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Saathi

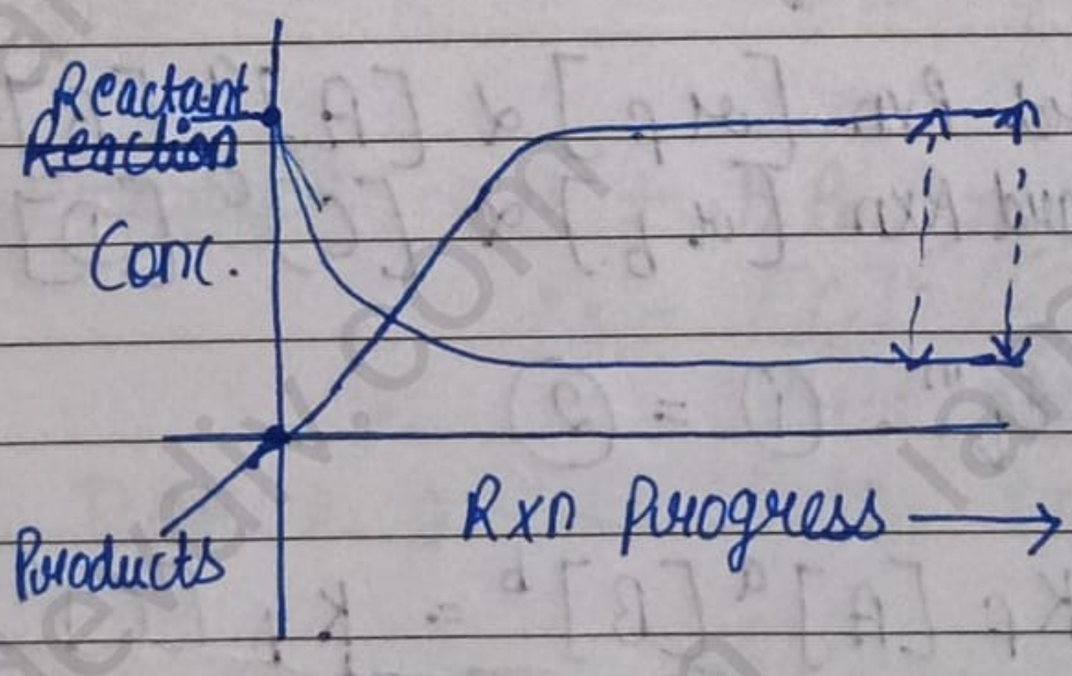
Chapter - Equilibrium

Equilibrium

- At Equilibrium the rate of forward rxn becomes equal to the rate of backward rxn.

$$A + B \underset{\text{backward}}{\overset{\text{forward}}{\rightleftharpoons}} C + D$$

- In the Initial face the concentration of A & B are maximum and that of C & D are min.
- As the rxn proceeds the conc. ~~the~~ of A & B decreases and C & D increases. Ultimately a stage comes when the conc. of reactants ~~to~~ & products becomes constant. This is called Equilibrium.



→ Properties of chemical Equilibrium

- At Equilibrium the conc. of reactants & products becomes Constant NOT EQUAL
- Equilibrium is dynamic in nature because rate of forward rxn equals to rate of backward rxn & the rxn does not stop

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- Equilibrium can be attain from reactant side & product side both
- A Catalyst does not alter the state of equilibrium but it helps the rxn to be faster.

Law of Mass Action

- Guldberg & Waage proposed a law which tells us about a rate of rxn & conc. of reactants relation
- The rate at which a substance reacts it is directly propotional to active mass & the rate of chemical rxn is directly proportional to the active masses of ~~the~~ reacting species.
- Active mass = molar conc. = No of moles dissolves per unit solution
- for ex:- $aA + bB \underset{\text{backward}}{\overset{\text{forward}}{\rightleftharpoons}} cC + dD$.

Rate of forward Rxn $[r_f] \propto [A]^a [B]^b \Rightarrow K_f [A]^a [B]^b$ -(1)
Rate of backward Rxn $[r_b] \propto [C]^c [D]^d \Rightarrow K_b [C]^c [D]^d$ -(2)

At Eq^m (1) = (2)

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

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

$\frac{K_f}{K_b} = K_c$ ↓ Eq^m constant

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

This law is also called law of chemical Equilibrium

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Note:-

- K_c depends upon temp. and independent upon conc.
- If the rxn is reversed the value of
- The value of $K'c = \frac{1}{K_c}$
- If the rxn is divided by 2 the value of $K'c = \sqrt{K_c}$
- If the rxn is multiplied by 2 the value of $K'c = K_c^2$
- If we add two eqn their K_c will be multiplied.

☆ Some Important points

- Active mass of solid is always taken as unity.
- Active mass of liquid in eqn with gas is taken unity
- If the rxn takes place in aqu. medium the conc. of water is taken unity.

The Relationship between K_p & K_c

For a rxn

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

$$K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b} \quad -(1)$$

If A, B, C, D are in gaseous state so

$$K_p = \frac{p_C^c \cdot p_D^d}{p_A^a \cdot p_B^b} \quad -(11)$$

$PV = nRT$

$$P = \frac{n}{V} RT$$

By putting the value of partial pressure in eqn (2)

$$K_p = \frac{[C_C \cdot RT]^c [C_D \cdot RT]^d}{[C_A \cdot RT]^a [C_B \cdot RT]^b} = \frac{[C_C]^c [C_D]^d}{[C_A]^a [C_B]^b} \cdot RT^{(c+d)-(a+b)}$$

$\boxed{P = CRT}$

$\Delta ng = (c+d)-(a+b) \Leftarrow K_p = K_c (RT)^{(c+d)-(a+b)}$

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

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