EQUILIBRIUM

EQUILIBRIUM IN PHYSICAL PROCESSES

❖ **INTRODUCTION**

Chemical Reaction: Symbolic representation of any chemical change in terms of reactants and products is called chemical reaction.

Ex. $N_2 + 3H_2 \rightarrow 2NH_3$

Types of Chemical Reaction All reactants and products are in same Phase $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	**On The Basis of Physical State** Reactants and products are in more than one phase $Zn(s) + CO_2(g) \rightarrow ZnO(s) + CO(g)$
On The Basis of Direction (i) Chemical reaction in which products can be converted back into reactants $N_2 + 3H_2 \quad 2NH_3$ $3Fe + 4H_2O \quad Fe_3O_4 + 4H_2$ $H_2 + I_2 \quad 2HI$	(i) Chemical reaction in which products cannot be converted back into reactants. $AgNO_3 + NaCl \longrightarrow AgCl + NaNO_3$ $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$ $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$ $2KClO_3 \longrightarrow 2KCl + 3O_2$
(ii) Proceed in forward as well as backward direction.	(ii) Proceed only in one direction (forward).
(iii) To obtain reversible reactions, if anyone of the reactant or product is in gaseous state, then the reaction should be carried out in closed vessel. $CaCO_3\ (s) \longrightarrow CaO\ (s) + CO_2\ (g) \uparrow$	(iii) Generally possible in open container.
(iv) These attain equilibrium.	(iv) These do not attain equilibrium.
(v) Reactants are never completely	(v) Reactants are completely converted

converted into products.	into products.
(vi) Generally thermal decomposition in closed vessel. $PCl_{5(g)} \longrightarrow PCl_{3(g)} + Cl_2\ (g)$	(vi) Generally thermal decomposition in open vessel. $PCl_{5(g)} \longrightarrow PCl_{3(g)} + Cl_2\ (g)$

On The Basis of Speed

(i) These reactions are completed in a very short interval of time. $HCl + NaOH \longrightarrow NaCl + H_2O$ Acid Base Salt Water	(i) These reactions take long time to complete. $H_2 + I_2 \longrightarrow 2HI$

On The Basis of Heat	
Exothermic Reaction	**Endothermic Reaction**
(i) Heat is evolved in these chemical reaction $R \longrightarrow P + x\ kcal$	(i) Heat is absorbed in these chemical reaction $R + x\ kcal \longrightarrow P$ or $R \longrightarrow P - x\ kcal$
(ii) Change in enthalpy $\Delta H = (-)\ ve$	(ii) Change in enthalpy $\Delta H = (+)\ ve$
Ex.: Formation reaction Exception $N_2 + O_2 \rightarrow 2NO/N_2O/NO_2$ $O_2 + F_2 \rightarrow O_2F_2/OF_2$	Ex. Dissociation reaction

Active Mass: The term active mass means the concentration of the reactants & products expressed in moles per liter (molar concentration). Active mass is usually expressed by enclosing the symbol of the reactant in square bracket [ ]

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

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

The active mass of solids and pure liquids is a constant quantity (unity) and solvent (excess) is considered as one. Because there is no change in activity with the change in quantity or volume of vessel.

Molar concentration $= \frac{w}{M_w \times V_{lit.}} = \frac{\rho}{M_w}$ (ρ = density in g/lit)

$$= \frac{\text{density of the substance}}{\text{molecular mass of the substance}}$$

as density of pure solids and liquids is constant and molecular mass is also constant. But this is not applicable to the substance in aqueous solution or gaseous state because their amount in a given volume can vary.

Following other names of active mass can also be use:

(i) mole/lit. (ii) gram mole/lit. (iii) gram molecules/lit.

(iv) molarity (v) Concentration (vi) Effective concentration

(vii) active quantity (viii) n/v (ix) C

(x) M (xi) [ ]

Ex.

(a) 25.4 g of iodine is present in 2 liters of solution

then $[I_2] = \frac{25.4}{254 \times 2} = 0.05$ mole/liter

(b) 8.5 g ammonia is present in a vessel of 0.5 liter capacity then

$[NH_3] = \frac{8.5}{17 \times 0.5} = 1$ mole/ litre

(c) Active mass of C (s) or S(s) or Zn(s) is equal to 1.

RATE OF REACTION

The change in concentration of reactants or products per mole in unit time is known as rate of the reaction.

Rate of reaction $= \frac{(n) change\ in\ concentration\ of\ rectants}{time}$

$= -(\frac{dc}{dt})$ reactants.

Here negative sign indicate that concentration of reactants decrease with time.

$$\text{Rate of reaction} = +\frac{\textit{change in concentration of products}}{\textit{time}} = +\left(\frac{\mathrm{dc}}{\mathrm{dt}}\right)\text{ products}$$

FACTORS AFFECTING RATES OF REACTIONS

(a) **State of Matter** : The decreasing order of rate of reaction in gas, liquid and solid state are-

$$\mathrm{g} > \ell > \mathrm{s}$$

(b) **Temperature** : Rate of reaction α temperature

(c) **Concentration** : Rate of reaction α concentration.

(d) **Catalyst** : Positive catalyst increases the rate of reaction.