Topic ⇒ Solubility Product and its applications.

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Solubility Product

In a saturated solution of a salt, there exists a dynamic equilibrium between the excess of the solute and the ions furnished by that part of the solute which has gone in solution.

e.g.

Consider, the case when a sparingly soluble salt, like silver chloride, is added to water. A very small amount dissolves and the rest of it remains in the solid state.

$$AgCl \rightleftharpoons Ag^+ + Cl^-$$

Applying the law of chemical equilibrium,

$$K = \frac{a_{Ag^+} \times a_{Cl^-}}{a_{AgCl}}$$

Since activity of a solid is taken as unity by convention, the above expression may be put as

$$K_{SP} = a_{Ag^+} \times a_{Cl^-}$$

K_{SP} is called **solubility product** of AgCl.

It is constant at a given temperature. It is more convenient to use concentration terms instead of activities. The constant is then known

as concentration solubility Product denoted by K'_{sp}.

$\therefore K'_{sp} = [Ag^+][Cl^-]$

Where the square brackets represents the concentrations of the entities enclosed within.

In the case of sparingly soluble salts since the ionic concentrations are very low, activity of each ion is almost equal to its concentration. Hence,

$K_{sp} = K'_{sp}$

i.e. Solubility Product is almost equal to concentration solubility product.

Applications of solubility product

1. Determination of solubilities of sparingly soluble salts. ⇒

Let, solubility of a sparingly soluble salt AgCl is s mole per litre. The Conc^n. of both Silver and chloride ion will be s mole per litre each.

$\therefore K_{sp} = [Ag^+][Cl^-] = s^2$

Hence, solubility of AgCl is related to the solubility product by the expression.

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

The solubility product of AgCl at a given temp. is determined by adding AgCl in a solution of KCl ~~of~~ of a known concentration say b moles per litre. The concentration of Ag^+ is a moles ~~per~~ per litre.

So, the concentration of chloride ion in solution will be $(a+b)$ moles per litre due to NaCl and KCl both.

Thus solubility product of silver chloride,

$K_{sp} = a(a+b)$

Since, both a and b are known. The solubility

of AgCl can easily be calculated.

Hence, Solubility of AgCl = $\sqrt{K_{sp}}$ mole per litre.

(ii) Predicting precipitation Reactions.
(iii) fractional precipitation
(iv) Precipitation of soluble salts
(v) Dissolution of Precipitates of Phosphates, Carbonates and sulphide etc. in Acid Solution.

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