

BSL-I-P-IA₃Methods for determination of order of reaction. —

Order of reaction is determined by following methods.

1. Differential rate expression: —

We know that rate of reaction for n th order is given by.

$$r_1 = -\frac{dc_1}{dt} = k_n C_1^n \quad \text{--- (i)}$$

$$\text{or } r_2 = -\frac{dc_2}{dt} = k_n C_2^n \quad \text{--- (ii)}$$

where r_1 and r_2 are the rate of reaction at the concentration of reactants C_1 and C_2

Dividing (i) by (ii) we get.

$$\frac{r_1}{r_2} = \frac{-dc_1}{dt} = \frac{k_n C_1^n}{k_n C_2^n}$$

$$\text{or } \frac{r_1}{r_2} = \left(\frac{C_1}{C_2}\right)^n$$

Taking logarithm we get

$$\log \frac{r_1}{r_2} = n \log \frac{C_1}{C_2}$$

$$\text{or } \boxed{n = \frac{\log \frac{r_1}{r_2}}{\log \frac{C_1}{C_2}}}$$

Thus knowing experimentally r_1, r_2 and C_1 and C_2 the ~~rate of reaction~~ order of reaction can be determined.

2. Half life or fractional change method:-

In general we know that

$$t_{1/2} \propto \frac{1}{a^{n-1}} \quad \text{--- (i)}$$

where $t_{1/2}$ = half life.

a = initial concentration

n = order of reaction.

From different initial concentration.

$$(t_{1/2})_1 \propto \frac{1}{a_1^{n-1}} \quad \text{--- (ii)}$$

$$\text{or } (t_{1/2})_2 \propto \frac{1}{a_2^{n-1}} \quad \text{--- (iii)}$$

Dividing (ii) by (iii)

$$\frac{(t_{1/2})_1}{(t_{1/2})_2} = \left(\frac{a_2}{a_1}\right)^{n-1}$$

Taking log both side

$$\log(t_{1/2})_1 - \log(t_{1/2})_2 = (n-1) [\log a_2 - \log a_1]$$

$$\text{or, } n = 1 + \frac{\log(t_{1/2})_1 - \log(t_{1/2})_2}{\log a_2 - \log a_1}$$

Thus ~~for~~ knowing the $t_{1/2}$ for two initial concentrations a_1, a_2 , order of reaction can be calculated.

(3) Integration method:- In this

method the value of initial concentration, concentration at time t and time t' value is substituted in integral equation of ~~first~~ order of reaction.

The equation which give constant value of k with different value of concentration and time, is the order of reaction.

It is also called half and initial method.

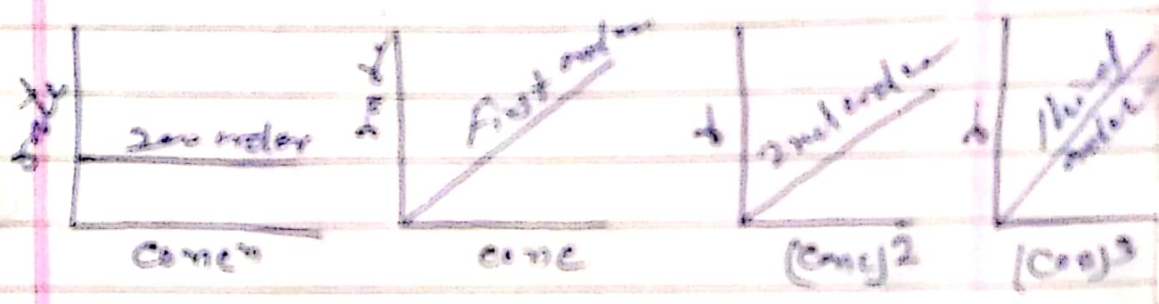
~~Example~~ - If k is constant

4. Graphical method:- In this

~~method the rate of reaction at given time and concentration is experimentally calculated.~~

In this method concentration verses time is plotted in the graph and rate of reaction is calculated. After that order of reaction is determined by graph given below.

(a) plots of rate of reaction vs concentration.



(b) Plots of concentration versus time on basis of integral rate laws.

