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29-07-20

Deg - I (Sub) - Chemical Kinetics
Topics — Rate of Reaction & factors affecting Rate of Reaction.

Rate of Reaction :—

Def :— It is defined as the change in Concentration of any one of the Reactants or products per unit time.

Consider a hypothetical Reaction.

Reactant (R) ⟶ Product (P)

In which one mole of reactant Convert to one mole of product.

The rate of reaction expressed as

$$\text{Rate of Reaction} = \frac{\text{Decrease in Conc}^{n} \text{ of R}}{\text{Time taken}}$$

$$= \frac{\text{Increase in Conc}^{n} \text{ of P}}{\text{Time taken}}$$

If $[R]_1$ & $[P]_1$ are the Conc^{n} of R & P respectively at time t_1 & $[R]_2$ & $[P]_2$ at time t_2.

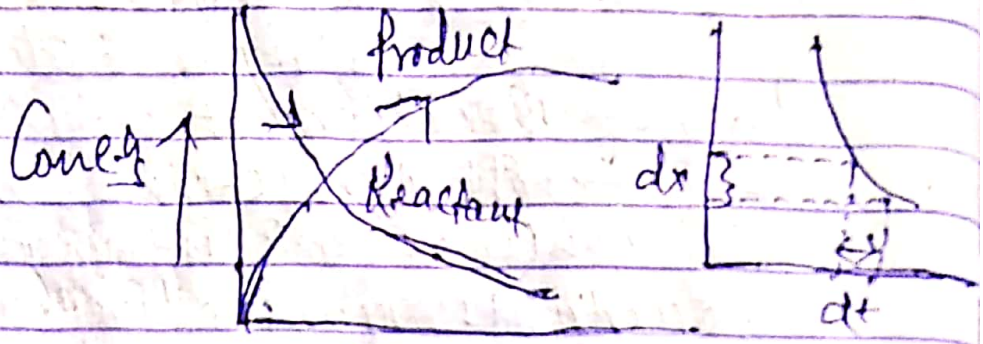
$$\text{Rate of Reaction} = -\frac{\Delta[R]}{\Delta t}$$

$$= +\frac{\Delta[P]}{\Delta t}$$

$\Delta[R] = [R]_2 - [R]_1$, $\Delta t = t_2 - t_1$

$\Delta[P] = [P]_2 - [P]_1$

-ve sign indicates that the Concentration of Reactant decrease with time.



Rate of Reaction also expressed as

$$\text{Rate} = \frac{dx}{dt}$$

Example for the reaction of general type.

$$A + B \longrightarrow P + Q$$

Rate of RXN.

$$\left(\frac{dx}{dt}\right) = -\frac{d[A]}{dt} = -\frac{d[B]}{dt} = +\frac{d[P]}{dt} + \frac{d[Q]}{dt}$$

But if reaction involving different stoichiometric coefficient of Reactants and Products

$$aA + bB \longrightarrow pP + qQ$$

The unique value of rate of reaction can be expressed as

$$\frac{dx}{dt} = -\frac{1}{a}\frac{d[A]}{dt} = -\frac{1}{b}\frac{d[B]}{dt} = +\frac{1}{p}\frac{d[P]}{dt} = +\frac{1}{q}\frac{d[Q]}{dt}$$

Factors affecting Rate of Reaction

There are various factors upon which the rate of reaction depends.

(1) Nature of Reactant:-

(a) Physical State of Reactant:- The rate of reaction also depend upon their physical state.

Rate gases > Liquid > Solid.

(b) Surface-area of contact:- larger the surface-area higher is their rate of Rxn.

$Zn + HCl \longrightarrow$ slow
(granules)

$Zn + HCl \longrightarrow$ fast
(powder)

(c) Bonding nature:- A chemical reaction involves the breaking of old-bond & formation of new-bond.

