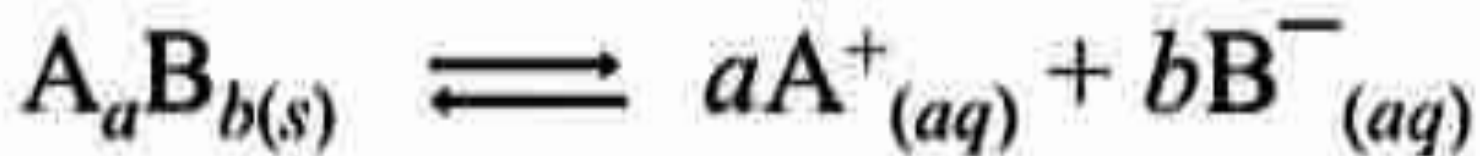


Solubility product constant

KSP

The solubility product constant, K_{sp} , is the equilibrium constant for a solid substance dissolving in an aqueous solution. It represents the level at which a solute dissolves in solution. The more soluble a substance is, the higher the K_{sp} value it has.



$$K_c = \frac{[A^+]^a [B^-]^b}{[A_a B_b]}$$

$$K_{sp} = [A^+]^a [B^-]^b$$

K_{sp} , called the solubility product constant.

Product of *ion concentrations* in a saturated solution.

- ⌘ The equilibrium constant expression for this dissolution is called a solubility product constant.
- ⌘ K_{sp} = solubility product constant

$$K_{sp} = [Ag^+][Cl^-] = 1.8 \times 10^{-10}$$

- ⌘ Molar concentration of ions raised to their stoichiometric powers at equilibrium

Solubility and Solubility Products

(1) What is the solubility of AgCl if the K_{sp} is 1.6×10^{-10}



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

If s is the solubility of AgCl, then:

$$[\text{Ag}^+] = s \text{ and } [\text{Cl}^-] = s$$

$$K_{sp} = (s)(s) = s^2 = 1.6 \times 10^{-10}$$

$$s = \sqrt{1.6 \times 10^{-10}}$$

$$s = 1.3 \times 10^{-5} \text{ mol/L}$$

Using K_{sp} to Calculate Molar Solubility

- Define the molar solubility (S) as $Ba^{2+}(aq)$ and $SO_4^{2-}(aq)$ molar concentrations at equilibrium.

$$\begin{aligned}K_{sp} &= [Ba^{2+}][SO_4^{2-}] \\ &= S \times S \\ &= S^2\end{aligned}$$

Therefore

$$S = \sqrt{K_{sp}}$$

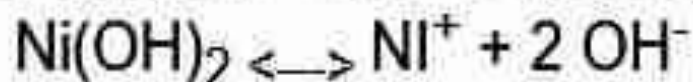
- $(S) = [Ba^{2+}] = [SO_4^{2-}]$

$$\begin{aligned}S &= \sqrt{K_{sp}} \\ &= \sqrt{1.07 \times 10^{-10}} \\ &= 1.03 \times 10^{-5} \text{ M}\end{aligned}$$

Calculate K_{sp} of $Ni(OH)_2$ in water, Molar solubility is 5.2×10^{-6} M

To find K_{sp} from MOLAR SOLUBILITY

1) Find the conc of the ions



1:2 ratio in the Ni so,

$$[Ni^{2+}] = \text{molar solubility} (5.2 \times 10^{-6} \text{ M})$$

$$[OH^{-}] = (2 \times \text{Molar solubility}) = (5.2 \times 10^{-6} \text{ M} \times 2)$$

$$[OH^{-}] = (10.4 \times 10^{-6}) \rightarrow (1.04 \times 10^{-5})$$

2) Find the K_{sp} by setting up expression

$$K_{sp} = [Ni^{2+}][OH^{-}]^2$$

$$K_{sp} = (5.2 \times 10^{-6} \text{ M})(1.04 \times 10^{-5})^2$$

$$K_{sp} = 5.6 \times 10^{-16}$$

Procedure:-

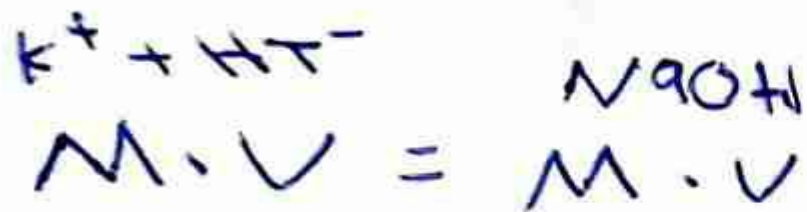
- 1-Into five clean dry conical flasks, add 1 gm of KHT (potassium acid tartarate) + 40 ml of different molarities of KCl .
 - a-In the first flask add 40 ml D.W.
 - b-In the second flask add 40 ml of 0.01 M KCl.
 - c-In the third flask add 40 ml of 0.02 M KCl.
 - d-In the fourth flask add 40 ml of 0.03 M KCl.
 - e-In the fifth flask add 40 ml of 0.04 M KCl.

Note:- you are provided with 0.1 molar KCl eg. In order to prepare 40 ml of 0.01 M KCl take 4 ml of 0.1 M KCl and complete the volume with water to 40 ml depending on the dilution equation

$$C_1 \cdot V_1 = C_2 \cdot V_2 \quad \text{and so on.}$$

- 2-shake for 10 minutes , leave 15 minute for equilibration.
- 3-Filter, rinse the flask with the first portion of the filtrate (eg. 1 ml), complete the filtration.
- 4-Take 10 ml of the filtrate, titrate against M/50 NaOH using phenolphthaline as an indicator.
- 5-Calculate the solubility product of potassium acid tartarate.

Calculation:-



$$M \Rightarrow 10_{ml} = 0.02 \times E \cdot P$$

$$\therefore M = \frac{E \cdot P}{500}$$

$$\textcircled{1} \quad KSP = [HT^-][K^+]$$

$$KSP = \left[\frac{E \cdot P}{500} \right] \left[\frac{E \cdot P}{500} \right]$$

$$\textcircled{2} \quad KSP = [HT^-][K^+ + K^+_{\text{from KCl}}]$$