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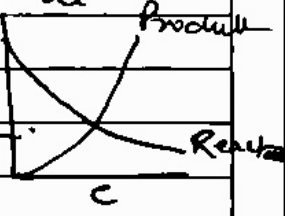
The branch of chemistry where we study about the rate of chemical reaction & mechanism of reaction is called Chemical Kinetics.

Rate of Chemical Reaction : (r) : The change in concentration of reactant or product with respect to time is called rate of Chemical reaction. During reaction the concentration of reactant decreases with respect to time, whereas the conc$^{n}$ of product increases with respect to time. It is of Two types :




1) Instantaneous rate ($r_i$)
11) Average rate. ($r_A$)

I Instantaneous rate : The change in concentration of a particular @ time is called rate of reaction. $r_i = \pm \frac{dx}{dt}$

+ve sign shows increase of concentration with respect to time (i.e for product) & -ve sign shows decrease of concentration with respect to time (i.e for reactant).

II Average rate of reaction : ($r_A$) :→ The total change in concentration with respect to total time taken is called average rate of reaction ($r_A$).

$$r_A = \pm \frac{\Delta x}{\Delta t}$$

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Molecularity :- → The total no. of moles of reacting species taking part in an elementary reaction is called Molecularity. Elementary reaction means these reaction which finishes in one step only is called elementary reaction & if the no. of steps in chemical reaction is more than one to complete it then the reaction is complex reaction. It is very clear as mentioned above the molecularity is only for elementary reaction not for complex.

. Generally it can not be more than three.
. It is a theoretical approach means it do not depends on experimental evidence.
. Molecularity can not not zero or -ve it is always a natural number.

i.e $2HI \xrightarrow{\Delta} H_2 + I_2$

molecularity = 1

$H_2 + Cl_2 \xrightarrow{h\nu} 2HCl$.

molecularity = 2

If the reaction finishes in more than one step then each step do not have the same rate of reaction, here we study about the mechanism of the reaction, and the slowest step (having slow rate) is the rate determining step.

i.e $2N_2O_5 \longrightarrow 4NO_2 + O_2$

According to rate law $r = k[N_2O_5]$

It is a Complex reaction and it take place in two steps:

$$N_2O_5 \xrightarrow{\text{slow}} NO_2 + NO_3$$

$$N_2O_5 + NO_3 \xrightarrow{\text{fast}} 3NO_2 + O_2$$

In the first step molecularity is one but in second step the molecularity is two, but the first step is slow so it is rate determing step and the molecularity in this step is the molecularity of the reaction, So overall the Molecularity of the reaction is one.

Order of reaction :→ During reaction whole the concentration of the reacting species may or may not change with respect to time experimently, these concentration of reactant which changes with respect to time experimently is written as the power of reating species, the sum of

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this power is called order of reaction. Or these concentrations of reacting species which are responsible to show the rate of reaction are written as the power of reacting species, and the sum of these power is called order of reaction.

- Order of reaction is always experimental evidence it can not be theoretical approach.
- Order of reaction can be zero or -ve or natural no. any one is possible.
- In natural no. also order of reaction practically can not be more than four.

for example:

$$NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$$

1st order reaction

$$PCl_5 \xrightarrow{\Delta} PCl_3 + Cl_2$$

1st order reaction.

$$H_2O_2 \xrightarrow{\Delta} H_2O + \frac{1}{2}O_2$$

1st order reaction.

Some times there are two reacting species but one is in excess so do not show change in Concentration, so the molecularity of the reaction becomes two but the order of reaction is one they are called Pseudounimolecular first order reaction.

$CH_3COOC_2H_5 + H_2O \longrightarrow CH_3COOH + C_2H_5OH$
(Excess)

Order of reaction is one.

$C_{12}H_{22}O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$.
(Excess) (Glu) (Fru).

order of reaction is one

These above reaction have molecularity two but order of reaction is one so they are Pseudounimolecular first order reaction.

Examples of zero order reaction—

$H_2(g) + Cl_2(g) \overset{hv}{\rightleftharpoons} 2HCl(g)$

$N_2O \xrightarrow[\Delta]{Pt} N_2 + \frac{1}{2}O_2$

$2NH_3 \xrightarrow{Mo} N_2 + 3H_2$

$CH_3COCH_3 + I_2 \xrightarrow{H^+} ICH_2 \cdot COCH_3 + HI$.

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Examples of second order reaction:-

$CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$ (Saponification)

$2NO_2 \xrightarrow{\Delta} 2NO + O_2$

$2O_3 \xrightarrow{U.V} 3O_2$

$2Cl_2O \xrightarrow{\Delta} 2Cl_2 + O_2$

Examples of third order reaction

$2NO + Cl_2 \longrightarrow 2NOCl$

$2FeCl_3 + SnCl_2 \longrightarrow SnCl_4 + 2FeCl_2$

$2NO + O_2 \longrightarrow 2NO_2$

Example of 0th order reaction:-

$4KClO_3 \xrightarrow{\Delta} 3KClO_4 + KCl.$

Difference between Molecularity & order of reaction:-

| Molecularity | order of reaction (sum of) |
|---|---|
| i. It is total no. of moles of reacting species in an elementary reaction. | It is the change in each of reacting species of reactant |
| ii. It is a theoretical approach. | It is experimental evidence. |
| iii. It is always a whole no. except zero & fractional or -ve. | It can be whole no. or fractional or -ve also. |
| iv. It can not be more than 3 generally. | It can not be more than four. |