Zero - order reaction :→ Integrated rate equation of zero order :→

In zero order reaction the rate of reaction do not depend on the concentration of reacting species as per time.

$$A \longrightarrow B$$

Initial Conc^n (t=0) A_0 0

By rate law

$$-\frac{d[A]}{dt} \propto [A]^n$$

Here $n = 0$,

So $\frac{d[A]}{dt} = K [A]^0$.

or $-\frac{d[A]}{dt} = K$ —— ①

or $-d[A] = K\,dt$ —— ②

Means the rate of reaction is independent from concentration of reacting species.

Integrate both side to equation II we have

$$\int d[A] = K \int dt$$

$$-[A] = Kt + C \quad \text{—— I}$$

Where C is constant called integration constant.

When $t = 0$, $[A] = [A_0]$

Hence

$$-[A] = K \times 0 + C$$

$$-[A_0] = C \quad \text{—— II}$$

Now we put the value of 'C' from equation II to I we have:

$$-[A] = Kt - [A_0]$$

$$\boxed{K = \frac{[A_0] - [A]}{t}}$$

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Determination of order of reaction:→

Order of reaction is an experimental evidence. or we calculate order of reaction only by experiments we can find out the order of reaction by following five methods:-

i. Initial rate method
ii. Integrated rate equation
iii. Graphical method.
iv. Half life method. &
v. Ostwald isolation method.

1. Initial method:→

When the no. of reactants are two or more than two, & their initial concentration are determined with their rate then by the help of these two we can find out the order of reaction. For this one concentration of both reactants are ~~kept~~ constant written with rate i.e rate equation.

$$aA + bB \longrightarrow Pd.$$

$$r_0 \propto [A]^a [B]^b.$$

$$\text{or} \quad r_0 = K \cdot [A]^a [B]^b,$$

In this ~~the~~ way ~~at~~ by given rate data we will write it as equations. Now we will select any two data in such a way by which one reactants concentration must be same whereas as others will change, by deviding both the equation we can find out the order of reaction.

If two rate equations are given with their initial concentrations then we will write the equation and by dividing them we can find order of reaction.

For example

Q For reaction $A + B \longrightarrow$ Products the rate is given below as function of ~~different~~ different initial concentrations of A & B, with rate. Determine order of reaction for A & B.

[A] moles/lit.	[B] moles/lit	Rate in moles/lit/min.
0.01	0.01	0.005
0.02	0.01	0.01
0.01	0.02	0.005

Ans Solution:

$$r_1 = K[A]^a [B]^b \quad \text{——— (I)}$$

Where a and b are order of reaction w.r.t to A & B

By data: we set eqn as per above equation we have

$$0.005 = K.[0.01]^a [0.01]^b \quad \text{——— I}$$
$$0.01 = K.[0.02]^a [0.01]^b \quad \text{——— II}$$
$$0.005 = K.[0.01]^a [0.02]^b \quad \text{——— III}$$

By eqn I/III we have:

$$\frac{0.005}{0.005} = \frac{K.[0.01]^a [0.01]^b}{K.[0.01]^a [0.02]^b}$$

$$1 = \left(\frac{1}{2}\right)^b$$

$$b = 0.$$

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Hence order with respect to B is zero.

Now we devide eqn I/II we have

$$\frac{0.005}{0.01} = \frac{k\cdot[0.01]^a\,\cancel{[0.01]^b}}{k\cdot[0.02]\,\cancel{[0.01]^b}}$$

$$\frac{5}{10}\,\frac{1}{2} = \left(\frac{1}{2}\right)^a$$

$$\frac{1}{2} = \left(\frac{1}{2}\right)^a$$

$$a = 1.$$

Hence order with respect to A is one.

So rate eqn : $\boxed{r = k\cdot[A]^1[B]^0}$

Total order of reaction = 1+0 = 1.

General equation is

$$\frac{r_1}{r_2} = \left(\frac{c_1}{c_2}\right)^n$$

n = order of reaction.

Q. The rate of reaction with initial concentration 2×10^{-3}M and 1×10^{-3}M are equal to $2.40\times10^{-4}\,Ms^{-1}$ and $0.60\times10^{-4}\,Ms^{-1}$ respectively. Cal. the order of reaction with respect to reactants at the rate Cott.

Soln

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

$$\frac{2.40\times10^{-4}}{0.60\times10^{-4}} = \left(\frac{2\times10^{-3}}{1\times10^{-3}}\right)^n$$

$$4 = (2)^n \quad , \quad n = 2.$$

Hence the order of reaction is two.

$$r = k \cdot (c)^n$$

$$2.40 \times 10^{-4} = k \cdot (2 \times 10^{-3})^2$$

$$k = 0.6 \times 10^{2} \, M s^{-1}$$