Chemistry Study Materials for Class 12
(NCERT Based Key Points of Chapter -04)
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CHEMICAL KINETICS

Key Points

Rate of reaction:- For a reaction R → P,

Rate of reaction = change of conc. of R or P / time interval

$$= \frac{-\Delta[R]}{\Delta t} = \frac{\Delta[P]}{\Delta t}$$

Unit of rate of reaction:- 1. mol $L^{-1}s^{-1}$ 2. atm s^{-1}

1. **Unifying rate of reaction**

For the reaction $2HI \rightarrow H_2 + I_2$

$$\text{Rate of reaction} = -\frac{1}{2}\frac{\Delta[HI]}{\Delta t} = \frac{\Delta[H_2]}{\Delta t} = \frac{\Delta[I_2]}{\Delta t}$$

Similarly, for the reaction

$5\,Br^-(aq) + BrO_3^-(aq) + 6\,H^+(aq) \rightarrow 3\,Br_2(aq) + 3\,H_2O(l)$

$$\text{Rate} = -\frac{1}{5}\frac{\Delta[Br^-]}{\Delta t} = -\frac{\Delta[BrO_3^-]}{\Delta t} = -\frac{1}{6}\frac{\Delta[H^+]}{\Delta t} = \frac{1}{3}\frac{\Delta[Br_2]}{\Delta t} = \frac{1}{3}\frac{\Delta[H_2O]}{\Delta t}$$

3. **Differential rate law (Rate law)**

$aA + bB \rightarrow cC + dD$

$$\text{Rate} \propto [A]^x\,[B]^y$$

$$\text{Rate} = k\,[A]^x\,[B]^y$$

$$-\frac{d[R]}{dt} = k[A]^x[B]^y$$

This is differential rate equation.

Order of reaction:- For the reaction

$aA + bB \rightarrow cC + dD$ Rate = $K[A]^x[B]^y$

$x + y$ = order of reaction (where x & y may or may not be equal to stoichiometric coefficient)

Note:-

i. if $x + y = 1$, reaction is called **I order reaction**.

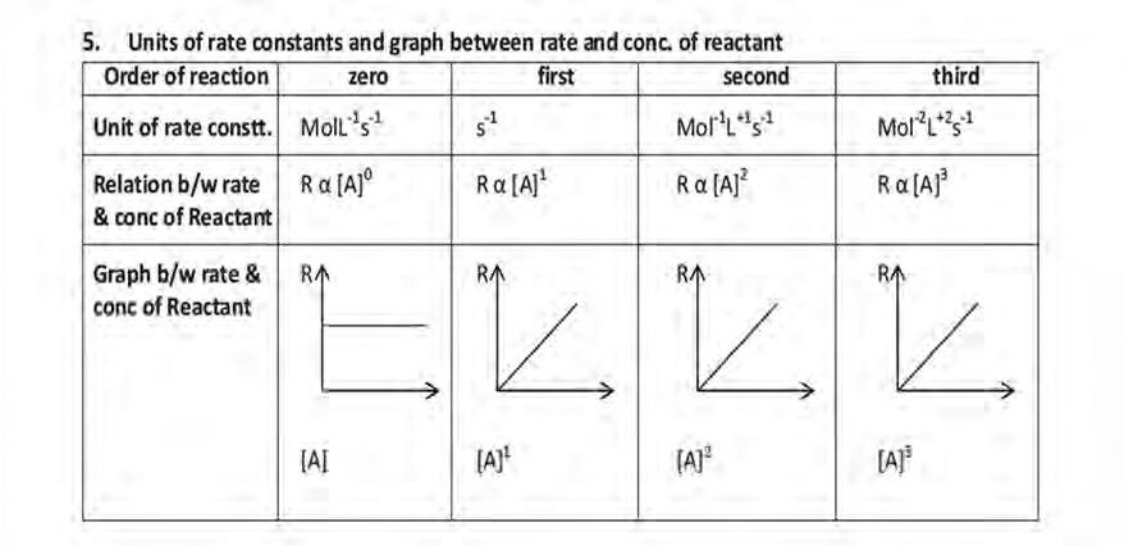
ii. if $x + y = 2$, reaction is called **II order reaction**.

iii. if $x + y = 3$, reaction is called **III order reaction**.

iv. if $x + y = 0$, reaction is called **zero order reaction**.

v. if $x + y$ = fraction , reaction is called **fractional order reaction**.

