Chemical kinetics:-

When we study about a reaction some basic questions arises in our mind, suppose for a reaction —

$$A + B \rightarrow C$$

Is the reaction energitically feasible? We know metallic sodium reacts with water but not gold. Because for first one it is energitically feasible but second one not. But for a unknown reaction the answer is given by Thermodynamics. If a reaction if $\Delta G = (-)ve$ then the reaction will be feasible but if it $\Delta G = +ve$ then not.

Similarly, upto what extent the reaction will proceed. The answer is thermodynamic $\Delta G = -RT\ln K$. where K equm constant.

But how fast the reaction will be and what will be its mechanism, the answer lies on chemical kinetics.

Rate of a reaction:-

If two friends decide to reach a certain destination with their motor cycle and starts their journey at a same time, who will reach earlier? The answer is simply, the person who have greater speed. Similarly for a reaction goes greater extent which have greater speed, eg Na reacts with water almost immediately but Mg slowly. Now speed of a reaction is here we calle rate of reaction. It means amount of product increase at unit time, similarly it means amount of reactant left at unit time. i.e Rate of a reaction means the rate of advancement of a overall reaction and advancement of a reaction is considered as unity when stoichiometric amount of any one of reactant undergoes the reaction

Suppose a reaction

$$mA + nB \rightarrow pC + qD$$

if $d\xi$ is be the advancement of the reaction at very short time dt.

then

$$dn_A = -m\,d\xi \quad \text{or} \quad \frac{dn_A}{dt} = \frac{d\xi}{dt} = -\frac{1}{m}\frac{dn_A}{dt}$$

$$dn_B = -n\,d\xi \qquad \frac{d\xi}{dt} = -\frac{1}{n}\frac{dn_B}{dt}$$

$$dn_C = p\,d\xi \qquad \frac{d\xi}{dt} = \frac{1}{p}\frac{dn_C}{dt}$$

$$dn_D = q\,d\xi \qquad \frac{d\xi}{dt} = \frac{1}{q}\frac{dn_D}{dt}$$

$\therefore$ where $\left(\frac{d\xi}{dt}\right)$ = degree of advancement of the reaction or advancement of a reaction per unit time.

Now $$-\frac{1}{m}\frac{dn_A}{dt} = -\frac{1}{n}\frac{dn_B}{dt} = \frac{1}{p}\frac{dn_C}{dt} = \frac{1}{q}\frac{dn_D}{dt}$$

Where n_A mole of 'A' or dn_A change of mole of 'A'

Now we know that $\frac{n}{V} = C$ (concentration)

So $$\frac{1}{V}\frac{d\xi}{dt} = -\frac{1}{V}\left(\frac{1}{m}\frac{dn_A}{dt}\right) = -\frac{1}{m}\frac{d(n_A/V)}{dt} = -\frac{1}{m}\frac{dc_A}{dt}$$

i.e. $\left(\frac{1}{V}\frac{d\xi}{dt}\right)$ is called rate of a reaction.

i.e. degree of advance of a reaction at unit volume is called Rate of a reaction.

eg

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

$$\text{Rate} = -\frac{dc_{N_2}}{dt} = -\frac{1}{3}\frac{dc_{H_2}}{dt} = \frac{1}{2}\frac{dc_{NH_3}}{dt}$$

or in general

$$\boxed{\text{Rate} = \frac{1}{\nu_i}\frac{dc_i}{dt}}$$

where ν_i = Stoichiometric coefficient of i^{th} constituent.