Key

Problem Set # 4 **From Solubility to K_{sp}**

The K_{sp} is a measure of the *solubility* of an ionic salt. The larger the value of the K_{sp}, the greater the solubility of the salt (***if you are comparing ionic salts with the same number of aqueous ions!***)

You can only calculate a K_{sp} if the solution is saturated. Only saturated salt solutions are in equilibrium. You can calculate the K_{sp} from the solubility of a salt, since the solubility represents the concentration required to saturate a solution.

1. Calculate the K_{sp} for $CaCl_2$ if 2.00×10^2 g of $CaCl_2$ is required to saturate 100.0mL of solution.

$CaCl_{2(s)} \rightleftharpoons \underset{x}{Ca^{2+}} + \underset{2x}{2Cl^-}$

$[CaCl_2] = \frac{2.00\times10^2 g}{0.1000 L} \times \frac{1 mol}{111.1 g} = 18.0 M = x$

$K_{sp} = [Ca^{2+}][Cl^-]^2 = (x)(2x)^2 = 4x^3 = 4(18.0)^3$

$K_{sp} = 23328 = \boxed{2.33\times10^4}$

2. Calculate the K_{sp} for $AlCl_3$ if 100.0g is required to saturate 150.0 mL of a solution.

$AlCl_{3(s)} \rightleftharpoons \underset{x}{Al^{3+}} + \underset{3x}{3Cl^-}$

$[AlCl_3] = \frac{100.0 g}{0.1500 L} \times \frac{1 mol}{133.5 g} = 4.994 M = x$

$K_{sp} = [Al^{3+}][Cl^-]^3 = (x)(3x)^3 = 27x^4$

$K_{sp} = 27(4.99)^4 = \boxed{16790}$

3. The solubility of SrF_2 is 2.83×10^{-5} M. Calculate the K_{sp}.

$SrF_{2(s)} \rightleftharpoons \underset{x}{Sr^{2+}} + \underset{2x}{2F^-}$

$x = $ molar solubility $= 2.83\times10^{-5}$ M

$K_{sp} = [Sr^{2+}][F^-]^2 = (x)(2x)^2 = 4x^3$

$K_{sp} = 4(2.83\times10^{-5})^3 = \boxed{9.07\times10^{-14}}$

4. The solubility of $GaBr_3$ is 15.8 g per 100.0 mL. Calculate the K_{sp}.

$GaBr_{3(s)} \rightleftharpoons \underset{x}{Ga^{3+}} + \underset{3x}{3Br^-}$

$[GaBr_3] = \frac{15.8 g}{0.1000 L} \times \frac{1 mol}{309.4 g} = 0.5107 M = x$

$K_{sp} = [Ga^{3+}][Br^-]^3 = (x)(3x)^3 = 27x^4$

$K_{sp} = 27(0.5107)^4 = \boxed{1.84}$

5. The solubility of Ag_2SO_4 is 1.33×10^{-7}g per 100.0 mL. Calculate the K_{sp}.

$Ag_2SO_{4(s)} \rightleftharpoons \underset{2x}{2Ag^+} + \underset{x}{SO_4^{2-}}$

$[Ag_2SO_4] = \frac{1.33\times10^{-7} g}{0.1000 L} \times \frac{1 mol}{311.9 g} = 4.264\times10^{-9} M = x$

$K_{sp} = [Ag^+]^2[SO_4^{2-}] = (2x)^2(x) = 4x^3 = 4(4.264\times10^{-9})^3 = \boxed{3.10\times10^{-25}}$

6. If 2.9×10^{-3} g of $Ca(OH)_2$ is needed to saturate 250.0 mL of solution, what is the K_{sp}?

$Ca(OH)_{2(s)} \rightleftharpoons \underset{x}{Ca^{2+}} + \underset{2x}{2OH^-}$

$[Ca(OH)_2] = \frac{2.9\times10^{-3} g}{0.2500 L} \times \frac{1 mol}{74.1 g} = 1.565\times10^{-4} M = x$

$K_{sp} = [Ca^{2+}][OH^-]^2 = (x)(2x)^2 = 4x^3 = 4(1.565)^3 = \boxed{1.5\times10^{-11}}$