1.) The molar solubility of PbI₂ is $1.51 \times 10^{-3} \text{ M}$. Calculate the value of $K_{sp}$ for PbI₂. (1.38$\times 10^{-8}$)

2.) It is observed that 7.53 mmol of BaF₂ will dissolve in 1.0 L of water. Use these data to calculate the value of $K_{sp}$ for barium fluoride. (1.7 $\times 10^{-6}$)

3.) The solubility of silver phosphate, Ag₃PO₄, at 25°C is $1.59 \times 10^{-5} \text{ mol/L}$. What is the $K_{sp}$ for the silver phosphate at 25°C? (1.73 $\times 10^{-18}$)

4.) Silver chromate, Ag₂CrO₄, has a $K_{sp}$ of 9.03 $\times 10^{-12}$. Calculate the solubility in mol/L of silver chromate. (1.31 $\times 10^{-4} \text{ M}$)

5.) Calculate the molar solubility of AgCl ($K_{sp} = 1.6 \times 10^{-10}$) in a 0.0049 M sodium chloride solution at 25°C. (3.3 $\times 10^{-8}$)

6.) You have two salts, AgX and AgY, with very similar $K_{sp}$ values. You know that $K_a$ for HX is much greater than $K_a$ for HY. Which salt is more soluble in acidic solution? (AgY)

7.) A 300.0-mL saturated solution of copper(II) periodate, Cu(IO₄)₂, contains 0.31 grams of dissolved salt. Determine the $K_{sp}$. (5.0 $\times 10^{-8}$)

8.) How many moles of Fe(OH)₂ ($K_{sp} = 1.8 \times 10^{-15}$) will dissolve in 1.0 liter of water buffered at pH = 9.73? (6.2 $\times 10^{-7}$)

9.) The $K_{sp}$ for PbF₂ is $4.0 \times 10^{-8}$. If a 0.036 M NaF solution is saturated with PbF₂, what is the [Pb²⁺] in solution? (3.1 $\times 10^{-5} \text{ M}$)

10.) Chromate ion is added to a saturated solution of Ag₂CrO₄ to reach 0.80 M CrO₄²⁻. Calculate the final concentration of silver ion at equilibrium ($K_{sp}$ for Ag₂CrO₄ is 9.0$\times 10^{-12}$). (3.4 $\times 10^{-6} \text{ M}$)

11.) Calculate the solubility of Ca₃(PO₄)₂ ($K_{sp} = 1.3 \times 10^{-32}$) in a 0.036 M Ca(NO₃)₂ solution. (8.3 $\times 10^{-15} \text{ M}$)

12.) How many moles of CaF₂ will dissolve in 3.0 liters of 0.041 M NaF solution? ($K_{sp}$ for CaF₂ = 4.0 $\times 10^{-11}$) (7.1 $\times 10^{-8}$)

13.) The $K_{sp}$ for BaF₂ is $2.4 \times 10^{-5}$. When 10 mL of 0.0100 M NaF is mixed with 10 mL of 0.0100 M Ba(NO₃)₂, will a precipitate form? (No, because $Q$ is $1.25 \times 10^{-7}$ and since it is less than $K_{sp}$ no precipitate will form.)
14.) Sodium chloride is added slowly to a solution that is 0.010 M in Cu\(^{+}\), Ag\(^{+}\), and Au\(^{+}\). The \(K_{sp}\) values for the chloride salts are \(1.9 \times 10^{-7}\), \(1.6 \times 10^{-10}\), and \(2.0 \times 10^{-13}\), respectively. Which compound will precipitate first? (AuCl)

15.) The \(K_{sp}\) of Al(OH)\(_3\) is \(2 \times 10^{-32}\). At what pH will a 0.6 M Al\(^{3+}\) solution begin to show precipitation of Al(OH)\(_3\)? (3.5)

16.) A solution contains 0.018 moles each of I\(^{-}\), Br\(^{-}\), and Cl\(^{-}\). When the solution is mixed with 200 mL of 0.24 M AgNO\(_3\), how much AgCl(s) precipitates out? (1.7 g)

\[
\begin{align*}
K_{sp} & \quad AgI = 1.5 \times 10^{-16} \\
K_{sp} & \quad AgBr = 5.0 \times 10^{-13} \\
K_{sp} & \quad AgCl = 1.6 \times 10^{-10}
\end{align*}
\]

17.) A 100.-mL sample of solution contains 10.0 mmol of Ca\(^{2+}\) ion. Enough Na\(_2\)SO\(_4\) is added to cause precipitation of 99.9% of the calcium as CaSO\(_4\). How many mmol of SO\(_4^{2-}\) will be in solution? The \(K_{sp}\) of CaSO\(_4\) is \(6.1 \times 10^{-5}\). Assume the volume remains constant. (60)

18.) What is the maximum concentration of iodide ions that will precipitate AgI but not PbI\(_2\) from a solution that is \(1.0 \times 10^{-3}\) M each in Ag\(^{+}\) and Pb\(^{2+}\)? For AgI, \(K_{sp} = 1.5 \times 10^{-16}\) and for PbI\(_2\), \(K_{sp} = 1.4 \times 10^{-8}\). (3.7 \times 10^{-3}\) M

19.) Given the following values of equilibrium constants:

\[
\begin{align*}
Cu(OH)_2(s) & \rightleftharpoons Cu^{2+}(aq) + 2OH^-(aq) & K_{sp} = 1.59 \times 10^{-19} \\
Cu(NH_3)_4^{2+}(aq) & \rightleftharpoons Cu^{2+}(aq) + 4NH_3(aq) & K = 1.0 \times 10^{-13}
\end{align*}
\]

What is the value of the equilibrium constant for the following reaction? (1.6 \times 10^{-6})

\[
Cu(OH)_2(s) + 4NH_3(aq) \rightleftharpoons Cu(NH_3)_4^{2+}(aq) + 2OH^-(aq)
\]

20.) Calculate the molar concentration of uncomplexed Zn\(^{2+}\) in a solution that contains 0.20 mole of Zn(NH\(_3\))\(_4^{2+}\) per liter and 0.0116 M NH\(_3\) at equilibrium. The overall \(K_f\) for Zn(NH\(_3\))\(_4^{2+}\) is \(3.8 \times 10^9\). (2.9 \times 10^{-3}\) M

21.) What is the molar solubility of lead(II) chromate in 0.070 M Na\(_2\)S\(_2\)O\(_3\)? For PbCrO\(_4\), \(K_{sp} = 2.0 \times 10^{-16}\); for Pb(S\(_2\)O\(_3\))\(_4^{4-}\), \(K_f = 2.2 \times 10^6\). (3.9 \times 10^{-7}\) M