CHEMICAL EQUILIBRIUM AND IONIC EQUILIBRIUM

Law of Mass Action : It states that the rate of a reaction is directly proportional to the of the molar concentrations of the reactants at a const temperature at any given time. The molar concentration number of moles per litre is also called active mass.

Let us consider a simple reaction between the species A and B;

$$aA + bB \longrightarrow \text{Product}$$

According to law of mass action

Rate of reaction; $r \propto [A]^a [B]^b$

$$r = K[A]^a[B]^b$$

Thus the law of mass action may be re-stated a the rate of a chemical reaction at any particular temperature is proportional to the product of molar Concentrations of reactants with each concentration term raised to the power equal to the number of molecules of the ~~reactant~~ respective reactants taking part in the reaction

Law of Chemical equilibrium and equilibrium constant:

The law of mass action may be applied to a reversible reaction to derive a mathematical expression for equilibrium constant known as law of chemical equilibrium.

Let us consider a simple reversible reaction

$$A + B \rightleftharpoons C + D$$

in which an equilibrium exists between the reactants (A & B) and the products (C & D). The forward reaction is

$$A + B \longrightarrow C + D$$

According to law of mass action,

Rate of forward reaction, $R_f \propto [A][B]$

$$R_f = k_f [A][B] \quad \text{---(1)}$$

where [A] and [B] are molar concentrations of reactants A and B respectively.

Similarly, the backward reaction is

$$C + D \longrightarrow A + B$$

Rate of backward reaction $\propto [C][D]$

$$R_b = k_b [C][D] \quad \text{---(2)}$$

At equilibrium, the rate of backward reaction equals the rate of forward reaction.

$$K_f [A][B] = K_b [C][D] \quad \text{—— (3)}$$

OR $$\frac{K_f}{K_b} = \frac{[C][D]}{[A][B]} \quad \text{—— (4)}$$

OR $$K = \frac{[C][D]}{[A][B]} \quad \text{—— (5)}$$

OR $$\boxed{K_c = \frac{[C][D]}{[A][B]}} \quad \text{—— (6)}$$

The combined constant, K_c, which is equal to K_f/K_b is called equilibrium constant and has a constant value for a reaction at a given temperature. The above equation is known as law of chemical equilibrium.

For a general reaction of the type

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

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

Thus equilibrium constant, K_c, may be defined as the ratio of product of molar conc. of product to that of molar conc. of reactants with each conc. term raised to the power of its stoichiometric coefficient in the balanced chemical equation at a constant temp.