a. Strontium bromide and potassium sulfate solutions combine to produce a strontium sulfate precipitate.
   b. Silver nitrate and potassium chloride solutions combine to produce a silver chloride precipitate.
   a. Magnesium nitrate and sodium carbonate solutions combine to make a magnesium carbonate precipitate.
   b. Manganese(II) chloride and ammonium carbonate solutions combine to produce a manganese(II) carbonate precipitate.

3. For each pair of reactants, write the two possible products, then use the solubility rules to determine if a precipitate will form. If a reaction will occur, write the balanced molecular equation, including states, and the net ionic equation.
   a. aluminum iodide + mercury(II) chloride →
   b. silver nitrate + potassium phosphate →
   c. copper(II) bromide + aluminum chloride →
   d. calcium acetate + sodium carbonate →
   e. ammonium chloride + mercury(I) acetate →
   f. calcium nitrate + hydrochloric acid (HCl) →
   g. iron(II) sulfide + hydrochloric acid →
   h. copper(II) hydroxide + acetic acid ($HC_2H_3O_2$) →

Solubility Equilibrium

4. How does the solubility of a compound relate to its K_{sp}?
5. For each compound, write a dissociation equation and a K_{sp} expression.
   a. copper(I) chloride
   b. lead(II) sulfate
   c. zinc hydroxide
   d. calcium phosphate

6. Calculate the K_{sp} for each of the salts whose solubility is listed below.
   a. $[CaSO_4] = 5.0 \times 10^{-3}$ mol/L
   b. $[MgF_2] = 2.7 \times 10^{-3}$ mol/L
   c. $[SrF_2] = 12.2$ mg/100 mL (hint: convert these units!)

7. For silver carbonate, iron(II) sulfide and calcium carbonate, calculate the solubility in mol/L for each of three salts. Use the Solubility Product Constants table to find K_{sp}.

8. Consider these slightly soluble salts:

PbS	$K_{sp} = 8.4 \times 10^{-28}$
$PbSO_4$	$K_{sp} = 1.8 \times 10^{-8}$
$Pb(IO_3)_2$	$K_{sp} = 2.6 \times 10^{-13}$

   a. Which is the least soluble?
   b. Calculate the solubility in mol/L for $PbSO_4$.
   c. How many grams of $PbSO_4$ can dissolve in 1 L of solution?
   d. Use what you know about Le Chatelier's Principle to determine how can you decrease the concentration of $Pb^{2+}(aq)$ in a saturated solution of $PbSO_4$ solution.

9. Given these slightly soluble salts:

$AgBr$	$K_{sp} = 5.35 \times 10^{-13}$
$AgCl$	$K_{sp} = 1.77 \times 10^{-10}$
AgI	$K_{sp} = 8.52 \times 10^{-17}$

   a. Put them in order from most to least soluble.
   b. For each, calculate the mass of solid needed to make 1.0 L of a saturated solution.

10. For a saturated solution of silver carbonate:
    a. Determine the concentration of silver ions.
    b. Determine the mass of silver carbonate solid needed to make 500.0 mL of a saturated solution.

Ion Product Constant

11. Determine if a precipitate will form given the ion concentrations in the mixed solution.
    a. $[Ca^{2+}] = 3.5 \times 10^{-7}$ M, $[SO_4^{2-}] = 1.2 \times 10^{-4}$ M
    b. $[Ag^{+}] = 1.2 \times 10^{5}$ M, $[Cl^{-}] = 5.1 \times 10^{-3}$ M

12. Determine if a precipitate will form if <u>500.0 mL of each solution</u> are mixed together.
    a. $[FeCl_2] = 4.3\times10^{-7}$ M, $[NaOH] = 8.1\times10^{-10}$ M
    b. $[AgNO_3] = 4.2\times10^{-4}$ M, $[KBr] = 6.1\times10^{-4}$ M

13. Will a precipitate form if 200.0 mL 0.00020M $Ca(NO_3)_2$ is mixed 300.0 mL of 0.00030M Na_2CO_3?

14. Will a precipitate form if 25.0 mL of 0.0020M $Pb(NO_3)_2$ is mixed with 25.0 mL of 0.040M NaBr?

15. Will a precipitate form if equal volumes of 0.00020M $Ca(NO_3)_2$ is mixed with 0.00030M Na_2CO_3?