Half life of 1st order reaction :- $(t_{1/2})$

It is the time during which the the concentration of reacting specie becomes half. It is indicated by $t_{1/2}$.

$$K = \frac{2.303}{t} \log_{10} \frac{a}{(a-x)}$$

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

then $$K = \frac{2.303}{t_{1/2}} \log_{10} \frac{a}{a - \frac{a}{2}}$$

or $$K = \frac{2.303}{t_{1/2}} \log 2$$

or $$K = \frac{2.303 \times 0.3010}{t_{1/2}}$$

or $$\boxed{t_{1/2} = \frac{0.693}{K}}$$

By the above expression it is clear that the ~~~~ half life of 1st order reaction is independent from initial concentration 'a'.

$t_{1/2}$

$[A_0]$

Teacher's Signature : _____

Half life of 2nd order reaction: →

When initial Concentration of reacting Specis A & B are same then

$$k = \frac{1}{t} \cdot \frac{x}{a(a-x)}$$

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

When $t = t_{1/2}$ $a - x = a - \frac{a}{2}$ $(\because x = \frac{a}{2})$

Hence, $t_{1/2} = \frac{1}{k} \cdot \frac{a/2}{a \cdot a/2}$

$$\boxed{t_{1/2} = \frac{1}{ka}}$$

or $$\boxed{t_{1/2} \propto \frac{1}{a}}$$

Hence $t_{1/2}$ depend on rate Constant & initial Concentration. but $t_{1/2}$ is inversely proportional to initial Concentration of reacting Specis.

Half life of zero order reaction:

$$k = \frac{1}{t}(A_0 - A) \text{ or } \frac{[A_0] - [A]}{t}$$

When $t = t_{1/2}$ then $A = \frac{A_0}{2}$

$$\boxed{t_{1/2} = \frac{A_0}{2k}}$$

Kinetics of decomposition of H_2O_2 :→

Hydrogen peroxide decomposes very fast and convert into H_2O & O_2.

$$H_2O_2 \longrightarrow H_2O + \frac{1}{2}O_2$$

It's Kinetics can be studied in two ways

1) The volume of O_2 gas collected is noted at different intervals of time & the results will be calculated by decomposition of H_2O_2

Volume of O_2 gas collected at zero time '0' (V_0). Then $a \propto V_0$	Amount of H_2O_2 taken initially ~~decomposed~~ = a
Volume of O_2 gas collected at any time 't' (V_t) Hence $(a-x) \propto V_t$	Amount of H_2O_2 decomposed at time t $(a-x)$

If we set it on 1st order Kinetic equation

i.e $$K = \frac{2.303}{t} \log \frac{a}{a-x}$$

OR $$K = \frac{2.303}{t} \log \frac{V_0}{V_t}$$

II When H_2O_2 solution is titrated against $KMnO_4$ solution → At the interval of time usually 5 cc of H_2O_2 is taken and titrated it against $KMnO_4$ solution, and it is repeated.

Volume of $KMnO_4$ solution used before the starting of reaction (at zero time), then the initial volume is V_0

Initial concentration of H_2O_2 is 'a'

So $a \propto V_0$.

Volume of $KMnO_4$ solution used at any time i.e 't' then its volume is V_t

Volume of H_2O_2 present at that time a is '$(a-x)$'.

i.e $(a-x) \propto V_t$

If the above values are substituted to 1st order reaction we get

$$K = \frac{2.303}{t} \log \frac{V_0}{V_t}$$