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.

$$A_aB_{b(s)} \rightleftharpoons aA^+_{(aq)} + bB^-_{(aq)}$$

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

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

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}

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

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

If s is the solubility of AgCl, then:

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

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

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

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

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.

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

Therefore

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

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

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

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

To find Ksp from MOLAR SOLUBILTIY

1) Find the conc of the ions

$Ni(OH)_2 \longleftrightarrow NI^{+} + 2\ OH^{-}$

1:1 ratio in the Ni so,

[Ni]= molar solubility($5.2*10^{-6}$ M)

[OH] = (2*Molar solubilty)= ($5.2*10^{-6}$ M*2)

[OH] = ($10*10^{-6}$) ---> ($1.0*10^{-5}$)

2) FInd the Ksp by setting up expression

$Ksp = [Ni][OH]^2$

$Ksp = (5.2*10^{-6}\ M)(1.0*10^{-5})^2$

$Ksp= 5.2*10^{-16}$

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 prepar 40 ml of 0.01 M KCl take 4 ml of 0.1 M KCl and complete the volum with water to 40 ml depending on the dilution equation

$C_1 . V_1 = C_2 . V_2$ 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:-

$K^+ + HT^-$

NaOH

$$M \cdot V = M \cdot V$$

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

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

① $$KSP = [HT^-][K^+]$$

$$KSP = \left[\frac{E.P_1}{500}\right]\left[\frac{E.P_1}{500}\right].$$

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