Some Important ...

Conjugate a Conjugate Base

Acid$_1$ + Base$_2$ ⇌ Acid$_2$ + Base$_1$

$HNO_3 + H_2O \rightleftharpoons H_3O^+ + NO_3^-$

$H_2SO_4 + H_2O \rightleftharpoons H_3O^+ + HSO_4^-$ (base) } Amphoteric behaviour of HSO_4^-

HSO_4^- (acid) $+ H_2O \rightleftharpoons H_3O^+ + SO_4^{=}$ }

$[Fe(H_2O)_6]^{3+} + H_2O \rightleftharpoons H_3O^+ + [Fe(H_2O)_5OH]^{2+}$

$NH_4^+ + H_2O \rightleftharpoons H_3O^+ + NH_3$

$H_2S + H_2O \rightleftharpoons H_3O^+ + HS^-$

$H_2O + NH_3 \rightleftharpoons NH_4^+ + OH^-$

$H_2O + HS^- \rightleftharpoons H_2S + OH^-$ – Q. why aqu. soln of NaHS will be basic and smell of H_2S?

$HF + HNO_3 \rightleftharpoons H_2NO_3^+ + F^-$

$HClO_4 + HF \rightleftharpoons H_2F^+ + ClO_4^-$ } HF and H_2SO_4 act as a bases in presence of $HClO_4$. (since HF and

$HClO_4 + H_2SO_4 \rightleftharpoons H_3SO_4^+ + ClO_4^-$ } H_2SO_4 accepts proton)

$CO(NH_2)_2 + NH_3 \rightleftharpoons NH_4^+ + NH_2CONH^-$ } Amphoteric behaviour of Urea $[NH_2-\underset{O}{\overset{\|}{C}}-NH_2]$

and

$HCOOH + CO(NH_2)_2$ (base) $\rightleftharpoons NH_2-\underset{O}{\overset{\|}{C}}-NH_3^+ + HCOO^-$ }

Define sparingly soluble salts

Salts having solubilities less than about 0.01 mole/lit in water at ordinary tempr are called sparingly soluble salts. AgCl is an example of a sparingly soluble salt.

Define solubility product (Ksp) and solubility product principle give an expression for Ksp of Calcium phosphate

Solubility product (Ksp):–

It was experimentally found that in saturated solutions of sparingly soluble salt, the product of the concentration of the constituent ions is a constant at a constant tempr. This product is called solubility product of the salt.

Solubility Product Principle :-

In a saturated solution of a sparingly soluble salt, the product of the concentration of the constituent ions is a constant at constant tempr.

Thus for an electrolyte $A_x B_y$, ionising as

$$A_X B_Y \rightleftharpoons X A^{Y+} + Y B^{X-}$$

According to solubility product principle,

$$[A^{Y+}]^x [B^{X-}]^Y = \text{constant at constant tempr}$$

$= K_{sp}$ of $A_x B_Y$ [K_{sp} = solubility produ

Q. Give an expression for Ksp of the following comp.

① $CaF_2 (s) \rightleftharpoons Ca^{2+}_{(aq)} + 2F^-(aq)$

$K_{s.p}$ of $CaF_2 = [Ca^{2+}][F^-]^2$

② $Al(OH)_3 (s) \rightleftharpoons Al^{3+}_{(aq)} + 3OH^-(aq)$

K_{sp} of $Al(OH)_3 = [Al^{3+}][OH^-]^3$

③ $Ca_3(PO_4)_2 (s) \rightleftharpoons 3Ca^{2+}(aq) + 2PO_4^{3-}(aq)$

K_{sp} of $Ca_3(PO_4)_2 = [Ca^{2+}]^3 [PO_4^{3-}]^2$

Q38 Define solubility product of a sparingly soluble salt.

⇒ In a saturated solution of a sparingly soluble salt, a dynamic equilibrium exists between the insoluble salt and its dissociated ions. In general, for a salt of the type $A_x B_y$ which in solution yields $A^{y\oplus}$ and $B^{x\ominus}$ ions according to the equilibrium:

$$A_x B_y (s) \rightleftharpoons x A^{y\oplus}(aq) + y B^{x\ominus}(aq)$$

on applying the law of mass action, the equilibrium constant is given by —

$$K_{eqm.} = \frac{a^x_{A^{y\oplus}} \cdot a^y_{B^{x\ominus}}}{a_{A_x B_y}}$$

Since for the pure solid, $a_{A_x B_y} = 1$ and then $K_{eqm.} = K_{s.p}$, where K_{sp} is called the solubility product constant or activity product. Therefore,

4/1

$$K_{sp} = a^{x}_{A^{y\oplus}} \cdot a^{y}_{B^{x\ominus}}$$

If a solution is saturated with a given salt, then product of the activities of its constituents ions raised to the appropriate power must be constant. This is called solubility product constant.

If the activity of each ion is written as the product of its concentration in gm. moles lit.$^{-1}$ and corresponding activity co-efficient, then we have

$$K_{sp} = \left(C^{x}_{A^{y\oplus}} \cdot C^{y}_{B^{x\ominus}}\right)\left(\gamma^{x}_{A^{y\oplus}} \cdot \gamma^{y}_{B^{x\ominus}}\right)$$

$$= \left(C^{x}_{A^{y\oplus}} \cdot C^{y}_{B^{x\ominus}}\right) \gamma_{\pm}^{(x+y)}$$

where $\gamma_{\pm}$ is the mean ionic activity co-efficient of $A^{y\oplus}$ and $B^{x\ominus}$ ions in the solution.

Defining, $K'_{sp} = C^{x}_{A^{y\oplus}} \cdot C^{y}_{B^{x\ominus}}$ and thus

$$\boxed{K_{sp} = K'_{sp} \cdot \gamma_{\pm}^{(x+y)}}$$

unlike K_{sp}, which is a constant at any given temperature, K'_{sp} is called concentration solubility product will vary with the activity co-efficient of $A^{y\oplus}$ and $B^{x\ominus}$ in the solution, i.e., with the ionic strength of the solution.

At low ionic strength, where the activity co-efficient approaches unity, K_{sp} and K'_{sp} are not greatly different. so that K'_{sp} define as above is approximately constant.

Any salt wheather highly soluble or sparingly soluble will have a solubility product value. However, K_{sp} value of highly soluble salts are very high and they do not have any analytical applications.

Findout the relation between solubility and solubility Product.

⇒ Let us consider the saturated solution of the salt Ag_2CrO_4, if solid salt is added, then in solution the following equilibrium exists:

$$Ag_2CrO_4(s) \rightleftharpoons 2Ag^{\oplus}(aq) + CrO_4^{2\ominus}(aq)$$

on applying the law of mass action, the solubility