Equilibrium: Solubility Product
Review Worksheet II

1. Write the equilibrium dissociation of the following ionic compounds.

   (a) calcium sulfide
   (b) lead(II) sulfate
   (c) silver phosphate
   (d) mercury(I) iodide
   (e) iron(III) hydroxide

2. Write the solubility product expressions for each equilibria in question 1.

3. The molar solubility of cobalt(II) iodate, $Co(IO_3)_2$, is 0.011 mol/L.

   (a) Write the equilibrium dissociation of $Co(IO_3)_2$.
   (b) Given the molar solubility of $Co(IO_3)_2$, what is the concentration of each ion in a saturated solution?
   (c) Calculate the solubility product constant, K_{sp}, for $Co(IO_3)_2$.

4. The molar solubility of barium thiosulfate, BaS_2O_3, is 0.0080 mol/L.

   (a) Write the equilibrium dissociation of BaS_2O_3.
   (b) Given the molar solubility of BaS_2O_3, what is the concentration of each ion in a saturated solution?
   (c) Calculate the solubility product constant, K_{sp}, for BaS_2O_3.

5. At $10°C$, the molar solubility of silver chloride is 6.2×10^{-6} mol/L. Find the solubility product constant of AgCl at this temperature. (Compare this value with the room temperature K_{sp}.)

6. Consider a saturated solution of silver sulfate, Ag_2SO_4, at room temperature.

$$Ag_2SO_{4(s)} \leftrightharpoons 2Ag^+_{(aq)} + SO_4^{2-}_{(aq)} \qquad K_{sp} = 1.4 \times 10^{-4}$$

   (a) Write the solubility product expression for this saturated solution.
   (b) What is the molar solubility of silver sulfate?
   (c) What is the concentration of each ion in the saturated solution?

7. A 500.0 mL saturated solution of calcium carbonate needs to be prepared.

   (a) Write the equilibrium dissociation of $CaCO_3$.
   (b) What is the molar solubility of $CaCO_3$ at room temperature?
   (c) Since 500.0 mL of the solution will be prepared, how many moles of calcium carbonate will be added to just saturate the solution?
   (d) What mass of calcium carbonate should be added to just saturate the solution at room temperature?

8. An aqueous potassium iodide solution is mixed with a solution containing lead(II) nitrate. The new concentrations after mixing will be $KI_{(aq)} = 0.035$ mol/L and $Pb(NO_3)_{2(aq)} = 0.0040$ mol/L.

(a) Write the double displacement reaction that will occur between these ionic compounds and indicate the likely precipitate.
(b) What is the trial ion product for the possible precipitate?
(c) Compare this value with the solubility product constant and predict whether the precipitate will form at room temperature.

9. Will a precipitate form at room temperature when 250 mL of 0.0011 mol/L $Al_2(SO_4)_{3(aq)}$ is added to 250 mL of 0.015 mol/L $BaCl_{2(aq)}$? Include a balanced chemical equation for the formation of the possible precipitate. Prove your answer.

10. A chemist adds 0.10 mg of magnesium chloride, $MgCl_2$, to 250 mL of 0.0010 mol/L $NaOH_{(aq)}$. Does a precipitate of magnesium hydroxide form at room temperature? Prove your answer.

11. The solubility of lead(II) chromate, $PbCrO_4$, in water is 4.8×10^{-7} mol/L.

(a) Qualitatively predict how the solubility will change if $PbCrO_4$ is added to a 0.10 mol/L solution of sodium chromate, Na_2CrO_4. Explain.
(b) Based on its solubility in water, calculate the K_{sp} of $PbCrO_4$.
(c) Determine the solubility of $PbCrO_4$ in a 0.10 mol/L solution of $Na_2CrO_{4(aq)}$.

12. Calculate the molar solubility of calcium sulfate, $CaSO_4$, in each of the following solutions at room temperature:

(a) pure water
(b) 0.10 mol/L $CaCl_{2(aq)}$
(c) 0.025 mol/L $Na_2SO_{4(aq)}$

13. Instead of using distilled water, a chemist prepares an aqueous solution of thallium(I) chloride, $TlCl_{(aq)}$, in tap water that contains 0.015 mol/L of $Cl^-_{(aq)}$.

(a) Given the K_{sp} of $TlCl$ is 1.0×10^{-6}, what is the greatest mass of thallium(I) chloride that could be dissolved in 500.0 mL of tap water?
(b) How much more could be dissolved in distilled water?