2025 - 2026
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IIT JEE CHEMISTRY

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Chemistry Fastest Revision

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Joint Entrance Examination

(JEE 2025-26)

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UNIT - 1

Some Basic Concepts IN Chemistry

➡ $\text{Density} = \dfrac{\text{Mass}}{\text{Volume}}$

Note :- $1 \text{ amu} = 1.66056 \times 10^{-24} g$

➡ Temperature $K = {}^\circ C + 273$

Celsius to Fahrenheit, $^\circ F = \dfrac{9}{5}(^\circ C) + 32^\circ$

Fahrenheit to Celsius, $^\circ C = \dfrac{5}{9}[^\circ F - 32^\circ]$

➡ $\text{Velocity } (v) = \dfrac{\text{Distance } (d)}{\text{time } (t)}$

➡ $\text{Acceleration } (a) = \dfrac{\text{Velocity}}{\text{time}}$

➡ $\text{Force } (F) = \text{mass} \times \text{acceleration}$

➡ $\text{Pressure } (P) = \dfrac{\text{Force}}{\text{Area}}$

➡ $\text{Vapour density } \textbf{OR} \text{ Relative density} = \dfrac{\text{Molar mass}}{2}$

➡ $\text{Atomic mass} = \dfrac{\text{Mass of an atom}}{\frac{1}{12}\text{th mass of } {}^{12}C}$

➡ $\text{Molecular Mass} = \dfrac{\text{Mass of an molecule}}{\frac{1}{12}\text{th mass of } {}^{12}C}$

➡ $\text{Mass \% of an element} = \dfrac{\text{Mass of element in 1 mole of compound}}{\text{Molar mass}} \times 100$

➡ Relation between atomic mass, equivalent mass and valency.

$\text{Atomic mass} = \text{Equivalent mass} \times \text{valency}$

➡ Dulong or Petit's law $\text{Atomic mass} = \dfrac{6.4}{\text{specific heat}}$

➡ $\text{Atomic mass of an element} = \dfrac{\text{Mass of one atom of the element}}{1 \text{ amu}}$

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➡ Gram atomic mass or gram atom

$\text{Number of gram atoms} = \dfrac{\text{Mass of element in grams}}{\text{Atomic mass of element in grams}}$

- **Metal to metal displacement** $\boxed{\dfrac{m_1}{m_2} = \dfrac{E_1}{E_2}}$

- **Percentage composition of a compound (X)**

$$\text{Percentage of element} = \frac{\text{Mass of element}}{M} \times 100$$

- **Mass percentage**

$$\text{Mass percentage of A} = \frac{\text{Mass of A}}{\text{Mass of A} + \text{Mass of B}} \times 100$$

- **Volume percentage**

$$\text{Volume percentage of A} = \frac{\text{Volume of A}}{\text{Volume of A} + \text{Volume of B}} \times 100$$

- **Parts per million**

$$\text{ppm} = \frac{\text{Mass of component A}}{\text{Total mass of solution}} \times 10$$

- **Molarity of a solution**

$$\text{Molarity (M)} = \frac{\text{Moles of solute}}{\text{Volume of solution in litres}}$$

OR

$$\text{Molarity (M)} = \frac{\text{Moles of solute}}{\text{Volume of solution in (mL)}} \times 1000$$

- **Molality of a solution**

$$\text{Molality (m)} = \frac{\text{Moles of solute}}{\text{Volume of solvent in kg}}$$

OR

$$\text{Molality (m)} = \frac{\text{Moles of solute}}{\text{Volume of solvent in (g)}} \times 1000$$

- **Mole fraction**

$$\text{Mole fraction of solute } (x_A) = \frac{n_A}{n_A + n_B}$$

$$\text{Mole fraction of solvent } (x_B) = \frac{n_B}{n_A + n_B}$$

Note :- The sum of mole fraction of all the component in solution is always equal to 1. $\boxed{x_A + x_B = 1}$

- $$\text{Normality} = \frac{\text{No. of gram equivalents of solute}}{\text{Volume of solution in litres}}$$

- $$\text{Normality} = \frac{\text{No. of gram equivalents of solute}}{\text{Volume of solution in (mL)}} \times 1000$$

- $$\text{Gram equivalents of solute} = \frac{\text{Mass of solute}}{\text{Equivalent of mass}}$$

➡ Relationship between Normality and Molarity of solutions

➡ $$\text{Normality} = \text{Molarity} \times \frac{\text{Molar mass}}{\text{Equivalent of mass}}$$

For acids, $\boxed{\text{Normality} = \text{Molarity} \times \text{Basicity}}$

For bases, $\boxed{\text{Normality} = \text{Molarity} \times \text{Acidity}}$

➡ **Normality Equation** $\boxed{N_1 V_1 = N_2 V_2}$

➡ **Molarity Equation** $\boxed{M_1 V_1 = M_2 V_2}$

N_1 = initial normality
N_2 = Normality of new solution
V_1 = initial Volume
V_2 = Volume of new solution
M_1 = initial molarity
M_2 = molarity of new solution

📍 **Note** :- One moles of atoms = 6.022×10^{23} atoms = Gram atomic mass of the elements

➡ $$\text{Moles of an element} = \frac{\text{Mass of element}}{\text{Atomic mass}}$$

➡ $$\text{Mass of one atom} = \frac{\text{Atomic mass}}{6.022 \times 10^{23}}$$

📍 **Note** :- One moles of molecules = 6.022×10^{23} molecules = Gram molecular mass

➡ $$\text{Moles of a compound} = \frac{\text{Mass of compound}}{\text{Molar mass}}$$

➡ $$\text{Mass of one molecule} = \frac{\text{Molecular mass}}{6.022 \times 10^{23}}$$

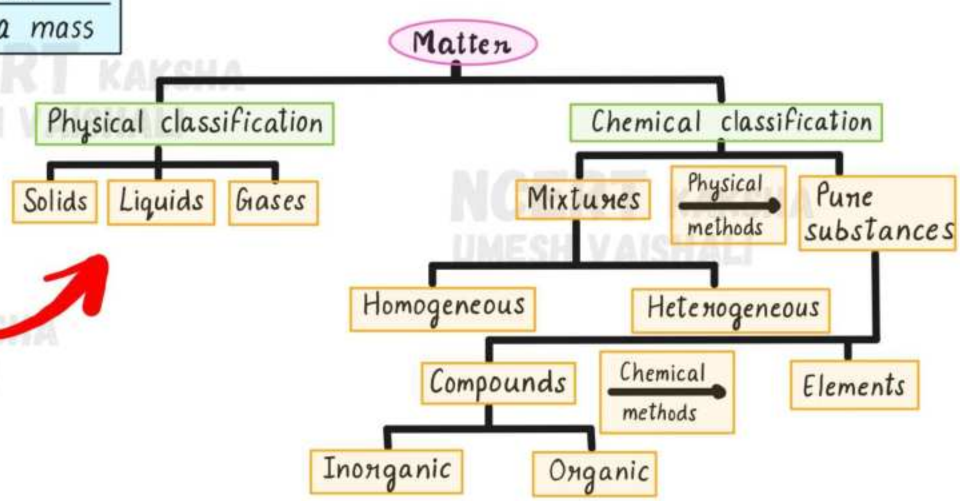
📍 **Note** :- Volume occupied by 1 mole of a gas at N.T.P. = 22.4 L

➡ $\boxed{\text{Molecular formula} = n\,(\text{Empirical formula})}$

and

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}}$$

IMPORTANT NOTE



UNIT - 2

States of Matter

- **No. of molecules of the gas** $n = \frac{m}{M}$

  n = no. of molecules of the gas
  m = mass
  M = molas mass

- **Pressure** $P = \frac{F}{A} = \frac{ma}{A}$

  P = Pressure
  F = Force
  A = Area
  a = acceleration

- **Temperature** $K = {}^\circ C + 273$

- **Relation between F and °C** $\frac{{}^\circ C}{5} = \frac{F^\circ - 32}{9}$

- **Boyle's law** $V \propto \frac{1}{P}$ (at constant Temperature and mass)

  or $V = \frac{1}{P}$

  or $PV = K = \text{constant}$ or $P_1 V_1 = P_2 V_2 = \text{constant}$

  K = constant
  V = volume
  P = Pressure

- **Charle's law** $V \propto T$ (at constant Pressure and mass)

  or $V = kT$

  or $\frac{V}{T} = k$ or $\frac{V_1}{T_1} = \frac{V_2}{T_2} = \text{constant}$

  T = absolute Temperature

- **Gay Lussac's law** $P \propto T$ (at constant volume and mass)

  or $P = kT$

  or $\frac{P}{T} = k = \text{constant}$ or $\frac{P_1}{T_1} = \frac{P_2}{T_2} = \text{constant}$

- **Avagadro's law** $V \propto n$ (at constant Temperature and Pressure)

  $V = kn$

  Avagadro's number = 6.023×10^{23}

  V = Volume
  n = number of molecules
  k = constant

- **Ideal Gas Equation** $PV = nRT$

  R = gas constant = $8.31\ J k^{-1}\ mol^{-1}$

- **Dalton's law of Partial Pressure** $P = P_1 + P_2 + P_3 + \ldots\ldots$ (at constant T and V)

- **Graham's law of diffusion** $r \propto \frac{1}{\sqrt{\alpha}}$ (at constant T and P)

  or $\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}}$ or $\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$

  r = rate of diffusion
  d = densitiy of gas

- $M = 2 \times d$ OR Molecular weight = 2 X Vapour density

- **Kinetic gas Equation** $PV = \frac{1}{3} mnu^2$

  u = root mean square velocity

- **Average Kinetic Energy of a molecule of a gas** $E_K = \frac{3}{2} kT$

  $k = \frac{R}{N}$ = Boltzmann's constant = $1.38 \times 10^{-23}\ JK^{-1}$

- **Compressibility Factor** $Z = \frac{PV}{nRT}$

  NOTE :- 1. Value of Z = 1 for ideal gas
  2. Value of Z > 1 and Z < 1 for real gas

- **Vanderwaal's Equation**

  - For n moles of a gas $\left[P + \frac{an^2}{V^2}\right](V - nb) = nRT$
  - For one moles of a gas $\left[P + \frac{a}{V^2}\right](V - b) = RT$

- **Maxwell's Distribution of velocities** $\boxed{\frac{dn_c}{n} = 4\pi\left[\frac{M}{2\pi RT}\right]^{1/2} c^2 e^{-Mc^2/2RT} dc}$

dn_c = number of molecules out of total number of molecules n, having velocities between c and $c+dc$
n = number of molecules
M = molecules weight
T = absolute Temperature

- **Most probable velocity** $\boxed{\alpha = \sqrt{\frac{2RT}{M}}}$
- **Average velocity** $\boxed{\bar{u} = \sqrt{\frac{8RT}{\pi m}}}$
- **Root mean square velocity** $\boxed{u = \sqrt{\frac{3RT}{M}}}$
- **Relation between $\bar{u}$, u and α** $\boxed{u : \bar{u} : \alpha = 1.00 : 0.921 : 0.816}$

u = Root mean square velocity
$\bar{u}$ = Average velocity
α = Most probable velocity

- **Viscocity** $\boxed{F = \eta A.\frac{dv}{dx}}$ η = Cofficient of viscocity
- $\boxed{\text{Fluidity} = \frac{1}{\eta}}$
- **Critical Temperature** $\boxed{T_c = \frac{8a}{27Rb}}$
- **Critical Pressure** $\boxed{P_c = \frac{a}{27b^2}}$
- **Critical compressibility factor** $\boxed{Z_c = \frac{P_c V_c}{RT_c} = 0.375}$
- **Critical volume** $\boxed{V_c = 3b}$
- **Boyle Temperature (T_B) and critical Temperature (T_c) in terms of vanderwaals constants**

$\boxed{T_B = \frac{a}{Rb}}$ $\boxed{T_c = \frac{8a}{27Rb}}$ $\boxed{T_B > T_c}$

- **Molar heat capacity = Specific Heat capacity x Molecular weight**

$\boxed{C_v = c_v \times M}$ $\boxed{C_p = c_p \times M}$

$\boxed{C_p - C_v = R = 8.314\,J}$ c_v, c_p = Specific heat capacities at constant volume and pressure

- **Ratio of molar capacities** $\boxed{\frac{C_p}{C_v} = \gamma}$
- **Value of C_v**

$\boxed{C_v = \frac{3}{2}R}$ (For monoatomic gas)
$\boxed{C_v = \frac{5}{2}R}$ (For diacomic gas)
$\boxed{C_v = 6R}$ (For triatomic gas)

- **Value of C_p**

$\boxed{C_p = \frac{5}{2}R}$ (For monoatomic gas)
$\boxed{C_p = \frac{7}{2}R}$ (For diacomic gas)
$\boxed{C_p = 8R}$ (For triatomic gas)

SOLID STATE

SOLIDS

Crystalline Solids
- Constituent particles have definite geometric arrangement
- long range order
- ➤ NaCl, Cu, Fe, S

Amorphous Solids
- Constituent particles do not have regular arrangement
- short range order
- ➤ glass, rubber, plastics

- Crystalline solids are anisotropic (different properties in different directions)
- Amorphous solids are isotropic (same properties in all directions)

