Q1. Determine order & molecularity of Hydrolysis of ester in Basic medium.

$$CH_3-\underset{\underset{O}{\parallel}}{C}-OC_2H_5 + H-OH \xrightarrow{OH^-} CH_3COOH + C_2H_5OH$$

Ans: Order = Molecularity = 2.

Study of Different order of reaction | Integrated Rate law:

(A) Zero order Reaction:

Reactions in which rate of reaction remain's independent, of initial Concentration of reactant's are said to be Zero order Reaction.

Zero order Reactions are relatively uncommon, But they occur under special Conditions. Some enzyme Catalysed reaction and reactions which occur in metal surface.

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Are few examples of Zero-order reactions.

ex:- (i) $H_{2(g)} + Cl_{2(g)} \xrightarrow{h\nu} 2HCl_{(g)}$

(ii) $2NH_{3(g)} \xrightarrow{Pt} N_{2(g)} + 3H_{2(g)}$

(iii) reaction B/w Acetone & Bromine.

(iv) Dissociation of HI on gold Surface.

(v) Adsorption of gases on metal Surface.

Differential rate equation:-

$$A \longrightarrow P$$

$t=0$ $\quad a$ mol $\quad$ –

$t=t$ $\quad (a-x)$ mol $\quad x$ mol.

rate law:- $\quad r = k[A]^0$ — (1)

r.o.r. $= -\frac{d}{dt}[A]$ — (2)

From eq. (1) & (2) –

$$\boxed{-\frac{d}{dt}[A] = k[A]^0} \Rightarrow \text{Differential rate equation}$$

OR

$$-\frac{d}{dt}(a - x - a) = k[A]^0$$

$$-\frac{d}{dt}(-x) = k[A]^0$$

$$\boxed{\frac{dx}{dt} = k[A]^0} \Rightarrow \text{Differential rate equation.}$$

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Calculation of rate Constant:

From Differential rate equation -

$$-\frac{d[A]}{dt} = k[A]^0$$

$$-\frac{d[A]}{dt} = k$$

$$-d[A] = k\,dt$$

Take $\int$ Both Side :

$$\int -d[A] = \int k \cdot dt$$

$$-\int 1 \cdot d[A] = k\int 1 \cdot dt$$

$$-[A]_t = k \cdot t + c \quad \text{--- (1)}$$

at $t = 0$; $[A]_t = [A]_0 = a$

Put in eq. (1)

$$-[A]_0 = k \cdot 0 + c \Rightarrow \boxed{c = -[A]_0}$$

Put value of c in eq. (1)

$$-[A]_t = kt - [A]_0$$

$$\boxed{kt = [A]_0 - [A]_t}$$ ***

Here: $[A]_0 \rightarrow$ initial Conc.

$[A]_t \rightarrow$ Conc. at time t

$t \rightarrow$ time, $k \rightarrow$ zero order rate constant.

In eq – ② put –

$[A] = a, [A]_t = a - x$

$kt = a - (a - x)$

$kt = a - a + x \Rightarrow \boxed{x = kt}$ ***

Here → x is dissociated conc. at time t.

ex:– t = 0, 20 mol/ltr | $a = [A]_0 = 20$

t = 10 min 15 mol/ltr | $a - x = [A]_t = 15$

$x = 5$

Half life of Zero order reaction

The time in which Half of the initial amount is consumed.

$t \rightarrow t_{1/2}, \; x = a/2; \; [A]_t = \frac{a}{2}$

Put value of x & t in $x = kt$

$\frac{a}{2} = k \cdot t_{1/2} \Rightarrow \boxed{t_{1/2} = \frac{a}{2k}}$

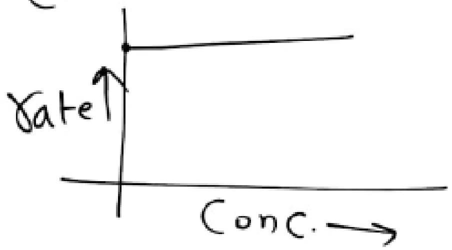
OR $\boxed{t_{1/2} = \frac{[A]_0}{2k}}$

$t_{1/2} \propto [A]_0$.

Graph :

① Rate V/s Con. (initial conc.)

$r = k[A]^0$



(2) $[A]_t$ V/s t

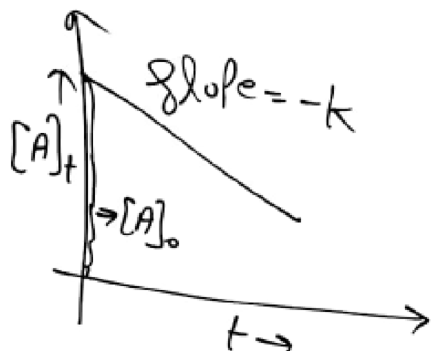
$kt = [A]_0 - [A]_t$

$[A]_t = -kt + [A]_0$

Compare

$y = -mx + c$

intercept at y-axis

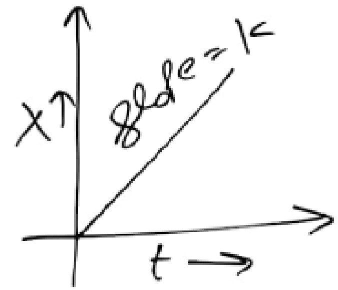


(3) x V/s t

$x = kt$ — ①

Compare

$y = mx$



(4) $t_{1/2}$ V/s $[A]_0$ ($t_{1/2}$ V/s a)

$t_{1/2} = \frac{1}{2k} \cdot [A]_0$

$y = mx$