Exap6:- Oxidation of NO & CO

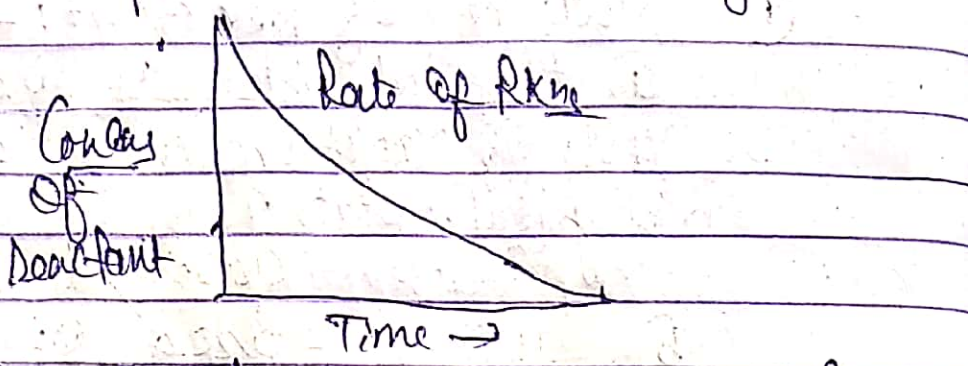
$2NO + O_2 \longrightarrow 2NO_2$ — (fast)

$2CO + O_2 \longrightarrow 2CO_2$ — (slow)

In above reaction the two reactant NO & CO appear to be very similar to each other but they differ in reaction-rate.

(2) Concentration of the reactant -

The rate of reaction is directly proportional to the Conc^{n} of reactant due to increase in the number of collision b/w the molecules. Higher the



Conc^{n} greater is the number of collision.

(3) Effects of Temperature :-

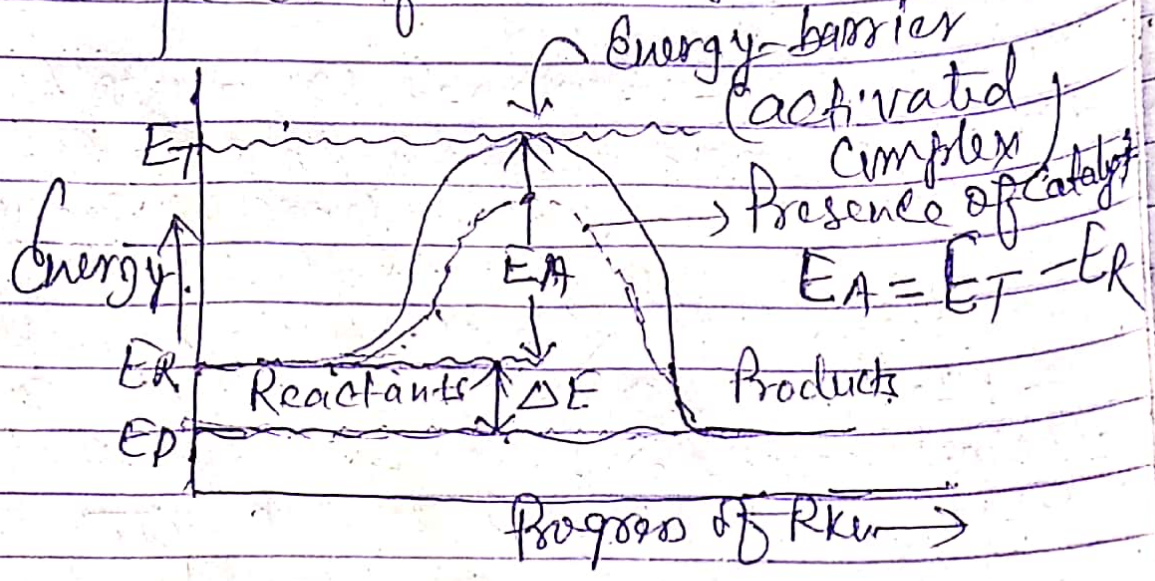
By increasing Temp^{r} not only increase the speed of reaction but it also initiates the reaction.

According to general approximate rule the rate of most of chemical reaction becomes almost double for every $10^{0}C$ rise in Temp^{r}.

$$\text{Temp}^{r}\text{. Coefficient} = \frac{K(t+10)}{Kt} \simeq 2 \text{ or } 2$$

A large number of reaction are known which do not take place at room-Temp^{r} but occur readily at higher Temp^{r}.

(4) Effects of Catalyst :- Those substance which increase the rate of reaction without undergoing any chemical change itself.



The presence of catalyst provides an alternating path with lower energy barrier. Thus energy of activation is lowered & hence a greater number of molecules can cross the barrier and change over to products.

E_T = Threshold Energy
E_A = Activation energy
E_R = Energy of reactant
E_P = Energy of product

Presence of catalyst increase the speed of forward reaction as well as Back reaction to the same extent in Reversible Rx