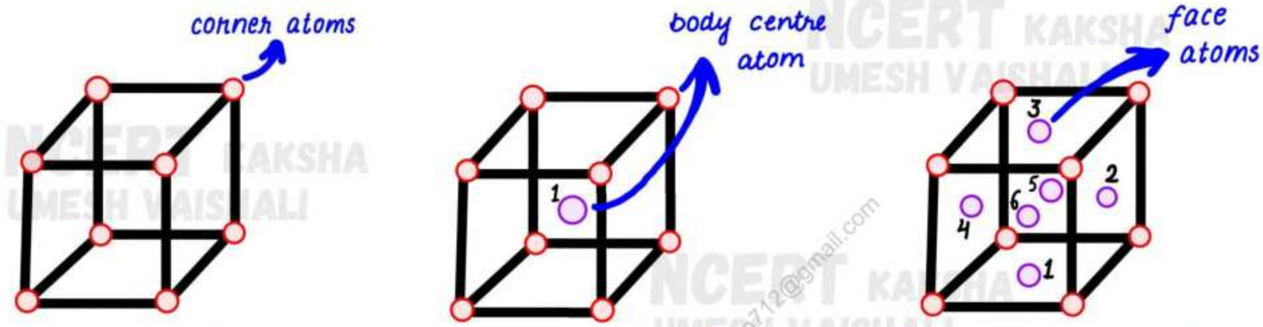
Crystalline Solids: MOLECULAR, IONIC, METALLIC, COVALENT OR NETWORK

MOLECULAR: Non polar, Polar, Hydrogen

➡ Seven Primitive Unit cells and their Possible Variations as Centered Unit Cells

Crystal System	Possible variations	edge lengths	Axial angles	Example
Cubic	Primitive, Body - centered Face - centered	$a = b = c$	$\alpha = \beta = \gamma = 90^\circ$	NaCl, Zinc blende, Cu
Tetragonal	Primitive Body - centered	$a = b \neq c$	$\alpha = \beta = \gamma = 90^\circ$	White tin, SnO_2, TiO_2, $CaSO_4$
Orthorhombic	Primitive, Body - centered Face - centered End - centered	$a \neq b \neq c$	$\alpha = \beta = \gamma = 90^\circ$	Rhombic Sulphur, KNO_3, $BaSO_4$
Hexagonal	Primitive	$a = b \neq c$	$\alpha = \beta = 90^\circ$ $\gamma = 120^\circ$	Graphite, ZnO, CdS
Rhombohedral OR Trigonal	Primitive	$a = b = c$	$\alpha = \beta = \gamma \neq 90^\circ$	Calcite $CaCO_3$ HgS cinnabar
Monoclinic	Primitive End - centered	$a \neq b \neq c$	$\alpha = \gamma = 90^\circ$ $\beta \neq 90^\circ$	Monoclinic Sulphur, $Na_2SO_4 . 10H_2O$
Triclinic	Primitive	$a \neq b \neq c$	$\alpha \neq \beta \neq \gamma \neq 90^\circ$	$K_2Cr_2O_7$, $CuSO_4.5H_2O$ H_3BO_3

Type of cell	no. of atoms at corners	no. of atoms in faces	no. of atoms in body	Total no. of atoms
Simple Cubic cell (scc)	$8 \times \frac{1}{8} = 1$	0	0	1
Body Centered Cubic (bcc)	$8 \times \frac{1}{8} = 1$	0	1	2
face centered Cubic (fcc)	$8 \times \frac{1}{8} = 1$	$6 \times \frac{1}{2} = 3$	0	4



Simple cubic {8 corner atoms}

Body-Centered Cubic {8 corner atoms, 1 body centre atom}

face-centered cubic {8 corner atoms, 6 face atoms}

Unit Cell	Distance between nearest neighbour (d)	Radius (r)	Edge length (a)	Coordination number	Packing Efficiency
scc	a	$\frac{a}{2}$	$2r$	6	52.4%
bcc	$\frac{a\sqrt{3}}{2}$	$\frac{\sqrt{3}a}{4}$	$4\sqrt{3}r$	8	68%
fcc	$\frac{a}{\sqrt{2}}$	$\frac{a}{2\sqrt{2}}$	$\sqrt{8}r$	12	74%

➡ density of Unit cell $\boxed{d = \frac{ZM}{a^3 N_a}}$

Z = no. of atoms in unit cell
m = mass
a = Edge length
M = Molar mass
N_a = Avagadro No.

➡ $\text{Packing Efficiency} = \frac{\text{Volume occupied by atoms in unit cell (v)}}{\text{Total Volume of the unit cell (V)}} \times 100$

➡ $\text{Radius Ratio} = \frac{\text{Radius of the cation}}{\text{Radius of the anion}} = \frac{r^+}{r^-}$

➡ **Mean free path (λ)** $\lambda = \frac{1}{\sqrt{2}\pi\sigma^2\left(\frac{N}{V}\right)}$

η = Cofficient of viscosity
ρ = Density of Liquid
r = radius of the tube
$\bar{v}$ = average velocity of the fluid

➡ **Reynold's number** $N_R = \frac{2r\bar{v}\rho}{\eta}$

➡ $$1 \text{ B.M.} = \frac{eh}{4\pi mc} = 9.27 \times 10^{-24}\ Am^2 \text{ OR } 9.27 \times 10^{-21} \text{ erg/gauss}$$

e = change on electron
h = planck's constant
m = mass of electron
c = velocity of light

➡ **Collision number** $N_c = \frac{\sqrt{2}\pi v_{av}\sigma^2 N}{V}$

v_{av} = Average veloeity of molecules
N = number of molecules
V = volume of molecules

➡ **Collision frequency (Z)** $Z = \frac{1}{\sqrt{2}}\pi v_{av}\sigma^2\left(\frac{N}{V}\right)^2$

Believe in yourself and ANYTHING is possible.

UNIT-3

Atomic Structure

➡ **Charge to mass ratio (e/m) of electrons**

$$\text{Charge/mass} = \frac{e}{m} = 1.76 \times 10^{11}\ c/kg$$

m_e = Mass of the electron in K

e = Magnitude of the charge on the electron

➡ $$\text{Mass of moving electron} = \frac{\text{rest mass of electron}}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$$

➡ **Mosley's Law** $\sqrt{v} = a(z-b)$

➡ $$\text{Average atomic weight} = \frac{\Sigma A_1 X_1}{\Sigma X \text{ Total}}$$

Particle	Mass (kg)	Relative mass (u)	Approximate mass (u)	charge	Relative charge
Electron (e)	9.10939×10^{-31}	5.4858×10^{-4}	0	-1.6022×10^{-19} C	-1
Proton (p)	1.67262×10^{-27}	1.00737	1	$+1.6022 \times 10^{-19}$ C	+1
Neutron (n)	1.67493×10^{-27}	1.00867	1	0	0

➡ Mass number → A

$^{A}_{Z}X$ ← Symbol of the element

Atomic number → Z

Atomic number (Z) = Number of protons (p) = Number of electrons (e)

Mass number (A) = Number of protons (p) = Number of neutrons (n)

Note :- One unit charge = 4.80298×10^{-10} esu or = 1.60210×10^{-19} Coulombs

One u = $\frac{1}{12}$th the mass of C-12 or = 1.66056×10^{-27} kg

➡ $\boxed{c = \lambda \times v}$ and $\boxed{v = c\bar{v}}$

λ = wavelength v = velocity   c = Speed of light

➡ $\boxed{\bar{v} = \frac{1}{\lambda}}$ $\bar{v}$ → wave number

➡ $\boxed{T = \frac{1}{\nu}}$ T → Time period

➡ **Energy of Photon** $\boxed{E = h\nu = \frac{hc}{\lambda} = hc\bar{\nu}}$

h = planck's constant = 6.626×10^{-34} J

ν = frequency of Light

➡ **Einstein equation for Photoelectric Effect** $\boxed{\frac{1}{2}mv^2 = h\nu - h\nu_0}$

ν_0 = threshold frequency

$h\nu_0$ → work function

- **De-Broglie Equation OR Matter waves** $\boxed{\lambda = \frac{h}{mv}}$ $\boxed{\lambda = \frac{h}{p}}$ p = momentum

- **Relationship between K.E. and λ of moving particle** $\boxed{\lambda = \frac{h}{\sqrt{2 \times K.E. \times m}}}$

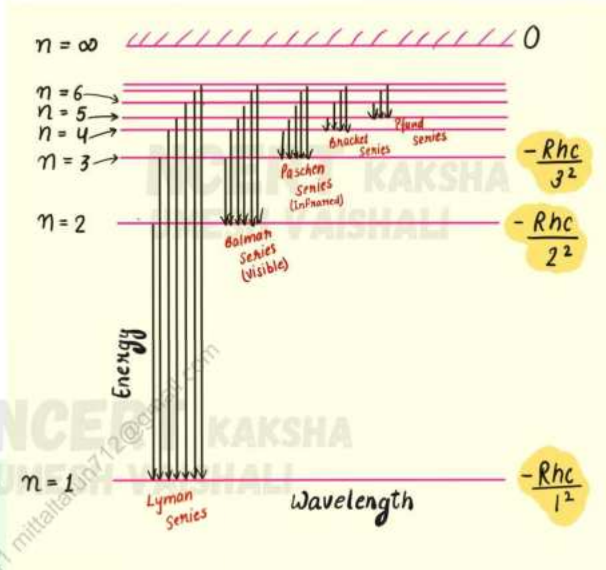
- **Heisenberg uncertainty principle** $\boxed{\Delta x \times \Delta p \geq \frac{h}{4\pi}}$; $\boxed{\Delta x \times \Delta v \geq \frac{h}{4\pi m}}$

  Δx = uncertainty in momentum   Δp = uncertainty in position

- **Rydberg Equation** $\boxed{\frac{1}{\lambda} = \bar{\nu} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]}$

Hydrogen like ions are those which contain only one electron, $\boxed{\frac{1}{\lambda} = \bar{\nu} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]z^2}$

R = Rydberg constant ($109677\ cm^{-1}$)
n_1, n_2 = integers, $n_2 > n_1$
z = nuclear charge or Atomic number



- **Spectral lines of H-atom**

Lyman	$n_1 = 1$	$n_2 = 2, 3, 4, 5 \Rightarrow$ ultraviolet
Balmer	$n_1 = 2$	$n_2 = 3, 4, 5, 6 \Rightarrow$ visible
Paschen	$n_1 = 3$	$n_2 = 4, 5, 6 \Rightarrow$ infrared
Brackett	$n_1 = 4$	$n_2 = 5, 6, 7 \Rightarrow$ infrared
Pfund	$n_1 = 5$	$n_2 = 6, 7, 8 \Rightarrow$ infrared

Note :-

Value of l	0	1	2	3	4	5 ...
Designation	s	p	d	f	g	h ...

n	1	2	3	4 ...
shell	K	L	M	N ....

Name	Symbol	Imfomation provided	Permitted values
Principal	n	shell	1, 2, 3, 4...
Azimuthal	l	subshell	0, 1, 2, 3...(n − 1)
Magnetic	m_l	orbital	$-l$ ... 0 ... $+l$
Spin	m_s	spin	+½ − ½

- **Bohr model**

• Angular momentum quantized $\boxed{mvr = \frac{nh}{2\pi}}$

- Energy of the electron in a particular orbit of hydrogen atom

$$\boxed{E_n = -R_H\left[\frac{1}{n^2}\right]} \quad \text{OR} \quad \boxed{E_n = \frac{-2\pi^2 me^4}{n^2 h^2}}$$

R_H = Rydberg constant = $\frac{2\pi^2 me^4}{h^2}$

$n = 1, 2, 3......$

- Bohr radius $\boxed{r_n = \frac{n^2 h^2}{4\pi^2 me^2 Z}}$ $\boxed{r_n = a_0 n^2}$ for hydrogen atom $Z = 1$, $a_0 = 52.9\ pm$

- Velocity of electron in any orbit $\boxed{v = \frac{2.19 \times 10^6 Z}{n}\ ms^{-1}}$

- $\boxed{\text{Number of revolution} = \frac{2\pi m v Z e^2}{n^2 h^2}}$

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➡ Schrodinger wave equation

$$\boxed{\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{8\pi^2 m}{h^2}[E-V]\psi = 0}$$

OR $\boxed{\hat{H}\psi = E\psi}$

Hamiltonian operator

➡ $\boxed{\text{Angular momentum} = \frac{h}{2\pi}\sqrt{l(l+1)}}$

➡ $\boxed{\text{Spin angular momentum} = \frac{h}{2\pi}\sqrt{S(S+1)}}$

➡ $\boxed{\text{Total spin} = \pm\left(\frac{1}{2} \times n\right)}$ where n = number of unpaired electrons

➡ $\boxed{\text{Magnetic moment of an atom} = \sqrt{n(n+2)}\ BM}$

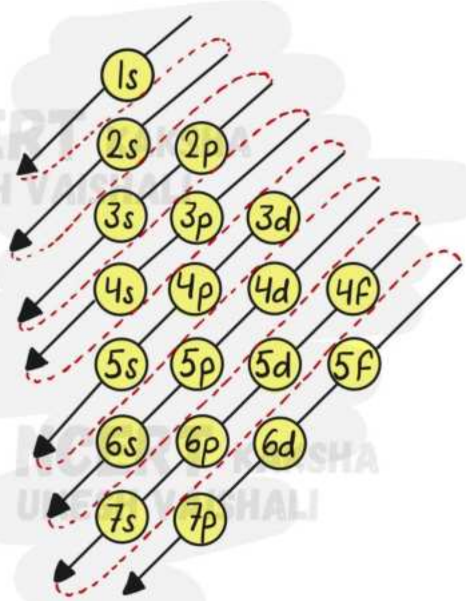
$$\left[\underset{\text{(Bohr Magneton)}}{BM} = \frac{eh}{4\pi mc}\right]$$

➡ $\boxed{\text{Volume of shell} = 4\pi r^2 dr}$

➡ $\boxed{\text{Total number of nodes} = n - l}$

➡ $\boxed{\text{nodal Planes OR angular nodes} = l}$

➡ $\boxed{\text{Radial nodes} = n - l - 1}$



📍 **Note** :- Sequence of energy levels

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, ud, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s

UNIT-4

Chemical Bonding and Molecular Structure

CHEMICAL BOND

Ionic Bond
Formed by transfer of electrons from one atom to other

- The ionisation enthalpy of atom forming the cation should be low.
- The electron gain enthalpy of atom forming the anion should be highly negative.
- Lattice enthalpy should be high.

