SUBJECT - CHEMISTRY
CLASS - BSc (Hons) PART - I
PAPER - II
GROUP - A
TOPIC - 2nd order reaction
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2nd order reaction: The reaction in which is rate is determined by the variation of two Concentration terms is called 2nd order reaction. There are two cases of 2nd order reactions:

Case I: when initial Concentrations of reactants are the Same

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

Initial Concentrations: a a

Concentrations after time t: $a-x$ $a-x$

Since x moles have been reacted, then rate

$$\frac{dx}{dt} \propto (a-x)(a-x)$$

$$\frac{dx}{dt} = K(a-x)(a-x) \quad \text{or} \quad \frac{dx}{(a-x)^2} = Kdt$$

Let $z = a-x$ $\therefore dz = -dx$

$$\therefore \int \frac{dx}{(a-x)^2} = -\int \frac{dz}{z^2} = \int z^{-2} dz = \frac{z^{-2+1}}{-2+1} = z^{-1} = \frac{1}{z} = \frac{1}{a-x}$$

$$\therefore \frac{1}{a-x} = Kt + I$$

when $t=0$ $x=0$ then $I = \frac{1}{a}$.

putting the value of I in above equation, we get.

$$\frac{1}{a-x} - \frac{1}{a} = kt$$

or Rate Constant, $k = \frac{1}{t} \cdot \frac{x}{a(a-x)}$

$\therefore$ unit of $k = \frac{1}{sec} \cdot \frac{mole/litre}{mole/litre \times mole/litre} = litre\ mole^{-1} sec^{-1}$

Case II when initial concentrations of reactants are different or.

$$A + B \longrightarrow products$$

Initial Concentrations a b

Concentrations after time t: $a-x$ $b-x$

Therefore rate, $\frac{dx}{dt} = k(a-x)(b-x)$: or $\frac{dx}{(a-x)(b-x)} = kdt$

On integration $\frac{-\ln(a-x) - \ln(b-x)}{a-b} = kt + I$

when $t = 0$, $x = 0$ then $I = -\ln \frac{a}{b(a-b)}$

Therefore the above equation

$$\frac{-\ln(a-x) - \ln(b-x)}{a-b} = kt - \ln \frac{a}{b(a-b)}$$

or $\frac{2.303}{a-b} \log \frac{b(a-x)}{a(b-x)} = kt$

or Rate Constant, $k = \frac{2.303}{t(a-b)} \log \frac{b(a-x)}{a(b-x)}$