Ans. (i) **Ist order reaction :**

If the rate of the reaction is varied by the variation of only one concentration term of the reactant then such type of reaction is called the Ist order reaction.

—Order of reaction is known by the adding of the powers of the concentration terms of the reactant. It is obivious that the sum of the powers of the concentrations of the reactant of the Ist order reaction is one.

—Let us suppose that '*A*' is a reactant which is converted into the product '*B*' i.e.

$$A \longrightarrow B$$

then, the rate, $r = \frac{dx}{dt} = -\frac{d[A]}{dt} = +\frac{d[B]}{dt} = K[A]$

Here, the power of $[A] = 1$

Thus, it is a Ist order reaction.

Example : (a) Decomposition of H_2O_2 :

It decomposes into the following two steps. Ist step is the slowest one whereas the 2nd step is the fast. Since the slowest step is the rate determining step, hence according to thirs Ist step, its order is determined, which follows the Ist order :

Step-I : $H_2O_2 \xrightarrow{slow} H_2O + O$

Step-II : $O + O \xrightarrow{fast} O_2$

(b) Decomposition of N_2O_5 :

This is an another example of Ist order reaction which also involves into the following two steps in which Ist step is slow whereas the 2nd step is fast. Since we know that the slowest step is the rate determining step and hence since the Ist step is the slowest one, thus it also follows the Ist order kinetics.

Step-I : $N_2O_5 \xrightarrow{slow} 2NO_2 + O_2$

Step-II : $O + O \xrightarrow{fast} O_2$ etc.

Ans. (ii) $\boxed{\textbf{Rate expression for the Ist order reaction :}}$

Let us suppose that following is the Ist order reaction—

$$A \longrightarrow \text{Product}$$

Rate, $r = \frac{dx}{dt} = -\frac{dC_A}{dt} \,\alpha\, C_A$ Where C_A = concentration of 'A'

or, $-\frac{dC_A}{dt} = kC_A$

or, $-\frac{dC_A}{C_A} = kdt$

After the ingegration of the both sides by Co to C in the L.H.S. and $t = 0$ to 't' in the R.H.S., we get—

$$-\int_{Co}^{C} \frac{dC_A}{C_A} = k\int_{o}^{t} dt$$

or, $-ln\frac{C}{C_o} = kt$

or, $-ln\frac{C_o}{C} = kt$

or, $K = \frac{1}{t} \ln \frac{C_o}{C}$

By converting '*ln*' into 'log'

or, $$\boxed{K = \frac{2.303}{t} \log \frac{C_o}{C}}$$

Where $\begin{cases} k = \text{rate constant} \\ C_o = \text{concentration of the reactant when the time } 't' = 0 \text{ and} \\ C = \text{concentration of the reactant after time } 't' \end{cases}$

Ans. (iii) Unit for the rate constant of the Ist order reaction :

Since, rate constant, $k = \frac{2.303}{t} \log \frac{C_o}{C}$

$$= 2.303 \times \frac{1}{time} \log \frac{\cancel{moles/litre}}{\cancel{moles/litre}}$$

$$= \frac{1}{time}$$

$$= time^{-1}$$

Thus, the unit of the rate constant, *k* of the Ist order reaction is $time^{-1}$. If we express time in second then its unit will be in sec^{-1} and similarly if we express time in minute, then the unit of the Ist order reaction will be in min^{-1}.

It is evident that 'C_o' and 'C' are the two concentration terms which are involved as a ratio in the above expression and are cancelled out by their own units respectively. Thus it is clear that the rate constant of the Ist order reaction is independent of the unit of the concentration terms of the reactant.

Ans. (iv) Half life period :

—It is denoted by '$t^1/_2$'

—It is a such type of time in which the concentration of the reactant becomes to half to its initial concentrations.

Expression of the half life period of the Ist order reaction—

Since, we know that—

$$k = \frac{2.303}{t} \log \frac{C_o}{C}$$

or, $$t = \frac{2.303}{k} \log \frac{C_o}{C} \quad \text{(i)}$$