Covalent Bond
Formed by sharing of electrons between atoms.

- Each atom may contribute one or more electrons for sharing
- Atoms attain stable noble gas configurations.

Coordinate Bond
Covalent bond in which both the electrons in the shared pair come from one atom.

- One of the atoms or group of atom is deficient of two electrons
- Other atom has stable noble gas configuration.

Lattice Enthalpy depends upon

- **Size of ions**. Smaller the size of ion, higher is lattice enthalpy
- **Charge on ions**. Greater the charge on ions, higher is lattice enthalpy

➤ $LiF > NaF > KF > RbF$; $AlCl_3 > BaCl_2 > NaCl$

- MOs are formed by the combination of atomic orbitals of same symmetry and of nearly same energy.
- If z-axis is internuclear axis, $2p_z$ orbitals combine to from σ MOs while $2p_x$ and $2p_y$ can combine to from π MOs.
- 2s orbital may combine with $2p_z$ orbital but it cannot combine with $2p_x$ or $2p_y$ orbitals.
- Larger the bond order of a molecule, greater will be its bond dissociation energy and smaller will be its bond length.

- **Formal charge on an atom in a lewis structure** $\boxed{FC = V - L - \frac{1}{2}S}$

Where, FC = Formal charge on an atom
V = Total number of valence electrons in the free atom
L = Total number of electrons present as non-bonding (lone pair)
S = Total number of bonding (shared) electron

- **Bond length** $\boxed{R = r_A + r_B}$ r_A, r_B = convalent radii

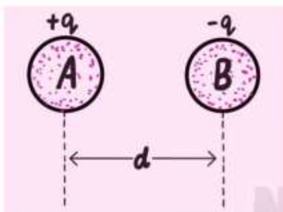
- $\boxed{\text{Resonance energy} = \text{Actual bond Energy} - \text{Energy of the most stable of resonating structures}}$

- $\boxed{\mu = q \times d}$

distance between the atoms

dipole moment

charge on any of the atoms



Note :- 1D = 1×10^{-18} esu cm

Debye

- $$\boxed{\%\ \text{ionic character} = \frac{\text{observed dipole moment}}{\text{Dipole moment for complete ionic character}} \times 100}$$

- **Addition of wave functions** (bonding molecular orbital) $\boxed{\Psi(MO) = \Psi_A + \Psi_B}$ $\boxed{\sigma = \Psi_A + \Psi_B}$

- **Subtraction of wave functions** (anti bonding molecular orbital) $\boxed{\Psi^*(MO) = \Psi_A - \Psi_B}$ $\boxed{\sigma^* = \Psi_A - \Psi_B}$

- $\boxed{\text{Bond order} = \frac{N_b - N_a}{2}}$

Where N_b = Number of electrons in bonding MO
Na = Number of electrons in anti-bonding MO

- **Hybridization** $\boxed{H = \frac{1}{2}\left[V + M - C + A\right]}$

H = number of orbitals involved in hybridization
V = number of electrons in valence shell of the central atom
M = number of monovalent atom
C = Charge on cation
A = Charge on anion

Note :- Bond order ∝ stability of molecule ∝ Dissociation energy ∝ $\frac{1}{\text{Bond length}}$

Note :- 1 Å = 10^{-10} m and 1 pm = 10^{-10} m

Angstrom

Picometers

LCAO = Linear combination of atomic orbitals

UNIT-5

Chemical Thermodynamics

System

Open system
- can exchange matter and energy with surroundings

Closed system
- can exchange energy and not matter with surroundings

Isolated system
- can neither exchange energy nor matter with surroundings

Properties of system

Intensive
- independent of amount of substance
- ▶ T, P, viscosity, specific heat capacity

Extensive
- depends upon amound of substance
- ▶ mass, volume, energy, enthalpy, entropy

Note :- PROCESSES

Constant temperature	⇒	Isothermal
Constant pressure	⇒	Isobaric
Constant volume	⇒	Isochoric
Constant heat	⇒	Adiabatic

Note :- Sign conventions for heat (q) and work (w)

Heat absorbed by the system	⇒	q (+)
Heat envolved by the system	⇒	q (−)
Work done on the system	⇒	ω (+)
Work done by the system	⇒	ω (−)

➡ For isothermal irreversible change $\boxed{q = -w = p_{ex}(V_f - V_i)}$

➡ For isothermal reversible change

$$\boxed{q = -\omega = nRT \ln \frac{V_f}{V_i} = 2.303\, nRT \log \frac{V_f}{V_i} = 2.303\, nRT \log \frac{P_i}{P_f}}$$

V_i = initial volume
V_f = final volume
P_i = initial pressure
P_f = final pressure

➡ Difference between internal Energies $\boxed{\Delta U = U_A - U_B}$ U_A, U_B = Internal Energies in states A and B

➡ Work $\boxed{W = F \times dl}$ dl = displacement of the point of the application in the direction which force acts.

➡ Law of conservation of Energy (First Law of Thermodynamics)

$\boxed{\Delta U = q + W}$ **OR** Change in internal energy = [Heat added to the system] + [Work done on the system]

➡ Enthalpy $H = U + pV$ U = internal energy V = Volume p = pressure

➡ Enthalpy change $\Delta H = H_B - H_A$ H_A = Enthalpy of state A, H_B = Enthalpy of state B

➡ Relation between ΔH and ΔU $\Delta H = \Delta U + \Delta n_g RT$ **OR** $p\Delta V = \Delta n_g RT$ change in the no. of gaseous moles

📍 **Note** :-

Exothermic reaction	Endothermic reaction
$H_P < H_R$	$H_P > H_R$
ΔU OR ΔH = − ve	ΔU OR ΔH = + ve

➡ Heat capacity $C = \frac{q}{\Delta T}$ q → heat, ΔT → temperature

➡ Molar heat capacity $C_m = \frac{C}{n}$

➡ Specific heat capacity **OR** Simply heat capacity $C_s = \frac{q}{m \times \Delta t}$

➡ Relationship between C_p and C_v $C_p - C_v = R$

➡ Standard Enthalpy $\Delta_r H^\circ = \sum_i a_i \Delta_f H^\circ(\text{products}) - \sum_i b_i \Delta_f H^\circ(\text{reactants})$

➡ Hess's Law $\Delta_r H = \Delta_r H_1 + \Delta_r H_2 + \Delta_r H_3 + \ldots\ldots$

➡ $\Delta_{sol} H^\circ = \Delta_{lattice} H^\circ + \Delta_{hyd} H^\circ$

$\Delta_{hyd} H^\circ$ = hydration enthalpy
$\Delta_{lattice} H^\circ$ = lattice enthalpy

➡ $\Delta_f H^\circ = \Delta_{sub} H^\circ + \Delta_i H^\circ + \frac{1}{2}\Delta_a H^\circ + \Delta_{eg} H^\circ + \Delta_{lattice} H^\circ$

$\Delta_a H^\circ$ = Enthalpy of atomization
$\Delta_{eg} H^\circ$ = Electron gain Enthalpy
$\Delta_i H^\circ$ = ionsiation Enthalpy

➡ Standard Enthalpy of fusion $\Delta_{fus} H^\circ = H^\circ_{liquid} - H^\circ_{solid}$

➡ Enthalpy of Sublimation $\Delta_{sub} H^\circ = \Delta_{fus} H^\circ + \Delta_{vap} H^\circ$ $\Delta_{vap} H^\circ$ = Enthalpy of vapourisation

➡ Bond Enthalpy $B.E. = \frac{1}{4}(\Delta_a H^\circ)$

➡ Entropy $\Delta S = S_{(\text{final state})} - S_{(\text{initial state})}$

➡ For reversible process, $\Delta S = \frac{q_{rev}}{T}$

➡ Total Entropy change $\Delta S_{total} = \Delta S_{sys} + \Delta S_{surr}$

➡ Entropy change during Phase transistion $\Delta_{trans} S = \frac{q_{rev}}{T}$

➡ Entropy of fusion $S^\circ_{water} - S^\circ_{ice} = \Delta_{fus} S^\circ = \frac{\Delta_{fus} H^\circ}{T_f}$ $\Delta_{fus} H^\circ$ = Enthalpy of fusion, T_f = fusion temperature

➡ Entropy of Vapourisation $\Delta_{vap} S^\circ = \frac{\Delta_{vap} H^\circ}{T_b}$ $\Delta_{vap} S^\circ$ = Standard Enthalpy of vapourisation, T_b = boiling point

➡ Entropy of Sublimation $\Delta_{sub} S^\circ = \frac{\Delta_{sub} H^\circ}{T}$ $\Delta_{sub} H^\circ$ = Enthalpy of sublimation

- Gibbs Energy OR Gibbs function $\boxed{G = H - TS}$

- Gibbs Energy change $\boxed{\Delta G = \Delta H - T\Delta S}$ $\boxed{\Delta G = -nFE}$

F = Faraday constant = 96500 C
E = e.m.f. of the cell
$\Delta_r G^\circ$ = Standard Gibbs Energy

- $\boxed{\Delta G = \Sigma \Delta_f G^\circ (\text{products}) - \Sigma \Delta_f G^\circ (\text{reactants})}$

- $\boxed{\Delta_r G = \Delta_r G^\circ + RT \ln Q}$ OR $\boxed{\Delta_r G^\circ = -2.303\, RT \log K}$

- Utility of Third Law of Thermodynamics $\boxed{S = \int_0^T \frac{C_P}{T} dT}$

- Standard Molar Entropy

$\boxed{\Delta_r S^\circ = \Sigma S^\circ (\text{products}) - \Sigma S^\circ (\text{reactants})}$

Note :- Conditions of ΔG

$\Delta G = -ve$	Spontaneous process
$\Delta G = 0$	Equilibrium state
$\Delta G = +ve$	Non-Spontaneous process

- Mechanical work = Force (F) X Displacement (d)

- Electrical work = Potential Difference (V) X charge (q)

- Gravitational work = mgh

your only limit is your Mind ❤

UNIT-6

Solutions

CONCENTRATION OF SOLUTIONS

amount of solute present in a given quantity of solution

Molality and mole fraction are independent of temperature

Molarity (M)

$$\frac{\text{Moles of solute}}{\text{vol of solution (mL)}} \times 1000$$

Molality (m)

$$\frac{\text{Moles of solute}}{\text{Wt. of solvent (g)}} \times 1000$$

Mole Fraction (x)

$$\frac{\text{Moles of solute}}{\text{Total moles of solution}}$$

Normality (N)

$$\frac{\text{Equiv. of solute}}{\text{vol of solution (mL)}} \times 1000$$

➡ Mass Percentage (w/w)

$$\text{Mass \% of the component} = \frac{\text{Mass of Solute}}{\text{Total Mass of the solution}} \times 100$$

(solute = component)

OR

$$\text{Percent by Mass} = \frac{\text{Mass of solute}}{\text{Mass of solute} + \text{Mass of solvent}} \times 100$$

$$\text{Mass fraction} = \frac{\text{Mass of solute}}{\text{Mass of solution}}$$

➡ Strength **OR** Concentration (Gram per litre)

$$\text{Concentration of solution} = \frac{\text{Mass of solute in grams}}{\text{Volume of the solution in litres}} \times 100$$

➡ Volume Percentage (V/V)

$$\text{Volume \% of the component} = \frac{\text{Volume of Solute}}{\text{Total Volume of the solution}} \times 100$$

➡ Mass by Volume percentage (W/V)

$$\text{Mass by Volume \%} = \frac{\text{Mass of Solute}}{\text{Volume of Solution}} \times 100$$

➡ Parts Per Million (ppm)

$$\text{ppm} = \frac{\text{Number of parts of the component}}{\text{Total no. of parts of all components of the solution}} \times 10^6$$

➡ Mole fraction

$$\text{Mole fraction of the component} = \frac{\text{no. of moles of the component}}{\text{Total no. of moles of all the component}}$$

➡ Mole fraction of the solvent in the solution $x_A = \dfrac{n_A}{n_A + n_B}$

➡ Mole fraction of the solute in the solution $x_B = \dfrac{n_B}{n_A + n_B}$

Note :- sum of the mole fraction of the component is unity $x_A + x_B = 1$

➡ $$\text{Molarity (M)} = \frac{\text{Moles of Solute}}{\text{Volume of Solution in litre}}$$
(Molar concentration)

➡ $$\text{Molality (m)} = \frac{\text{Moles of Solute}}{\text{Mass of Solvent (in kg)}} = \frac{\text{Number of mass of Solute}}{\text{Mass of Solvent (in grams)}} \times 1000$$

$$\text{Normality} = \frac{\text{Gram equivalents of solute}}{\text{Volume of solution in litre}} = \frac{W_B}{\text{GEM of solute} \times V\text{ (in mL)}}$$

$$\text{Gram equivalents of solute} = \frac{\text{Mass of solute}}{\text{Equivalent mass}}$$

➡ Henry's law $p = K_H x$

p = Partial Pressure
K_H = Henry's law constant
x = mole fraction of the gas

➡ Raoult's law $p_1 \propto x_1$ OR $p_1 = x_1 p_1^\circ$

➡ Raoult's law for volatile solute

$p_1 = p_1^\circ x_1$, $p_2 = p_2^\circ x_2$

p_1 = partial vapour pressure of 1
p_2 = partial vapour pressure of 2
p_1° = vapour pressure of pure 1
p_2° = vapour pressure of pure 2

➡ Total pressure $p = p_1 + p_2 = p_1^\circ x_1 + p_2^\circ x_2$

➡ Raoult's law for non-volatile solute

$$M_B = \frac{p_A^\circ}{p_A^\circ - p_A}\left(\frac{W_B \times W_A}{W_A}\right)$$

