Chapter 15 Part 2

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Q_{sp}

$$AgCl(s) \leftrightharpoons Ag^+(aq) + Cl^-(aq)$$

If for the equilibrium concentrations,

$$K_{sp} = [Ag^+][Cl^-]$$

Then for any concentrations,

$$Q_{sp} = [Ag^+][Cl^-]$$

Precipitation

$$AgCl(s) \leftrightharpoons Ag^{+}(aq) + Cl^{-}(aq)$$

If

$$K_{sp} = [Ag^{+}][Cl^{-}] = 1.77 \times 10^{-10}$$

and for a particular set of conditions,

$$Q_{sp} = [Ag^{+}][Cl^{-}] = 5.3 \times 10^{-8}$$

Will a precipitant form?

Precipitation

- If Q_{sp} is smaller than K_{sp}, a precipitant will not form.
- If Q_{sp} is larger than K_{sp}, a precipitant will form.

Precipitation

A solution containing $Pb(NO_3)_2$ is mixed with one containing NaBr to form a solution that is 0.0150 M in $Pb(NO_3)_2$ and 0.00350 M in NaBr. Will a precipitant form in the newly mixed solution? The K_{sp} of $PbBr_2 = 4.67 \times 10^{-6}$.

Precipitation

The first step in a commercial process in which magnesium is obtained from seawater involves precipitating Mg^{2+} as $Mg(OH)_2(s)$. The magnesium ion concentration in seawater is about 0.059 M. If a seawater sample is treated so that its $[OH^-]$ is maintained at 2.0×10^{-3} what will be $[Mg^{2+}]$ remaining in solution when precipitation stops ($K_{sp} = 1.8 \times 10^{-11}$)?

Precipitation, Q_{sp}, and K_{sp}

Consider the generic reaction:

$$AB(s) \rightleftharpoons A^{2+}(aq) + B^{2-}(aq)$$

Under which condition will a precipitate form?

A. $Q_{sp} < K_{sp}$

B. $Q_{sp} = K_{sp}$

C. $Q_{sp} > K_{sp}$

D. a precipitate forms under all conditions

Fractional Precipitation

- When two anions form slightly soluble compounds with the same cation, the less soluble compound (usually, the compound with the lower K_{sp}) precipitates first when adding the cation to a solution of both anions

Fractional Precipitation

$AgNO_3(aq)$ is slowly added to a solution that has $[CrO_4{}^{2-}] = 0.010$ M and $[Br^-] = 0.010$ M. K_{sp} of $Ag_2CrO_4 = 1.1 \times 10^{-12}$, and K_{sp} of $AgBr = 5.0 \times 10^{-13}$.

A. Show that $AgBr(s)$ should precipitate before $Ag_2CrO_4(s)$ does by finding $[Ag^+]$ at both equilbriums.
B. When $Ag_2CrO_4(s)$ begins to precipitate, what is $[Br^-]$ remaining in solution?

Fractional Precipitation

A solution contains 1.0×10^{-2} M Ag^{+} and 2.0×10^{-2} M Pb^{2+}. When Cl^{-} is added, both AgCl $\left(K_{sp} = 1.8 \times 10^{-10}\right)$ and $PbCl_2$ $\left(K_{sp} = 1.7 \times 10^{-5}\right)$ can precipitate. (A) What concentration of Cl^{-} is necessary to begin the precipitation of each salt? (B) Which salt precipitates first? (C) When the second salt begins to precipitate, what is will be the concentration of the cation of the first salt remaining in solution?

Fractional Precipitation

Addition of which salt will selectively precipitate lead from a mixture of Pb^{2+} and Mg^{2+}?

A. Na_2CO_3
B. NaF
C. both Na_2CO_3 and NaF
D. neither Na_2CO_3 nor NaF

Formula	K_{sp}
$PbCO_3$	7.4×10^{-14}
$MgCO_3$	6.82×10^{-6}
PbF_2	3.3×10^{-8}
MgF_2	5.16×10^{-11}

Solubility and pH

Should $Mg(OH)_2(s)$ precipitate from a solution that is 0.010 M $MgCl_2$ and also 0.10 M NH_3? The K_{sp} of $Mg(OH)_2$ is $K_{sp} = 1.8 \times 10^{-11}$. The K_b of NH_3 is 1.8×10^{-5}.