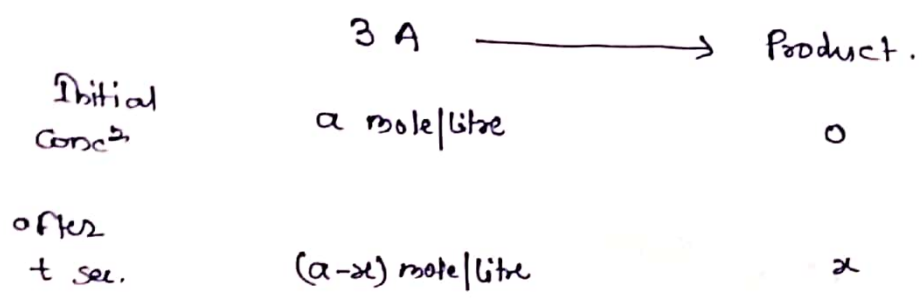


* Expression of rate constant for 3rd order Reaction:-



It is a 3rd order reaction.

$\therefore \frac{dx}{dt} \propto [A]^3$

$\approx \frac{dx}{dt} = k (a-x)^3$

Where k = rate constant of 3rd order reaction.

On rearranging and integrating —

$$\int \frac{dx}{(a-x)^3} = k \int dt$$

$\approx \frac{1}{(a-x)^2} = kt + I$ ————— ①

Where, I = Integration Constant.

When $t=0$ $x=0$

\therefore Eqⁿ —① becomes —

$$I = \frac{1}{a^2}$$

putting the value of I in Eqⁿ —① we get —

$$\frac{1}{(a-x)^2} = kt + \frac{1}{a^2}$$

$$kt = \frac{1}{(a-x)^2} - \frac{1}{a^2}$$

$$\approx kt = \frac{a^2 - a^2 - x^2 + 2ax}{(a-x)^2 a^2}$$

$$\approx kt = \frac{(2a-x)x}{2a^2 (a-x)^2}$$

$$\approx k = \frac{1}{t} \times \frac{(2a-x)x}{2a^2 (a-x)^2} \quad \text{--- (2)}$$

E_1^3 - (2) is the expression of rate constant for 3rd order reaction.

characteristics of 3rd order reaction -

① Half life time ($t_{1/2}$) -

from 3rd order kinetics -

$$k = \frac{1}{t} \times \frac{(2a-x)x}{2a^2 (a-x)^2}$$

When $t = t_{1/2}$, $x = a/2$

$$k = \frac{1}{t_{1/2}} \times \frac{(2a - a/2)^{a/2}}{2a^2 (a - a/2)^2}$$

$$t_{1/2} = \frac{1}{k} \times \frac{3^{3/2} \times a^{3/2}}{2a^2 \times \left(\frac{a}{2}\right)^2}$$

$$\therefore t_{1/2} = \frac{1}{k} \frac{3}{2a^2}$$

$$\therefore t_{1/2} \propto \frac{1}{a^2}$$

Thus, half life period of 3rd order reaction is inversely proportional to the square of the initial concentration.

② Unit of 3rd order reaction -

$$k = \frac{1}{t} \times \frac{(2a-x)x}{2a^2(a-x)^2}$$

$$k = \frac{1}{\text{sec}} \times \frac{\text{Conc}^2 \times \text{Conc}^2}{(\text{Conc}^2)^2 \times (\text{Conc}^2)^2}$$

$$k = \frac{1}{\text{sec}} \times \frac{1}{(\text{mol/L})^2}$$

$$k = \text{mol}^{-2} \text{ liter}^2 \text{ sec}^{-1}$$

③ Examples of 3rd order reaction -

(i) Reduction of Ferric chloride to Stannous chloride -



② Oxidation of nitric oxide



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From
Dr. A. R. Gupta.
chemistry.