➡ Relative lowering of vapour pressure

$$\frac{p_1^\circ - p}{p_1^\circ} = \frac{W_2}{M_2} \times \frac{M_1}{W_1}$$

➡ Ideal Solution

1.) Raoults law is obeyed
2.) $\Delta_{mix} H = 0$
3.) $\Delta_{mix} V = 0$

➡ Non-Ideal Solution

1.) donot obey Raoult's law
2.) $\Delta_{mix} H \neq 0$
3.) $\Delta_{mix} V \neq 0$

➡ Elevation of boiling point (Ebullioscopy) $\Delta T_b = K_b m$

K_b = ebulliscopic constant

$$\Delta T_b = \frac{K_b \times W_2 \times 1000}{M_2 \times W_1}$$

➡ **Depression of freezing point (Cryoscopy)**

$$\Delta T_f = K_f m$$

K_f = cryoscopic constant

$$\Delta T_f = \frac{K_f \times W_2 \times 1000}{M_2 \times W_1}$$

➡ **Osmotic pressure (π)**

$$\pi = CRT$$

$$\pi = \frac{n_2}{V} RT$$

$$\pi = \frac{W_2 \times R \times T}{M_2 \times V}$$

W_1 = Mass of Solvent
W_2 = Mass of Solute
M_1 = Molar mass of solvent
M_2 = Molar mass of solute
C = Molarity
T = Temperature

➡ **Van't Hoff factor (i)**

$$i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$$

$$i = \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$

$$i = \frac{\text{Total no. of moles of particles after association / dissassociation}}{\text{no. of moles of particles before association / dissassociation}}$$

Note :-

In case of association , $i < 1$
In case of dissociation , $i > 1$
When there is neither association , nor dissociation , $i = 1$

➡ **Degree of Disassociation**

$$\alpha = \frac{i-1}{n-1}$$

n = number of ions

➡ **Modified form of Colligative properties**

1.) $$\frac{p_1^\circ - p_1}{p_1^\circ} = i\frac{n_2}{n_1}$$

2.) $$\Delta T_b = i K_b m$$

3.) $$\Delta T_f = i K_f m$$

4.) $$\pi = i\, n_2 RT/V$$

➡ **Relation between Molarity and normality**

Normality × Equivalent mass (solute) = Molarity × Molar mass (solute)

➡ **Relation between Molarity and normality with mass percentage**

$$\text{Molarity} = \frac{p \times d \times 10}{\text{Molecular mass (solute)}}$$

$$\text{Normality} = \frac{p \times d \times 10}{\text{Equivalent mass (solute)}}$$

p = mass percentage
d = density

➡ **Relation between molarity (M) and molality (m)**

$$m = \frac{1000 \times M}{(1000 - d) - (M \times GMM_B)}$$

➡ Relation between Molality (m) and Mole fraction of solute (x_B)

$$\boxed{x_B = \frac{m \times GMM_A}{1000 + m \times GMM_A}}$$ Also, $$\boxed{m = \frac{1000\, x_B}{x_A \times GMM_A}}$$

➡ Dilution Formula $\boxed{M_1 V_1 = M_2 V_2}$ similarly, $\boxed{N_1 V_1 = N_2 V_2}$

➡ Molarity of a mixture $$\boxed{M = \frac{M_1 V_1 + M_2 V_2}{V_1 + V_2}}$$

➡ Relation between molarity (M) and mole fraction of solute (x_B)

$$\boxed{x_B = \frac{M \times GMM_A}{M(GMM_A - GMM_B) + 1000d}}$$ Also, $$\boxed{M = \frac{1000 \times d \times x_B}{x_A \times GMM_A + x_B + GMM_B}}$$

➡ Absorption coefficient $\boxed{\alpha = \frac{\nu}{VP}}$

ν = volume of the gas dissolved
V = Volume , P = Pressure

➡ Van't Hoff Theory of dilute solutions

- **Boyle - Van't Hoff law** $\boxed{P \propto C}$ (when temprature is constant)

OR $\boxed{P \propto \frac{1}{V}}$

OR $\boxed{PV = \text{constant}}$ OR $\boxed{\pi V = \text{constant}}$

- **Pressure - Temperature law (Gay Lussac - Van't Hoff law)**

$\boxed{P \propto T}$

OR $\boxed{\frac{P}{T} = \text{constant}}$ OR $\boxed{\frac{T}{T} = \text{constant}}$

- **Third law** for sol^n I $PV = n_1 ST$
for sol^n II $PV = n_2 ST$

➡ $$\boxed{\text{Formality } F = \frac{\text{number of Formula Mass}}{\text{number of litres of sol}^n}}$$

UNIT-7

Equilibrium

EQUILIBRIUM

State at which measurable properties do not change with time

Homogeneous
- Reactants and products in same phase

Heterogeneous
- Reactants and products in different phases

➡ Law of mass action

$$\text{Rate of reaction},\ r = k[A]^a[B]^b[C]^c$$

k = Rate constant **OR** Velocity constant

➡ Law of Chemical Equilibrium

Rate of forward reaction = Rate of backward reaction

$K = \frac{K_f}{K_b}$ = Equilibrium constant

OR $$\frac{K_f}{K_b} = \frac{[C][D]}{[A][B]}$$ **OR** $$K = \frac{[C][D]}{[A][B]}$$

➡ Concentration Quotient

$$(Q) = \frac{[C][D]}{[A][B]}$$

➡ Relationship between K_p and K_c

$$K_p = K_c(RT)^{\Delta n_g}$$

➡ Temperature dependence of Equilibrium constant (VantHoff Equation)

$$\log\frac{K_2}{K_1} = \frac{\Delta H}{2.303\,R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

K_1, K_2 = Equilibrium constant
T_1, T_2 = Temperature
ΔH = Enthalpy change

(i) If $\Delta H = 0$ then $K_2 = K_1$ (ii) If $\Delta H = +ve$ then $K_2 > K_1$ (iii) If $\Delta H = -ve$ then $K_2 < K_1$

Note :- Equilibrium constant decreases with increase in temperature.

➡ Relationship between K, Q and ΔG

$$\Delta G = \Delta G^\circ + RT\ln Q$$

and

$$\Delta G^\circ = -2.303\ RT\log K_c$$

ΔG° = Standard Gibbs Energy

Note :-

Increase in temperature $\xrightarrow[\text{in the direction of}]{\text{shifts the equilibrium}}$ Endothermic reaction

Decrease in temperature $\xrightarrow[\text{in the direction of}]{\text{shifts the equilibrium}}$ Exothermic reaction

Increase in pressure $\xrightarrow[\text{in the direction of}]{\text{shifts the equilibrium}}$ Lesser number of gaseous moles

Decrease in pressure $\xrightarrow[\text{in the direction of}]{\text{shifts the equilibrium}}$ Larger number of gaseous moles

$\boxed{pH = -\log[H_3O^+]}$ $\boxed{pH = -\log[OH^-]}$ $\boxed{pH + pOH = pK_w = 14}$

Henderson's equation for buffer solution

For acidic buffer, $\boxed{pH = pK_a + \log\frac{[Salt]}{[Acid]}}$

For basic buffer, $\boxed{pH = 14 - pK_a - \log\frac{[Salt]}{[Base]}}$

For acidic solution = $pH < 7$
For basic solution = $pH > 7$
For neutral solution = $pH = 7$

Dissociation constants of acids $\boxed{K_a = \frac{c\alpha^2}{1-\alpha} \approx c\alpha^2}$ $\boxed{\alpha = \sqrt{\frac{K_a}{c}}}$ $\boxed{[H_3O^+] = \sqrt{K_a \cdot c}}$

Dissociation constants of Base $\boxed{K_b = \frac{c\alpha^2}{1-\alpha} \approx c\alpha^2}$ $\boxed{\alpha = \sqrt{\frac{K_b}{c}}}$ $\boxed{[OH^-] = \sqrt{K_b \cdot c}}$

Note :- $\boxed{pK_a = -\log K_a}$ Larger the value of pK_a weaker the acid is

$\boxed{pK_b = -\log K_b}$ Larger the value of pK_b weaker the base is

Salt	Example	(K_H) Hydrolysis constant	(h) Degree of Hydrolysis	pH of solution
Weak acid and strong Base	CH_3COONa	$\frac{K_w}{K_a}$	$\sqrt{\frac{K_w}{K_a \cdot c}}$	$\frac{1}{2}pK_w + \frac{1}{2}pK_a + \frac{1}{2}\log c$
Strong acid and Weak Base	NH_4Cl	$\frac{K_w}{K_a}$	$\sqrt{\frac{K_w}{K_b \cdot c}}$	$\frac{1}{2}pK_w - \frac{1}{2}pK_b - \frac{1}{2}\log c$
Weak acid and Weak Base	CH_3COONH_4	$\frac{K_w}{K_a \cdot K_b}$	$\sqrt{\frac{K_w}{K_a \cdot K_b}}$	$\frac{1}{2}pK_w + \frac{1}{2}pK_a - \frac{1}{2}pK_b$
Strong acid and strong Base	NaCl	Does not undergo hydrolysis		

Le-Chatelier's Principle

Effect of concentration

- addition of reactants shifts equilibrium in forward direction.
- addition of products shifts equilibrium in backward direction.

Effect of temperature

- increase of temperature shifts equilibrium in endothermic direction.
- decrease of temperature shifts equilibrium in exothermic direction.

Effect of pressure

- increase of pressure shifts equilibrium in the direction of lesser number of moles.
- decrease of pressure shifts equilibrium in the direction of large number of moles.

Effect of catalyst

- a catalyst does not affect equilibrium constant.

UNIT-8

Redox Reactions & Electrochemistry

Oxidation & Reduction

Electronic concept

Oxidation: A process in which one or more electrons are lost.

Reduction: A process in which one or more electrons are gained.

Oxidising agent OR oxidant: A substance which can accept one or more electrons.

Reducing agent or reductant: A substance which can give one or more electrons.

In terms of oxidation number

Oxidation: A process which involves increase in oxidation number.

Reduction: A process which involves decrease in oxidation number.

Oxidising agent: A substance whose oxidation number decreases.

Reducing agent: A substance whose oxidation number increase

Oxidation Number

- For elementary state, O.N is zero.
  e.g., He (O.N. = 0), H_2 (O.N. = 0), S_8 (O.N. = 0)
- oxidation number of hydrogen is +1 except in hydrides NaH, LiH, CaH_2 (−1).
- Oxidation number of oxygen is always −2 except
  in peroxides, H_2O_2, Na_2O_2 (−1)
  in superoxides KO_2 (−1/2)
  in OF_2 (+2)
  O_2F_2 (+1)
- Combination reaction $2Mg + O_2 \longrightarrow 2MgO$
- Decomposition reaction $2KClO_3 \longrightarrow 2KCl + 3O_2$
- Displacement reaction
  $CuSO_4 + Zn \longrightarrow Cu + ZnSO_4$
  $Sn + 2HCl \longrightarrow SnCl_2 + H_2$
  $Br_2 + 2I^- \longrightarrow 2Br^- + I_2$

→ Equivalent Weight (E) of oxidant and Reductant

$$\text{Equivalent Weight} = E = \frac{M_0}{X}$$

where
M_0 = molecular mass
X = number of electrons transferred (loss or gain) by one mole of oxidising or reducing agent as given by their balanced ionic half reaction

Equivalent Mass $\text{equivalent mass} = \dfrac{\text{molar mass}}{\text{n - Factor}}$

- **Element** $E = \dfrac{\text{Atomic mass of element}}{\text{Valence of element}}$
- **Ion** $E = \dfrac{\text{Formula mass of ion}}{\text{charge on ion}}$
- **Salt** $E = \dfrac{\text{Formula mass of salt}}{\text{Total positive or negative charge on cationic or anionic part}}$
- **Acid** $E = \dfrac{M_{acid}}{\text{Basicity}}$
- **Base** $E = \dfrac{M_{base}}{\text{Acidity}}$
- **Acid salt** $E = \dfrac{M}{\text{Replaceable 'H' left in the salt}}$
- **Redox change** $E = \dfrac{M_{\text{oxidant or reductant}}}{\text{Number of electrons lost or gained by one molecule of oxidant of reductant}}$

ELECTROCHEMISTRY

EMF of a cell (cell potential) $E_{cell} = E_{Cathode} - E_{Anode}$

Gibb's Free Energy $\Delta_r G^\circ = -RT \ln K_c$ OR $\Delta_r G^\circ = -2.303\, RT \log K_c$

Ohm's law $V = IR$

V = Potential difference
I = Current

$\frac{l}{A}$ = cell constant

Specific Resistance (Resistivity) $R = \rho \dfrac{l}{A}$

R = Resistance
A = Area
l = length

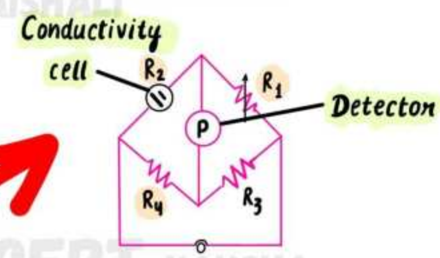
Wheatstone Bridge

Conductance $G = \dfrac{1}{R} = \dfrac{A}{\rho l} = K \dfrac{A}{l}$

G = conductance
K = conductivity

Conductivity $K = \dfrac{1}{\rho} = \dfrac{1}{R} \times \dfrac{l}{A} = G \times \dfrac{l}{A}$

Wheatstone bridge $\dfrac{R_1}{R_2} = \dfrac{R_3}{R_4}$



Molar Conductivity $\Lambda_m = K \times V$ OR $\Lambda_m = \dfrac{K \times 1000}{c}$

