

Rate of reaction = $\frac{\text{Change in concentration of product}}{\text{time}}$

$$= \left(\frac{dc}{dt} \right) \text{ products.}$$



Law of mass action

The rate of any reaction is directly proportional to the product of active masses of reactants raised to the power equal to their stoichiometric coefficient.



$$r \propto [A]^a [B]^b$$

$$r_f = K_f [A]^a [B]^b \quad K_f = \text{rate constant of forward reaction}$$

$$r_b = K_b [C]^c [D]^d \quad K_b = \text{rate constant of backward reaction.}$$

At equilibrium

$$r_f = r_b \\ K_f [A]^a [B]^b = K_b [C]^c [D]^d$$

Equilibrium Constant (K)

$$\frac{K_f}{K_b} = K_{\text{equilibrium}} = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

$K_{\text{equilibrium}}$ is a constant and is called the equilibrium constant

MIND MAP

Chemical Equilibrium

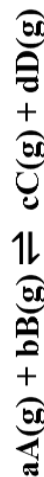
$K_{\text{eq}} >>> 1 \Rightarrow$ very high conversion of reactants into products

$K_{\text{eq}} \approx 1 \Rightarrow$ Concentration of reactant and products is similar

$K_{\text{eq}} <<< 1 \Rightarrow$ very low conversion of reactants into products

$$\text{Active mass} = \frac{\text{moles}}{\text{Volume in litres}}$$

$$= \frac{\text{grams(w)}}{\text{Volume in litres(V)}} \\ = \frac{\text{mol. wt. (M}_w\text{)} \times \text{Volume in litres(V)}}{w \times 1000} \\ = \frac{w \times 1000}{M_w \times V(\text{mL})}$$



$$K_P = \frac{[P_C]^c [P_D]^d}{[P_A]^a [P_B]^b}$$

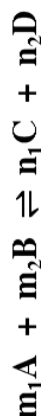
where various pressures are the partial pressures of various gasses substances.

$K_x \rightarrow$ Equilibrium constant in terms of mole fraction

$$K_X = \frac{X_C^c X_D^d}{X_A^a X_B^b}$$

Where X_X, X_B, X_C, X_D are the mole fractions of A, B, C and D respectively.

Relation between K_P and K_C



$$K_C = \frac{[C]^{n_1} [D]^{n_2}}{[A]^{m_1} [B]^{m_2}}$$

$$K_P = \frac{(P_C)^{n_1} (P_D)^{n_2}}{(P_A)^{m_1} (P_B)^{m_2}}$$

Relation between K_P and K_x

$$K_P = K_X P^{\Delta n_g}$$

If $\Delta n_g = 0$, $K_P = K_C = K_X$

K_{eq} from Thermodynamics

$$\Delta G^\circ = -RT \ln K_{\text{eq}}$$

$$\ln \frac{K_2}{K_1} = \ln K_2 - \ln K_1 \\ = \frac{-\Delta_r H^\circ}{R} \left[\frac{1}{T_2} - \frac{1}{T_1} \right]$$

Van't Hoff equation

MIND MAP

Le Chatelier's Principle

Chemical Equilibrium

	$\Delta n=0$ $H_2 + I_2 \rightleftharpoons 2HI$	$\Delta n > 0$ or +ve $PCl_5 \rightleftharpoons PCl_3 + Cl_2$	$\Delta n < 0$ or -ve $N_2 + 3H_2 \rightleftharpoons 2NH_3$
Effect	$x \propto (v)^0 \propto (P)^0$	$x \propto (v)^{1/2} \propto \left(\frac{1}{P}\right)^{1/2}$	$x \propto \left(\frac{1}{v}\right) \propto (P)$
(i) Pressure (se)	x unchanged	x decreases	x increases
(ii) Volume (se)	x unchanged	x increases	x decreases
(iii) Mixing of inert gas at			
(a) constant pressure	x unchanged	x increases	x decreases
(b) constant volume	x unchanged	x unchanged	x unchanged