EQUILIBRIUM





Solubility Product (Ksp)

$$aA \rightleftharpoons cC + dD$$

$$Ksp = [C]^{O}[D]^{d}$$

Ionic Product of water

$$2H_2O \rightleftharpoons H_3O^+ + OH^-$$

$$K_W = [H_3O^+][OH^-] = 1\times10^{-14}M^2$$

$$\therefore [OH^-] = [H^+] = 10^{-7}M @ 298\ K$$

$$pK_W = pK_a + pK_b = 7 + 7 = 14$$

Ostwald's Dilution Law

Applicable for weak electrlytes

$$\therefore K_c = C\alpha^2 \text{ or } \alpha = \sqrt{\left(\frac{K_c}{C}\right)}$$

$$\text{So, } \alpha = \frac{1}{\sqrt{c}} \text{ or } \propto \sqrt{v}$$

where V is the volume of solution at infinite dilution

Hydrolysis of Salts

Salts of strong base and strong acid does not undergo hydrolysis. eg. naCl, KCl

- Salt of weak base and Strong Acid

$$K_h = \frac{k_w}{K_b};\ P^H = \frac{1}{2}\left[pK_{2_a} - pK_b - \log c\right]$$

- Salt of weak Acid and weak base

$$K_h = \frac{K_w}{K_a \times K_b};\ p^H = \frac{1}{2}[pK_w - pK_a - pK_b]$$

Acids and Base

- Acids: Liberates H_2 on reacting with metals Turns blue litumus into red
- Base: Taste bitter and feel soapy Turns red litmus into blue

$$\text{Acidic} \Rightarrow [H_3O^+] > [OH^-]$$

$$\text{Basic} \Rightarrow [H_3O^+] < [OH^-]$$

$$\text{Neutral} \Rightarrow [H_3O^+] = [OH^-]$$

Direction of reaction

$Q_c > K_c$

Reaction goes from left to right

$Q_c < K_c$

Reaction goes from right to left

$Q_c = K_c$

No Net reaction occurs

Factor's of reaction

Le Chatlier's Principle

- Effect of concentration change concentration $\rightarrow$, equilibrium shift forward.
- Effect of pressure change equilibrium will shift in the direction having smaller number of moles.
- Effect of temperature change

  For exothermic $\rightarrow$ low temperature favors formation of reactants.

  For Endothermic $\rightarrow$ High temperature favors formation of products.
- Effect of inert gas $\rightarrow$ No change
- Effect of catalyst $\rightarrow$ No change

Law of chemical Equilibrium Equilibrium Law

$$aA + bB \rightleftharpoons cC + dD$$

$$K_c = \frac{[C]^C\,[D]^d}{[A]^a\,[B]^6}$$

Here K_c is equilibrium constant

Relation between equilibrium constant k_p and k_c

$$K_p = K_c(RT)^{\Delta ng}$$

Gibb'S energy

$$\boxed{\Delta G = RT \ln K}$$

ΔG = -ve. Spontaneous reaction

Reaction proceeds forward.

ΔG = +ve. Non Spontaneous reation

Reaction proceeds backward

ΔG = zero. equilibrium achieved

p^H Concept

$$p^H = -\log[H^+]$$

$$\text{OR}$$

$$p^H = -\log[H_3O^+]$$

for weak acid $\rightarrow$ $P^H = \frac{1}{2}(C_pK_a - \log C)$

Definition

Chemical reaction reach a state of dynamic equilibrium in which the rate of forward reaction and backward reation are same and there is no net change in composition

Physical Equilibrium

Equilibrium set up in a physical process like evaporation of water etc.

$(S) \rightleftharpoons (l)$

$(l) \rightleftharpoons (g)$

$(g) \rightleftharpoons (S)$

Chemical Equilibrium

Equilibrium attained in a chemical reaction

$$3H_2 + N_2 \rightleftharpoons 2NH_3$$

- Possible only in a closed system.
- Both reaction occur at same rate
- All measurable property remains constant

Homogeneous

Reactant and product are in same phase

Hetrogeneous

Reactant and product are in different phase