C = Molar Concentration
V = Volume
Λ°_m = Limiting Molar Conductivity

Limiting Molar Conductivity $\Lambda_m = \Lambda^\circ_m - A c^{1/2}$

→ Nernst Equations for a general electrode reaction

$$E_{(M^{n+}/M)} = E^{\circ}_{(M^{n+}/M)} - \frac{RT}{nF} \ln \frac{[M]}{[M^{n+}]}$$

$$E_{(M^{n+}/M)} = E^{\circ}_{(M^{n+}/M)} - \frac{2.303\,RT}{nF} \log \frac{1}{[M^{n+}]}$$

$$E_{(M^{n+}/M)} = E^{\circ}_{(M^{n+}/M)} - \frac{0.059}{n} \log \frac{1}{[M^{n+}]}$$ At 298 K

$E^{\circ}_{M^{n+}/M}$ = Standard Electrode potential
$E_{M^{n+}/M}$ = Electrode potential
R = 8.314 $JK^{-1}Mol^{-1}$
T = Temperature in kelvin
n = no. of electrons gained
F = Faraday constant (96500 C mol^{-1})

→ Nernst Equations for a general electrochemical reaction

$$E_{(M^{n+}/M)} = E^{\circ}_{(M^{n+}/M)} - \frac{RT}{nF} \ln \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

$$E_{(M^{n+}/M)} = E^{\circ}_{(M^{n+}/M)} - \frac{2.303\,RT}{nF} \log \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

$$E_{(M^{n+}/M)} = E^{\circ}_{(M^{n+}/M)} - \frac{0.059}{n} \log \frac{[C]^c[D]^d}{[A]^a[B]^b}$$ At 298 K

→ Kohlrausch's law $\Lambda^{\circ}_m = \nu_+ \lambda^{\circ}_+ + \nu_- \lambda^{\circ}_-$

λ°_+ = limiting molar conductivity of Cation
λ°_- = limiting molar conductivity of Anion

→ Calculation of Molar conductivies of a weak electrolyte at infinite dilution

$$\Lambda^{\circ}_{m(CH_3COOH)} = \Lambda^{\circ}_{m(CH_3COONa)} + \Lambda^{\circ}_{m(HCl)} - \Lambda^{\circ}_{m(NaCl)}$$

→ Degree of Dissociation $\alpha = \frac{\Lambda_m}{\Lambda^{\circ}_m}$

→ $\log K_c = \frac{n}{0.0591} E^{\circ}_{cell}$

K_c = Equilibirium constant

→ Dissociation constant $K = \frac{c(\Lambda_m)^2}{\Lambda^{\circ}_m(\Lambda^{\circ}_m - \Lambda_m)}$

→ Solubility of sparingly soluble salts $\text{Solubility} = \frac{K \times 1000}{\Lambda^{\circ}_m}$

→ Concentration cells $E_{cell} = \frac{0.0591}{n} \log \frac{C_2}{C_1}$ where $C_2 > C_1$

→ Faraday's law

★ First law $W = Z \times I \times t$ $[\because Q = I \times t]$

★ Second law $\frac{W_1}{W_2} = \frac{E_1}{E_2}$

Z = Propationality

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UNIT-9

Chemical Kinetics

$$\text{Rate of Reaction} = \frac{\text{Decrease in concentration of R}}{\text{Time taken}}$$

OR

$$\text{Rate of Reaction} = \frac{\text{Increase in concentration of R}}{\text{Time taken}}$$

OR

$$\text{Rate of Reaction} = -\frac{\Delta[R]}{\Delta t} = \frac{\Delta[P]}{\Delta t}$$

- Differential Rate Equation

K = Rate Constant

Reaction $A + B \rightarrow \text{Products}$

$$\text{Rate} = K[A]^x[B]^y \quad \textbf{OR} \quad \frac{-dR}{dt} = K[A]^x[B]^y$$

- Reaction $A + B \rightarrow \text{Products}$ $\quad \text{Rate} = K[A]^x[B]^y$

$$\text{Order of Reaction} = x + y$$

x = order of Reaction with respect to A
y = order of Reaction with respect to B

- Integrated Rate Equation for Zero order Reactions

$$k = \frac{[R]_0 - [R]}{t}$$

- Integrated Rate Equation for First order Reactions

$$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$$

- Half life of a zero order Reaction

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

- Half life of a first order Reaction

$$t_{1/2} = \frac{0.693}{k}$$

P_i = initial Pressure $\quad P_t$ = total Pressure

- Integrated Rate Equation for a gaseous state

$$k = \frac{2.303}{t} \log \frac{P_i}{(2P_i - P_t)}$$

- Arrhenius Equation

$$K = Ae^{-E_a/RT}$$

A = Arrhenius factor or frequency factor
E_a = Activation Energy
R = Gas constant at T_1
T = Temperature in kelvin

K_2 = Rate constant at T_1
K_1 = Rate constant at T_2

$$\log \frac{K_2}{K_1} = \frac{E_a}{2.303\,R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$E_a = -2.303 \times R \times \text{slope}\left(\text{in a plot of } \log k \text{ vs } \frac{1}{T}\right)$$

- Collision theory of Chemical Reactions

$$\text{Rate} = PZ_{AB}e^{-E_a/RT}$$

Z_{AB} = The collision frequency of reactants A and B
P = Probability factor
$e^{-E_a/RT}$ = Fraction of molecules with energies equal to or greater than E_a

$$\boxed{\text{Temperature cofficient} = \frac{\text{Rate constant at } (T+10)^\circ}{\text{Rate constant at } T^\circ}}$$

$$\boxed{\text{Average rate of reaction} = \frac{\text{Change in concentration}}{\text{Time interval}} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}}$$

Activation Energy = Threshold Energy − Average kinetic Energy of the reacting molecules

OR

$$\boxed{E_a = E\,(\text{Threshold}) - E\,(\text{reactants})}$$

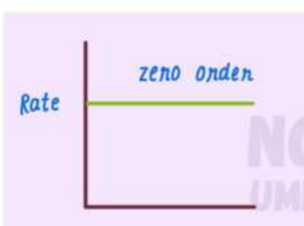
Note :- Low activation Energies = Fast reaction
High activation Energies = Slow reaction

$$\boxed{\Delta H = E_a\,(\text{forward}) - E_a\,(\text{backward})}$$

Note :- E_a (forward) < E_a (backward) then ΔH = − ve
E_a (forward) > E_a (backward) then ΔH = + ve

Order	Units of k	Integrated Rate Equation	Half life Period
Zero	$mol\ L^{-1}\ s^{-1}$	$A = -kt + [A]_0$	$\frac{R_0}{2k}$
First	s^{-1}	$\log[A] = \frac{-kt}{2.303} + \log[A_0]$	$\frac{0.693}{k}$
Second	$L\ mol^{-1}\ s^{-1}$	$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$	$\frac{1}{[R_0]}$

Important Graph :-



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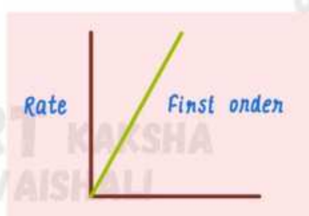

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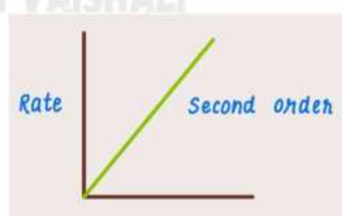


$[R]^2$

UNIT - 10

Surface Chemistry

➡ **Freundlich Adsorption isotherms** $\boxed{\frac{x}{m} = k.p^{1/n}}$ $(n>1)$

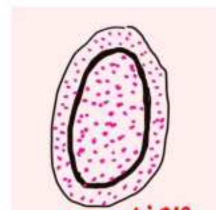
taking logarithm both sides, $\boxed{\log \frac{x}{m} = \log k + \frac{1}{n} \log p}$

➡ **Adsorption from solution Phase** $\boxed{\frac{x}{m} = k.C^{1/n}}$

taking logarithm both sides, $\boxed{\log \frac{x}{m} = \log k + \frac{1}{n} \log C}$

Adsorption

Absorption



Sorption

Size of particles of solutions

True solutions	Colloids	Suspensions
$< 10^{-9}$ m	10^{-9} m to 10^{-6} m	$> 10^{-6}$ m
< 1 nm	1 nm - 1000 nm	> 1000 m

➡ **Some Enzymatic Reactions**

Enzyme	Source	Enzymatic Reactions
Invertase	Yeast	Sucrose → Glucose and fructose
Zymase	Yeast	Glucose → Ethyl alcohol and carbon dioxide
Diastase	Malt	Strach → Maltose
Maltase	Yeast	Maltose → Glucose
Urease	Soyabeen	Urea → Ammonia and Carbon dioxide
Pepsin	Stomach	Proteins → Amino acids

➡ **Types of Colloidal systems**

Dispersed phase	Dispersion medium	Type of colloid	Examples
Solid	Solid	Solid sol	Some coloured glasses and gem stones
Solid	Liquid	Sol	Paints, cell fluids
Solid	Gas	Aerosol	Smoke, dust
Liquid	Solid	Gel	Cheese, butter, jellies
Liquid	Liquid	Emulsion	Milk, hair cream
Liquid	Gas	Aerosol	Fog, mist, cloud, insecticide sprays
Gas	Solid	Solid sol	Pumice stone, foam rubber
Gas	Liquid	Foam	Froth, whipped cream, soap lather

Note :- 'lyophilic' means liquid loving
'lyophobic' means liquid hating

Note :- Ziegler - Natta catalyst $[Ti-R_3A]$ polymerisation of olefins

Wilkinson's catalyst $[RhCl(PPh_3)]$ hydrogenation of alkenes

Lindlar's catalyst $[Pd-BaSO_4]$ poisoned by traces of quinoline

Note :-

Dispersion medium	Name of colloidal solution
Water	Hydrosols or aquasol
Alcohol	Alcosols
Benzene	Benzosols
Air	Aerosols

Note :- Gold numbers of some protective colloids

Sol	Gold number
Gelatin	0.005 - 0.01
Caselin	0.01 - 0.02
Haemoglobin	0.03 - 0.07
Egg albumin	0.1 - 0.2
Gum arabic	0.15 - 0.25
Starch	20 - 25
Dextrin	6 - 20

UNIT-11

Classification of Elements and Periodicity in Properties

PERIODICITY

the recurrence of similar properties of the elements after certain regular intervals when arranged in the increasing order of atomic numbers is called periodicity.

Cause of periodicity

is the repetition of similar electronic configurations of the atoms in their valence shell after certain regular intervals

Note :-

- **Mercury** → liquid at room temperature
- **Tungsten** → highest melting point (3380°C)
- **Silver** → conductor of electricity
- **Helium** → maximum ionisation enthalpy
- **Caesium** → electropositive element

➡ **Atomic number and Modern Periodic Law** $\boxed{\sqrt{\nu} = a(Z-b)}$

ν = frequency of the emitted X-Ray   a, b = Constants   Z = atomic number

➡ **Covalent Radius**

$$r_{covalent} = \frac{\text{Inter nuclear distance between two-bonded atoms}}{2}$$

➡ **Effective Nuclear charge** $\boxed{Z^* = (Z-\sigma)}$

Z^* = Effective nuclear charge
Z = actual nuclear charge
σ = screening constant

➡ **Mulliken's scale**

$$\text{Electronegativity} = \frac{\text{Ionization potential} + \text{Electron affinity}}{2}$$

➡ **Allred - Rochow scale**

$$\chi = \frac{0.359\,Z}{r^2} + 0.744$$

Z → Effective nuclear charge
r → covalent radius of the atom in Å
χ = Electronegativity

➡ **Pauling's Scale** $\boxed{\chi_A - \chi_B = 0.208\sqrt{\Delta E}}$

χ_A, χ_B → Electronegativities of the the atoms A and B

$$\Delta E = \text{Actual bond Energy} - \sqrt{(E_{A-A} \times E_{B-B})}$$

➡ **Relation between Pauling and Mulliken values of electronegativities**

$\boxed{\text{(Pauling) } \chi = 0.34\ \chi\text{ (Mulliken)} - 0.2}$

➡ **Atomic volume**

$$\text{Atomic volume} = \frac{\text{Gram atomic weight}}{\text{Density in solid state}}$$

UNIT-12

General Principles and Processes of Isolation of Metals

➡ Principal ores of some important metals

Metal	Name	Composition
Aluminium (Al)	Bauxite	$AlO_x(OH)_{3-2x}$ (where $0 < x < 1$)
	Feldspar	$KAlSi_3O_8$
	Cryolite	Na_3AlF_6
	Kaolinite (a form of clay)	$Al_2(OH)_4Si_2O_5$
Iron (Fe)	Haematite	Fe_2O_3
	Magnetite	Fe_3O_4
	Siderite	$FeCO_3$
	Iron pyrites	FeS_2
	Limonite	$Fe_2O_3.3H_2O$
Copper (Cu)	Copper glance	Cu_2S
	Copper pyrites	$CuFeS_2$
	Malachite	$CuCO_3.Cu(OH)_2$
	Cuprite (ruby copper)	Cu_2O
	Azurite	$2CuCO_3.Cu(OH)_2$
Zinc (Zn)	Zinc blende or Sphalerite	ZnS
	Calamine	$ZnCO_3$
	Zincite	ZnO
	Willemite	Zn_2SiO_4
	Franklinite	$ZnO.Fe_2O_3$
Manganese (Mn)	Pyrolusite	MnO_2
	Braunite	Mn_2O_3
Calcium (Ca)	Limestone	$CaCO_3$
	Gypsum	$CaSO_4.2H_2O$
Magnesium (Mg)	Magnesite	$MgCO_3$
	Dolomite	$CaCO_3.MgCO_3$
Lead (Pb)	Galena	PbS
	Cerrusite	$PbCO_3$
Silver (Ag)	Argentite or Silver glance	Ag_2S
	Horn silver	$AgCl$
	Ruby silver	$Ag_2S.Sb_2S_3$
Mercury (Hg)	Cinnabar	HgS

➡ **Gibbs free Energy** $\boxed{\Delta G = \Delta H - T\Delta S}$ OR $\boxed{\Delta G^\circ = -RT\ln K}$

ΔH → Enthalpy change

ΔS → Entropy change

$\boxed{\Delta G^\circ = -nE^\circ F}$

Note :-
- The red bauxite is purified by Baeyer's process.
- The white bauxite is purified by Serpeck's process.