5. Units of rate constants and graph between rate and conc. of reactant



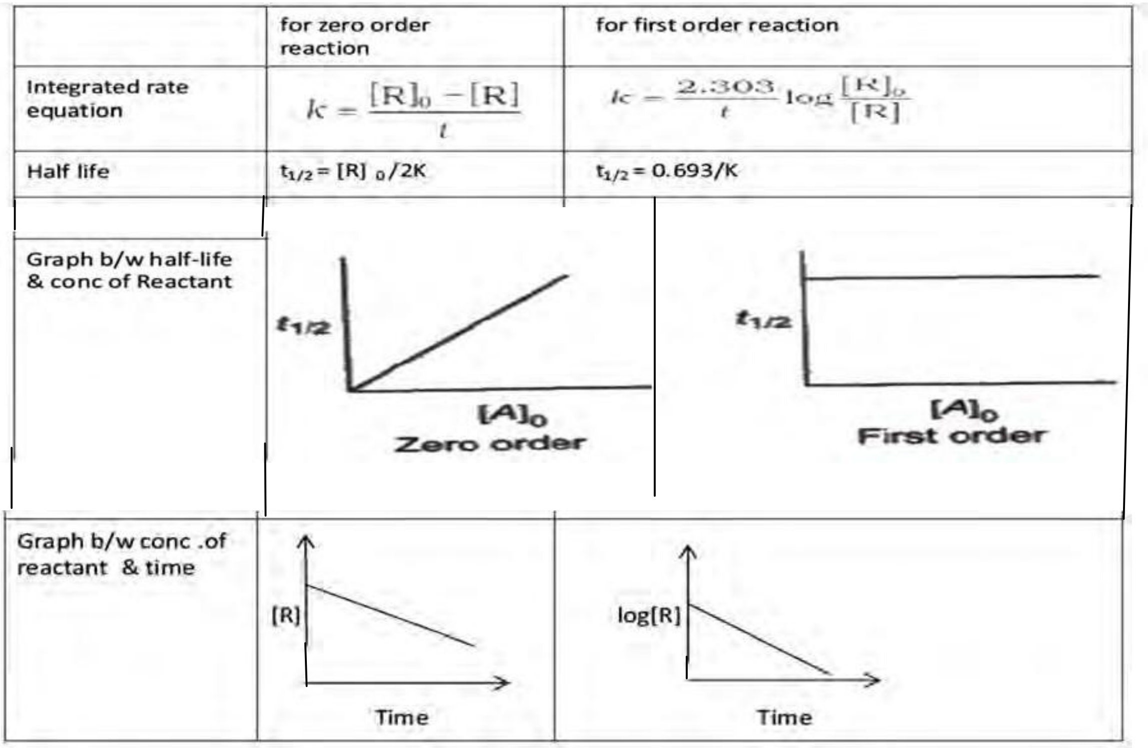
5. Units of rate constants and graph between rate and conc. of reactant

Order of reaction	zero	first	second	third
Unit of rate constt.	$MolL^{-1}s^{-1}$	s^{-1}	$Mol^{-1}L^{+1}s^{-1}$	$Mol^{-2}L^{+2}s^{-1}$
Relation b/w rate & conc of Reactant	R α $[A]^0$	R α $[A]^1$	R α $[A]^2$	R α $[A]^3$
Graph b/w rate & conc of Reactant	R [A]	R $[A]^1$	R $[A]^2$	R $[A]^3$

