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B.Sc-I. PIA, Chemistry

**Order of reaction:-** The number of reactants molecules whose concentration changes during the reaction is called order of reaction.

or

Sum of the powers of concentration term in rate law equation is called order of reaction.

Example→

$$aA + bB \rightarrow cC + dD.$$

Rate law equation is

$$\frac{dx}{dt} = K[A]^a[B]^b$$

then over all rate of reaction is a+b.

If $\frac{dx}{dt} = K[A]^a[B]^0$

then Rate of reaction = a

As rate of reaction does not depends upon concentration term of B.

Important thing about order of reaction

(1) It may be zero, whole number or fraction number or even (−)ve integer.

(2) It is an experimental quantity

(3) It is equal to number of reactants molecules whose concentration change during reaction.

4. ~~It~~ The order of reaction greater than three is rare in number because order of reaction is calculated from rate determination step and does not depends upon the sum of ~~balance~~ co-efficient of balance chemical reactions.

<u>Integral rate equation for first order reaction:</u>—

Let us consider a first order reaction

$$A \longrightarrow \text{products}$$

| | A | products |
|---|---|---|
| $t=0$ | a mole/litre | 0 |
| $t$ | $(a-x)$ mole/litre | $x$ |

From rate law equation

$$\frac{dx}{dt} \propto (a-x) \quad \text{—— (I)}$$

$$\Rightarrow \frac{dx}{dt} = K_1(a-x)$$

$K_1$ = rate constant.

$$\Rightarrow \frac{dx}{(a-x)} = K_1 dt \quad \text{—— (II)}$$

Integrating we get

$$-\ln(a-x) = Kt + C \quad \text{—— (III)}$$

C = Integration constant

~~If~~ $t=0$, $x=0$, eqn (III) will be.

$$-\ln a = 0 + C \quad \text{—— (i)}$$

Putting value of C from eq^n (ii) in eq^n (iii)

$$-\ln(a-x) = K_1 t - \ln a$$

$$\Rightarrow K_1 t = \ln a - \ln(a-x)$$

$$\Rightarrow K_1 = \frac{1}{t} \ln \frac{a}{a-x}$$

$$\Rightarrow \boxed{K_1 = \frac{2.303}{t} \log \frac{a}{a-x}}$$

This is rate equation for first order.

Unit of first order rate constant –

$$K_1 = \frac{1}{sec} \times \frac{\text{concentration}}{\text{concentration}}$$

$\boxed{K_1 = sec^{-1}}$ Unit for $K_1$

Half life period :– At half life period $t_{1/2}$, the concentration will $\frac{a}{2}$

$$\therefore K = \frac{1}{t_{1/2}} \log \frac{a}{a - \frac{a}{2}}$$

$$\Rightarrow K = \frac{1}{t_{1/2}} \log \frac{a}{\frac{a}{2}}$$

$$\Rightarrow \boxed{K = \frac{1}{t_{1/2}} \log 2} \text{ or } t_{1/2} = \boxed{\frac{1}{K} \log 2}$$

It means half life period for first order is independent of initial concentration of reactant.