ORE

Step 1 CRUSHING AND GRINDING

↓ **Powdered Ore**

Step 2 CONCENTRATION OF THE ORE
- ⟵ Levigation
- ⟵ Electromagnetic separation
- ⟵ Electrostatic concentration
- ⟵ Forth Floatation
- ⟵ Leaching

↓ **Concentrated Ore**

Step 3 WORKING OF THE CONCENTRATED ORE (OXIDATION AND REDUCTION PROCESSES)
- ⟵ Roasting
- ⟵ Calcination
- ⟵ Smelthing

} **Conversion into metal oxide (oxidation)**

- ⟵ Hydrogen reduction
- ⟵ Auto reduction
- ⟵ Hydrometallurgy
- ⟵ Electrolytric reduction

} **Conversion of oxide to metal (reduction)**

↓ **Crude Metal**

Step 4 PURIFICATION AND REFINING
- ⟵ Distillation
- ⟵ Liquation
- ⟵ Poling
- ⟵ Electrolytic refining
- ⟵ Zone refining
- ⟵ Vapour phase refining

↓ **Pure Metal**

- Addition of alum to plaster of Paris **Keene cement**
- Plaster of Paris is heated at 200°C, it forms anhydrous calcium sulphate which is known as **dead plaster**

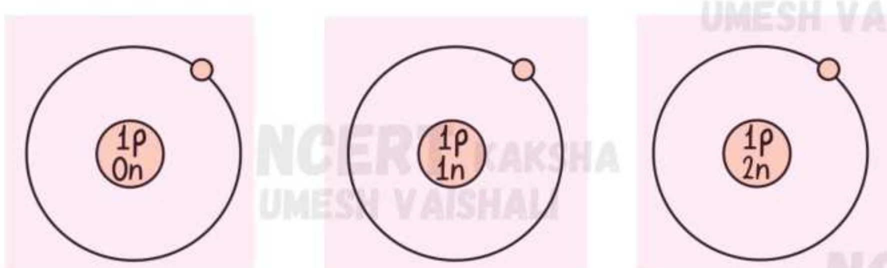
UNIT - 13

Hydrogen

- Hydrogen is the first element in the **periodic table** and is the **lightest element** known.
- Atomic number - 1 and electronic configuration is $1s^1$.
- Diatomic molecule $(H_2) \longrightarrow$ dihydrogen
- Hydrogen resembles alkali metals as well as halogen in its properties.
- The reactivity of Halogen towards dihydrogen decreases: $\boxed{F_2 > Cl_2 > Br_2 > I_2}$

Note :-
- H_2O_2 (Hydrogen peroxide)
- Zeolites (Hydrated sodium aluminium silicates) $Na_2Al_2Si_2O_8 \cdot xH_2O$

Property	Protium (H)	Deuterium (D)	Tritium (T)
Symbol	^1_1H or H	^2_1H or D	^3_1H or T
Atomic number	1	1	1
Mass number	1	2	3
Relative atomic mass	1.007825	2.014102	3.016049
Nuclear spin quantum number	½	1	½
Radioactive stability	Non-radioactive stable	Non-radioactive stable	Radioactive, emits β-particles ($t_{1/2}$ = 12.33y)



Protium ^1_1H or H | Deuterium ^2_1H or D | Tritium ^3_1H or T

- Merck process

$$\underset{\text{Sodium peroxide}}{Na_2O_2} + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O_2$$

HYDRIDES

- **Ionic**: formed by combination of H with highly electropositive metals. e.g. LiH, KH, CaH_2, SrH_2
- **Molecular or covalent**: formed by combination of elements of higher electronegativity. e.g. HF, H_2O, NH_3, B_2H_6, CH_4, H_2S, PH_3
- **Interstitial**: formed by elements of d-and f-block. e.g. $ZrH_{1.9}$, $TiH_{1.73}$, $LaH_{2.76}$
- **Complex**: $LiAlH_4$, $NaBH_4$

WATER

- Water is angular or bent molecule and H−O−H bond is 104.5°
- Water can act as a base towards acids stronger than itself and as an acid towards bases stronger than it.
- Water which produces lather with soap solution readily is called **soft water**.
- Water which does not produce lather with soap solution readily is called **hard water**.

HEAVY WATER

(D_2O) Deuterium

- Heavy water is D_2O which is obtained by prolonged hydrolysis of water or by fractional distillation.
- The reactions of D_2O are slower than those of H_2O.
- D_2O is used in nuclear reactors as a moderator

Find a way not an Excuse.

UNIT-14

s-Block Elements (Alkali and Alkaline earth metals)

s-Block Elements
[Noble gas]$ns^{1 \text{ or } 2}$

Group I- Alkali metals : [Noble gas]ns^1
- Li, Na, K, Rb, Cs, Fr
- show +1 oxidation state
- give characteristic flame colourations due to their low ionisation enthalpies
- exhibit photoelectric effect (except Li)
- Basic character:
  LiOH < NaOH < KOH < RbOH < CsOH

Group II- Alkaline earth metals: [Noble gas]ns^2
- Be, Mg, Ca, Sr, Ba, Ra
- show +2 oxidation state
- except Be and Mg, they give characteristic flame colourations.
- Basic character:
  $Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$

Note :-
- The element of group 1 ⟶ alkali metals
- The element of group 2 ⟶ alkaline earth metals

Element	Symbol	Atomic Number	Electronic configuration	
Lithium	Li	3	$1s^2 2s^1$ or	$[He]2s^1$
Sodium	Na	11	$1s^2 2s^2 2p^6 3s^1$ or	$[Ne]3s^1$
Potassium	K	19	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ or	$[Ar]4s^1$
Rubidium	Rb	37	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^1$ or	$[Kr]5s^1$
Cesium	Cs	55	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^6 6s^1$ or	$[Xe]6s^1$
Francium	Fr	87	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^{14} 5s^2 5p^6 5d^{10} 6s^2 6p^6 7s^1$ or	$[Rn]7s^1$

Note :-
- Sodium Carbonate ⟶ $Na_2CO_3 \cdot 10H_2O$ **(Washing soda)**
- Sodium hydrogen carbonate ⟶ $NaHCO_3$ **(Baking soda)**

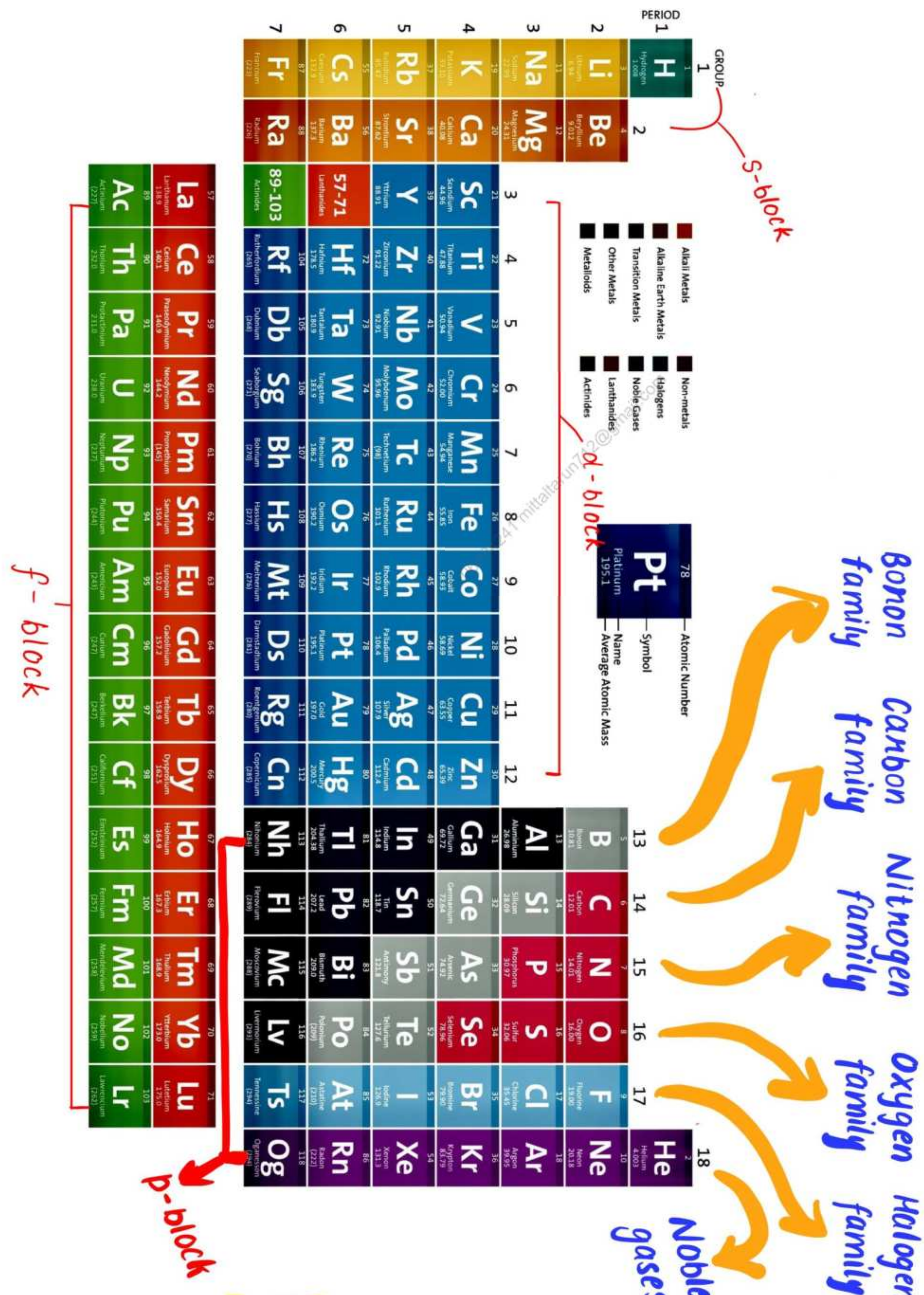
Element	Symbol	Atomic Number	Electronic configuration
Beryllium	Be	4	$[He]2s^2$
Magnesium	Mg	12	$[Ne]3s^2$
Calcium	Ca	20	$[Ar]4s^2$
Strontium	Sr	38	$[Kr]5s^2$
Barium	Ba	56	$[Xe]6s^2$
Radium	Ra	88	$[Rn]7s^2$

Note :-
- Calcium Hydride ⟶ CaH_2 (hydrolith)
- Chlorophyll is an important complex of magnesium.
- Calcium oxide **OR** Quicklime ⟶ CaO
- Calcium hydroxide **OR** slaked lime (lime water) ⟶ $Ca(OH)_2$
- Calcium carbonate **OR** limestone **OR** marble ⟶ $CaCO_3$
- Plaster of Paris ⟶ $(CaSO_4)_2 \cdot H_2O$ **OR** $CaSO_4 \cdot \frac{1}{2} H_2O$

focus on the Goal ♥

UNIT - 15

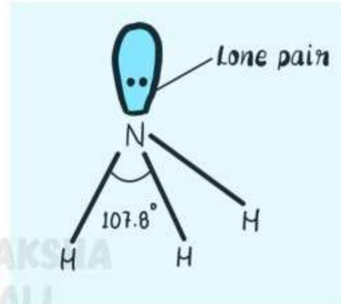
p- Block Elements



➡ GROUP-15 OR Nitrogen Family OR Pnicogens

General Electronic Configuration = $ns^2\,np^3$

Element	Symbol	Atomic No.	Electronic configuration
Nitrogen	N	7	[He] $2s^2 2p^3$
Phosphorus	P	15	[Ne] $3s^2 3p^3$
Arsenic	As	33	[Ar] $3d^{10} 4s^2 4p^3$
Antimony	Sb	51	[Kr] $4d^{10} 5s^2 5p^3$
Bismuth	Bi	83	[Xe] $4f^{14} 5d^{10} 6s^2 6p^3$

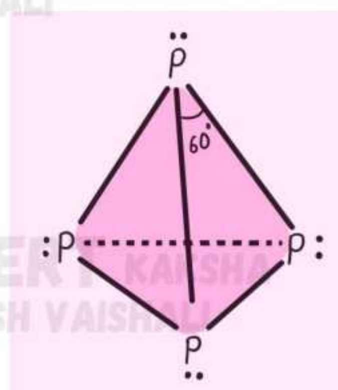


Shape of NH_3 Molecule

Note :- HN_3 (hydrogen azide OR hydrazoic acide)

➡ GROUP-16 OR Oxygen Family OR Chalcogens

Element	Atomic No.	Electronic configuration
Oxygen, O	8	[He] $2s^2 2p^3$
Sulphur, S	16	[Ne] $3s^2 3p^3$
Selenium, Se	34	[Ar] $3d^{10} 4s^2 4p^3$
Tellurium, Te	52	[Kr] $4d^{10} 5s^2 5p^3$
Polonium, Po	84	[Xe] $4f^{14} 5d^{10} 6s^2 6p^3$



Structure of White phosphorus

Note :- SULPHURIC ACID (king of chemicals)