6. Integrated rate equation for zero order and first order reaction

Note: 1. For zero order reaction **$t_{1/2}$ α conc. of reactant.**

2. **For I order reaction $t_{1/2}$ is independent of conc. of reactant.**
3. **$t_{1/2}$ α $[conc]^{1-n}$** when n = order of reaction.



	for zero order reaction	for first order reaction
Integrated rate equation	$k = \frac{[R]_0 - [R]}{t}$	$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$
Half life	$t_{1/2} = [R]_0/2K$	$t_{1/2} = 0.693/K$
Graph b/w half-life & conc of Reactant	$t_{1/2}$ $[A]_0$ Zero order	$t_{1/2}$ $[A]_0$ First order
Graph b/w conc .of reactant & time	[R] Time	log[R] Time

7. Arrhenius equation

$$\log K = \log A - E_a/2.303RT$$

$$\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

IMPORTANT DEFINITIONS

1 Pseudo first order reaction:- A bimolecular reaction, in which one reactant is present in large excess and rate of reaction is independent of its concentration. Such a reaction is called pseudo first molecular reaction.

Eg. $CH_3COOC_2H_5 + H_2O \rightarrow CH_3COOH + C_2H_5OH$ molecularity of reaction is two and order of reaction is one.

2.Molecularity of reaction:-The number of reacting species (atoms, ions or molecules) taking part in an elementary reaction, which must collide simultaneously in order to bring about a chemical reaction is called molecularity of a reaction.

Types of reaction based on molecularity

Unimolecular reactions	**Bimolecular reactions**	**Tri molecular reactions**
molecularity of reaction = 1	molecularity of reaction = 2	molecularity of reaction = 3
$NH_4NO_2 \rightarrow N_2 + 2H_2O$	$2HI \rightarrow H_2 + I_2$	$2NO + O_2 \rightarrow 2NO_2$

NOTE:-

i. It is theoretical value.

ii. It cannot be zero or a non integer.

iii. molecularity greater than three is not observed.

iv. molecularity is applicable only for elementary reactions. For complex reaction molecularity has no meaning.

3.Order of reaction:- the power to which conc. term of a reactant is raised in rate law expression is called order w.r.to that reactant. The sum of powers of conc. of all reactants in rate law expression is called over all order of reaction. for the reaction a

$$A + b\,B \rightarrow c\,C + d\,D$$

Rate = $K[A]^x\ [B]^y$ $x+y$ = order of reaction.

NOTE:-

i. Order of a reaction is an experimental quantity

ii. It can be zero and even a fraction

iii. Order is applicable to elementary as well as complex reactions

4. **Elementary step:-** Many reactions complete in a number of steps. Each individual step of a reaction is called elementary step.

Eg.Thereaction$2O_3 \rightarrow 3O_2$complete

$O_3 \longrightarrow O_2 + O$ step1 fast reaction

$O + O_3 \longrightarrow 2O_2$ step2 slow reaction

Thus the reaction has two elementary steps.

NOTE:-

(i)In elementary step stoichiometric coefficient of balanced equation is order w.r.to that reactant.

(ii) The slowest step in a reaction is called the **rate determining step.**

5. **Activation energy:-** The additional energy which is required by the molecules of reactants to cause effective collision is called activation energy. It is denoted by E_a and is given as

Activation energy = threshold energy – average energy of molecules of reactants

6. **Threshold energy:-** The minimum energy which must be required by the molecules of reactants to cause effective collision is called threshold energy.

7. **Collision frequency:-** The number of collision of reactant molecules per unit volume of reaction mixture per second is called collision frequency.

8. Examples- Zero order reaction: $H_2 + Cl_2 \xrightarrow{\text{Sunlight}} 2HCl$

I order reaction: All natural and artificial radioactive reactions.

II order reaction: $H_2 + I_2 \rightarrow 2HI$.

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P.T.O.