➡ GROUP-17 OR Halogen Family OR Halogens

Elements	Atomic number	Electronic configurations
Fluorine, F	9	[He] $2s^2 2p^3$
Chlorine, Cl	17	[Ne] $3s^2 3p^3$
Bromine, Br	35	[Ar] $3d^{10} 4s^2 4p^3$
Iodine, I	53	[Kr] $4d^{10} 5s^2 5p^3$
Astatine, At	85	[Xe] $4f^{14} 5d^{10} 6s^2 6p^3$

➡ GROUP-18 OR noble gases

Element		Atomic number	Electronic Configurations
Helium	He	2	$1s^2$
Neon	Ne	10	$1s^2 2s^2 2p^6$
Argon	Ar	18	$1s^2 2s^2 2p^6 3s^2 3p^6$
Krypton	Kr	36	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$
Xenon	Xe	54	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^6$
Radon	Rn	86	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 4f^{14} 5s^2 5p^6 5d^{10} 6s^2 6p^6$

- In hydrides –

Bond Angle $NH_3 > PH_3 > AsH_3 > SbH_3$

Basic Character $NH_3 > PH_3 > AsH_3$

Boiling Point $NH_3 > PH_3 < AsH_3 < SbH_3$

Stability $NH_3 > PH_3 > AsH_3 > SbH_3$

Reducing Character $NH_3 < PH_3 < AsH_3$

Oxoacids of Phosphorus

Name	Formula	Oxidation state of P
Phosphinic acid (OR Hypophosphorous acid)	H_3PO_2	+1
Phosphonic acid (OR orthophosphorous acid OR phosphorous acid)	H_3PO_3	+3
Pyrophosphorous acid	$H_4P_2O_5$	+3
Hypophosphoric acid	$H_4P_2O_6$	+4
Orthophosphoric acid OR phosphoric acid)	H_3PO_4	+5
Diphosphoric acid (pyrophosphoric acid)	$H_4P_2O_7$	+5
Metaphosphoric acid	HPO_3	+5
Peroxophosphoric acid	H_3PO_5	+5

Note :-

- Fluorine ↓ most electronegative element
- Chlorine ↓ highest negative electron gain enthalpy
- Iodine ↓ most metallic among halogens

UNIT-16

d-and f-Block Elements

d-Block Elements
$(n-1)\,d^{1-10}\,ns^{1\,or\,2}$

Four transition series

First transition series (3d)	Second transition series (4d)	Third transition series (5d)	Fourth transition series (6d)
Sc (21) – Zn (30)	Y(39) – Cd (48)	La (57), Hf (72) – Hg (80)	Ac (89), Rf (104) – Cn (112)

number of unpaired electrons

$$\boxed{\mu = \sqrt{n(n+2)}\ \text{BM}}$$

Magnetic moment

→ Magnetic Moment

$$\boxed{1\ \text{BM} = \frac{eh}{4\pi mc}}$$

h = Planck's constant
e = electronic charge
c = Velocity of light
m = mass of electron

- **Molybdenum** is used in X-ray tube for production of X-rays because it is heavy element.
- **Tantalum** is used in making bone na for surgery because it is resistant to corrosion.
- **Tungsten** is used in making filaments of electric bulbs because it has very high melting point.

First Transition Series (3d)

Element	Symbol	Atomic number	Outer electronic Configuration
Scandium	Sc	21	[Ar] $3d^1 4s^2$
Titanium	Ti	22	[Ar] $3d^2 4s^2$
Vanadium	V	23	[Ar] $3d^3 4s^2$
Chromium	Cr	24	[Ar] $3d^3 4s$
Manganese	Mn	25	[Ar] $3d^5 4s^2$
Iron	Fe	26	[Ar] $3d^6 4s^2$
Cobalt	Cu	27	[Ar] $3d^7 4s^2$
Nickel	Ni	28	[Ar] $3d^5 4s^2$
Copper	Cu	29	[Ar] $3d^{10} 4s$
Zine	Zn	30	[Ar] $3d^{10} 4s^2$

Second Transition Series (4d)

Element	Symbol	Atomic number	Outer electronic Configuration
Yttrium	Y	39	[Kr] $4d^1 5s^2$
Zirconium	Zr	40	[Kr] $4d^2 5s^2$
Niobium	Nb	41	[Kr] $4d^4 5s^1$
Molybdenum	Mo	42	[Kr] $4d^5 5s^1$
Technetium	Tc	43	[Kr] $4d^6 5s^1$
Ruthenium	Ru	44	[Kr] $4d^7 5s^1$
Rhodium	Rh	45	[Kr] $4d^8 5s^1$
Palladium	Pd	46	[Kr] $4d^{10} 5s^0$
Silver	Ag	47	[Kr] $4d^{10} 5s^1$
Cadmium	Cd	48	[Kr] $4d^{10} 5s^2$

Third Transition Series (5d)

Element	Symbol	Atomic number	Outer electronic Configuration
Lanthanum	La	57	[Xe] $4f^0 5d^1 6s^2$
Hafnium	Hf	72	[Xe] $4f^{10} 5d^2 6s^2$
Tantalum	Ta	73	[Xe] $4f^{14} 5d^3 6s^2$
Tungsten	W	74	[Xe] $4f^{14} 5d^4 6s^2$
Rhenium	Re	75	[Xe] $4f^{14} 5d^5 6s^2$
Osmium	Os	76	[Xe] $4f^{14} 5d^6 6s^2$
Iridium	Ir	77	[Xe] $4f^{14} 5d^7 6s^2$
Platinum	Pt	78	[Xe] $4f^{14} 5d^9 6s^1$
Gold	Au	79	[Xe] $4f^{14} 5d^{10} 6s^1$
Mercury	Hg	50	[Xe] $4f^{14} 5d^{10} 6s^2$

- d-Block elements known as **Transition elements**
- **Promethium (Pm)** → Synthetic (man-made) radioactive lanthanoid.
- **Titanium and niobium** are used for alloying with aluminium or tin in making aircraft frames and jet engines because these alloys have high strength.

Fourth Transition Series (6d)

Element	Symbol	Atomic number	Outer electronic configuration
Actinium	Ac	89	[Rn] $5f^0 6d^1 7s^2$
Rutherfordium	Rf	104	[Rn] $5f^{14} 6d^2 7s^2$
Hafnium	Ha	105	[Rn] $5f^{14} 6d^3 7s^2$
Seaborgium	Sg	106	[Rn] $5f^{14} 6d^4 7s^2$
Bohrium	Bh	107	[Rn] $5f^{14} 6d^5 7s^2$
Hassium	Hs	108	[Rn] $5f^{14} 6d^6 7s^2$
Meitnium	Mt	109	[Rn] $5f^{14} 6d^7 7s^2$
Darmstadtium	Ds	110	[Rn] $5f^{14} 6d^8 7s^2$
Rontgenium	Rg	111	[Rn] $5f^{14} 6d^{10} 7s^1$
Copernicium	Cn	112	[Rn] $5f^{14} 6d^{10} 7s^2$

Element	Symbol	Atomic number	Outer electronic configuration
Lanthanum	La	57	[Xe] $5d^1 6s^2$
Cerium	Ce	58	[Xe] $4f^2 5d^0 6s^2$
Praseodymium	Pr	59	[Xe] $4f^3 5d^0 6s^2$
Neodymium	Nd	60	[Xe] $4f^4 5d^0 6s^2$
Promethium	Pm	61	[Xe] $4f^5 5d^0 6s^2$
Samarium	Sm	62	[Xe] $4f^6 5d^0 6s^2$
Europium	Eu	63	[Xe] $4f^7 5d^0 6s^2$
Gadolinium	Gd	64	[Xe] $4f^7 5d^1 6s^2$
Terbium	Tb	65	[Xe] $4f^9 5d^0 6s^2$
Dysprosium	Dy	66	[Xe] $4f^{10} 5d^0 6s^2$
Holmium	Ho	67	[Xe] $4f^{11} 5d^0 6s^2$
Erbium	Er	68	[Xe] $4f^{12} 5d^0 6s^2$
Thulium	Tm	69	[Xe] $4f^{13} 5d^0 6s^2$
Ytterbium	Yb	70	[Xe] $4f^{14} 5d^0 6s^2$
Lutetium	Lu	71	[Xe] $4f^{14} 5d^1 6s^2$

Lanthanoids
$Z = 58-71$, La–Lu
[Xe] $4f^{1-14} 5d^{0-1} 6s^2$

f-block Elements
$(n-2)f^{0-14} (n-1)d^{0,1} ns^2$

Actinoids
$Z = 89-103$, Ac–Lr
[Rn] $5f^{1-14} 6d^{0-1} 7s^2$

Electronic Configuration of Lanthanoids

Electronic Configuration of Actinides

Element	Symbol	Atomic number	Outer electronic configuration
Actinium	Ac	89	[Rn] $6d^1 7s^2$
Thorium	Th	90	[Rn] $6d^2 7s^2$
Protactinium	Pa	91	[Rn] $5f^2 6d^1 7s^2$
Urunium	U	92	[Rn] $5f^3 6d^1 7s^2$
Neptunium	Np	93	[Rn] $5f^4 6d^1 7s^2$
Plutonium	Pu	94	[Rn] $5f^6 6d^0 7s^2$
Americium	Am	95	[Rn] $5f^7 6d^0 7s^2$
Curium	Cm	96	[Rn] $5f^7 6d^0 7s^2$
Berkelium	Bk	97	[Rn] $5f^9 6d^0 7s^2$
Californium	Cf	98	[Rn] $5f^{10} 6d^0 7s^2$
Einsteinium	Es	99	[Rn] $5f^{11} 6d^0 7s^2$
Fermium	Fm	100	[Rn] $5f^{12} 6d^0 7s^2$
Mendelevium	Md	101	[Rn] $5f^{13} 6d^0 7s^2$
Nobelium	No	102	[Rn] $5f^{14} 6d^0 7s^2$
Lawrencium	Lr	103	[Rn] $5f^{14} 6d^1 7s^2$

Difference between Lanthanoids and Actinoids

	Lanthanoids	Actinoids
1.	4f-orbital is progressively filled	5f-orbital is progressively filled
2.	+3 oxidation state is most common along with +2 and +4	show +3, +4, +5, +6, +7 oxidation states
3.	Only promethium (Pm) is radioactive	All are radioactive.
4.	They are less reactive than actinoids	They are more reactive.
5.	Magnetic properties are less complex	Magnetic properties are more complex

UNIT – 17

CO-Ordination Compounds

Coordination compound: $[CoBr_2(en)_2]Cl$

Coordination sphere
(Central metal atom and the ligands)
$[CoBr_2(en)_2]^+$

Ligands (ions or molecules which donate a pair of electrons)
en, Br^-

Ionizable part (counter ion to balance charge on complex sphere) Cl^-

Coordination number (number of coordinate bonds formed)
$2(Br) + 2 \times 2$ (en: bidentate) $= 6$

Central metal ion
(accepting electrons from ligands)
Co^{3+}

Coordination polyhedron
(spatial arrangement of ligands around metal ion) Octahedral

➡ Number of orbitals and Types of Hybridisations

Coordination no.	Type of hybridisation	Distribution of hybrid orbitals in space
4	sp^3	Tetrahedral
4	dsp^2	Square planar
5	sp^3d	Trigonal bipyramidal
6	sp^3d^2	Octahedral
6	d^2sp^3	Octahedral

➡ Nomenclature of some coordination compounds

S.No.	Formula	Name
1	$[Pt(NH_3)_2ClNO_2]$	diaamminechloridonitro-N-platinum(II)
2	$[CoCl_2(en)_2]Cl$	diachlorobis (ethane-1,2-diamine) cobalt(III) chloride
3	$K_3[Fe(C_2O_4)_3]$	potassium trioxalatoferrate(III)
4	$[Ag(NH_3)_2][Ag(CN)_2]$	diamminesilver(I) dicyanoargentate(I)

Relationship between the wavelength of light absorbed and the colour observed in some condition Entities

Coordination enity	Wavelength of light absorbed (nm)	Colour of light absorbed	Colour of coordination enity
$[Co(NH_3)_5Cl]^{2+}$	535	Yellow	Violet
$[Co(NH_3)_5(H_2O)]^{3+}$	500	Blue green	Red
$[Co(NH_3)_6]^{3+}$	475	Blue	Yellow orange
$[Co(CN)_6]^{3-}$	310	Ultraviolet	Pale yellow
$[Cu(H_2O)_4]^{2+}$	600	Red	Blue
$[Ti(H_2O)_6]^{3+}$	498	Blue green	Violet

Isomerism in Coordination Compounds

Structural Isomerism
- Linkage isomerism
- Coordination isomerism
- Ionisation isomerism

Stereoisomerism
- Geometrical isomerism
- Optical isomerism

distance

$$\boxed{\Delta_t = \frac{4}{9}\Delta_0}$$ → crystal field stabilization energy

- Strong field ligands (high Δ_e) form ⇒ Low spin complexes
- Weak field ligands (low Δ_e) form ⇒ High spin complexes

Stepwise and overall stability constant

$$\boxed{\beta_n = K_1 \times K_2 \times K_3 \times K_4 \ldots K_n}$$

$$\boxed{\text{Dissociation constant of complex} = \frac{1}{\text{Stability constant}}}$$

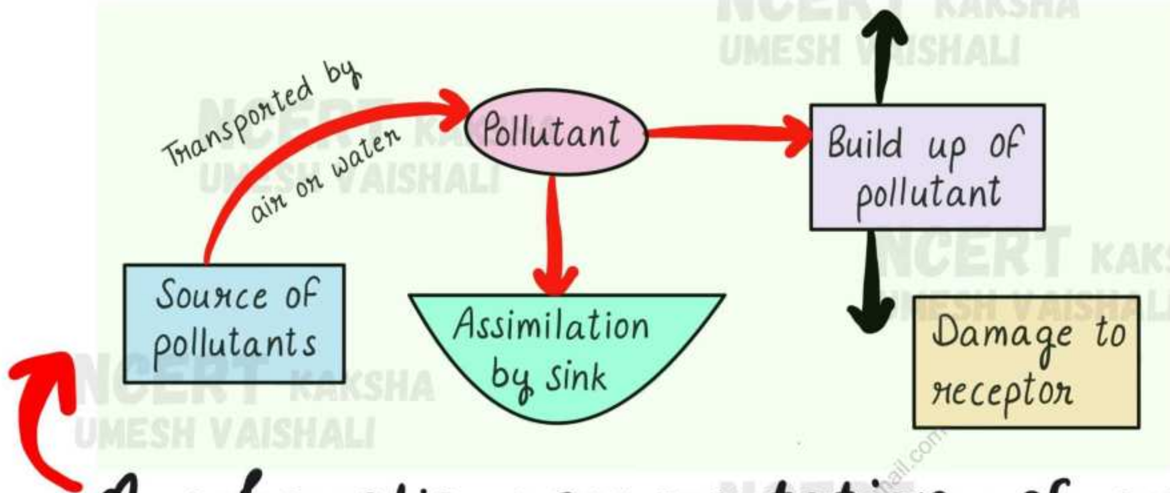
Mohr's salt $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$

Potash alum $K_2SO_4 \cdot Al_2SO_4 \cdot 24H_2O$

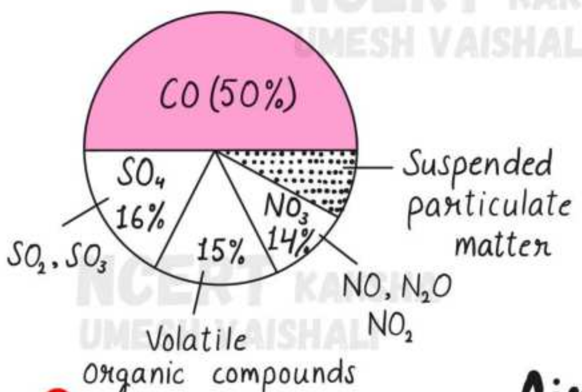
Carnallite $KCl \cdot MgCl_2 \cdot 6H_2O$

UNIT – 18

Environmental Chemistry



A schematic representation of an Environmental Pollution Process



Major Air Pollutants

Note :-

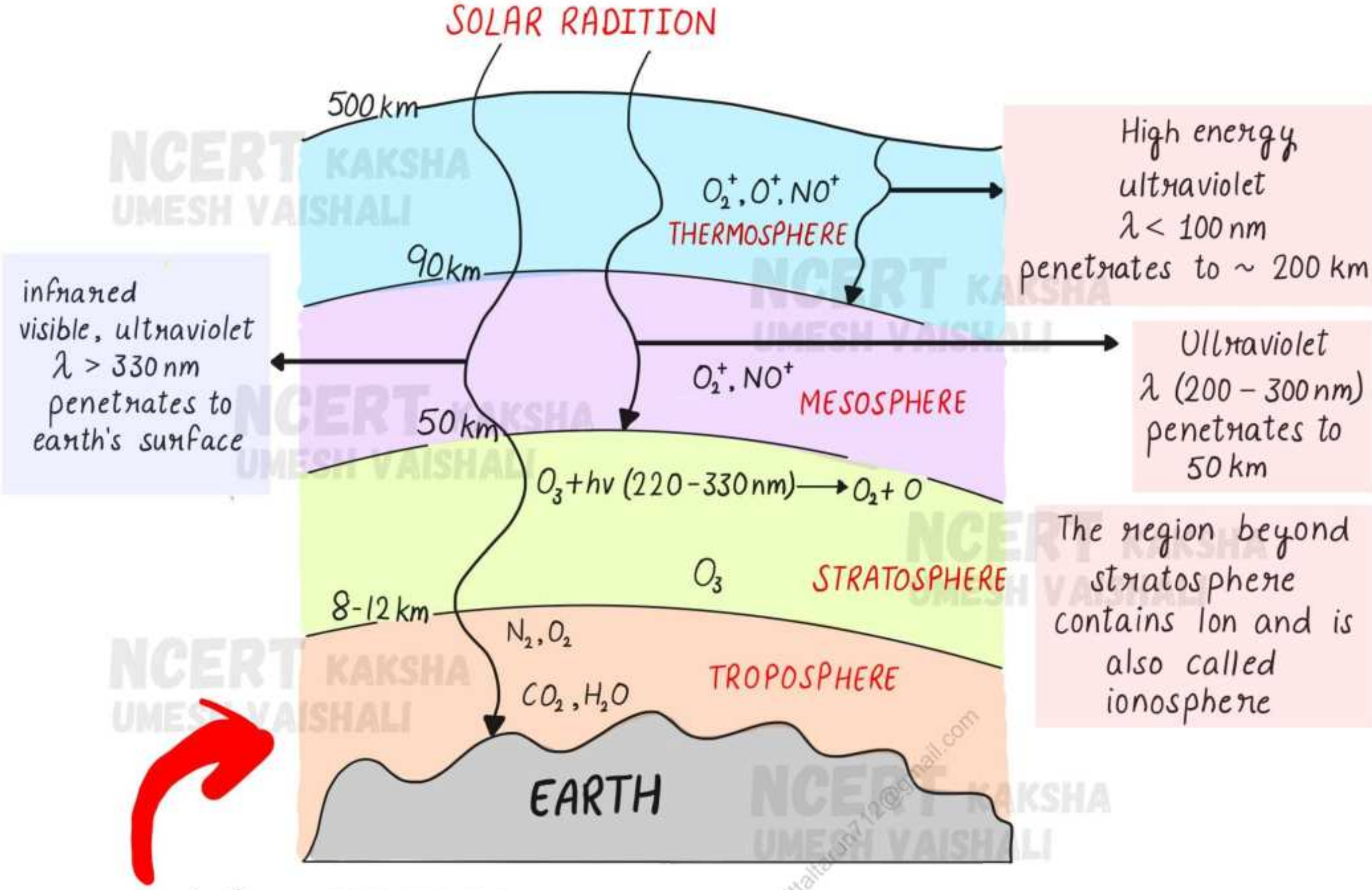
- TLV (Threshold limit value)
- MIC (methyle isocyanate)
- PAH (Polycyclic aromatic hydrocarbons)
- PAN (Peroxyacylnitrate) $R-\underset{\underset{O}{\|}}{C}OONO_2$

SMOG → smoke + fog ⟶ smog (containing harmful gases)

Note :-
- Asbestos causes asbestosis
- The dust containing silica (SiO_2) causes silicosis.
- The workers working in coal mines suffer from black lung disease.
- Textile workers suffer from white lung disease.

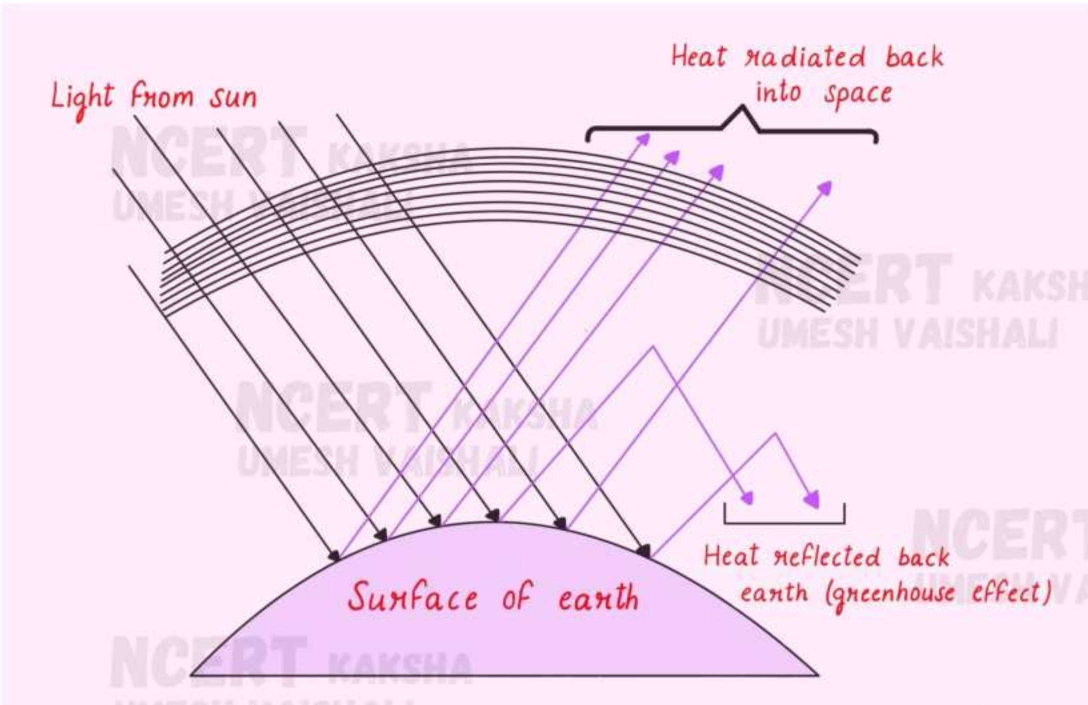
Note :-
- The Thick layer of ozone is called ozone blanket.
- The ozone layer is also known as protective shield.
- CFCs **(chlorofluorocarbons)**
- PSCs **(Polar stratospherio clouds)**

small o
Co – cobalt
CO – carbon monoxide
Capital O



Major regions of atmosphere

Pollutant	Major pollutant source
CO	Transportation, autoexhaust, petroleum, paper industries, iron and steel industries, solid waste disposals.
CO_2^*	Fuel combustion and industrial processes.
SO_2	Metallurgical operation, combustion of coal and oil, paper, manufacture of H_2SO_4.
NO, NO_2	Fertilizer industries, explosive industries, manufacture of HNO_3.
H_2S	Petroleum refining, coke ovens, natural gas plants.
Cl_2	Industrial processes such as paper, plastics, dyes, chlorinated hydrocarbons.
NH_3	Natural biological processes, industrial processes, ammonia works.
Hydrocarbons	Petroleum refineries, chemical processes, rubber manufacture transportation, solid waste disposal.
Particulates	Volcanic eruptions, metallurgical operations such as smelting and mixing, incomplete combustion in industrial processes.



Green house gases $\rightarrow$ CO_2, CH_4, O_3, H_2O vapour, CFCs

Green house Effect

Pollutant	Sources
Micro-organisms	Domestic sewage
Organic wastes	Domestic sewage, animal manures, food processing wastes, decaying plants and animals, paper discards, rags and other bio degradable wastes
Plant nutrients	Chemical fertilizers
Toxic heavy metals	Industries and chemical factories
Sediments	Insoluble particles of soil and rock and inorganic and organic compounds which wash into water from mining, agricultural activities, construction agricultural actities construction activities and soil erosion.
Pesticides	Chemicals used for killing insects, fungi and weeds
Radioactive wastes	Mining of uranium containing minerals and accidental release from nuclear plants.
Heat	Water used by industrial plants for cooling which is discharged as hot water.

Major water Pollutants and their sources

Permissible limits of Drinking water

Parameter	Pemissible limits (ppm)	Ill- effects of pollutants
Dissolved Oxygen	250	—
(pH)	5.5-9.5	Cramps, paralysis
Arsenic	0.05	
Barium	1.0	Toxic to heart
Cadmium	0.005	Anaemic, kidney dysfunction
Chromium	0.05	Carcinogenic
Fluoride	1-1.5	Skeleton disorder, nervouse breakdown and mottling of teeth enamel
Lead	0.05	Anamic, kidney dysfunction, nervous disorder, brain damage
Aluminium	0.2	
Selenium	0.01	Toxic at high levels
Copper	3.0	Toxic to plants and algae
Mercury	0.001	Highly toxic, mental disorders and death
Zinc	5.0	Toxic
Alkyl benzene-sulphonate	0.5	Irritation of the gastrointestinal tract
Chloride	600	Harms agricultural crops
Sulphate	500	Laxative and hypertension
Pesticides	0.005	Toxic, carcinogenic, kidney dysfunction

Note :-
- Polychlorinated biphenyls (PCBs)
- Biochemical oxygen diamond (BOD)
- chemical oxygen demand (COD)

The clean water would have a BOD value of less than 5 ppm whereas BOD of 17 ppm or more indicate highly polluted water.

- Sodium chlorate ($NaClO_3$)
- Sodium arsenate ($NaAsO_3$)

Note :- hydroxyapatite $[3Ca_3(PO_4)_2 \cdot Ca(OH)_2]$
Fluroapatite $[3Ca_3(PO_4)_2 \cdot CaF_2]$

Excessive nitrate in drinking water is also harmful and cause methemoglobinemia (blue baby syndrome)

DDT (dichloro disphenyl thrichloro ethane)

OR

[2,2 (bis - p - chlorophenyl) - 1,1,1- trichloromethane]

Important Note :-

- A major Air Pollution accident (Bhopal Gas Tragedy)
- 2 December 1984 in Bhopal (Madhya Pradesh) in the union carbide factory
- Deadly MIC (methyl isocynate) gas leaked

➡ MIC

$$\underset{}{CH_3NH_2} + \underset{\text{Phosgene}}{COCl_2} \longrightarrow \underset{\text{MIC}}{CH_3N=C=O} + 2HCl$$

Note :-
- PCDDs (polychloro dibenzodioxins)
- PCDFs (polychloro dibenzofurans)
- $Cl_2C = CCl_2$ (Tetrachloroethene)

➡ Acid Rain

- Rain water containing acids such H_2SO_4 and HNO_3 and has pH of 4-5
- Acid rain attacks marble of Taj Mahal of Agra

$$\underset{\text{Marble}}{CaCO_3} + \underset{\text{acid}}{H_2SO_4} \longrightarrow CaSO_4 + H_2O + CO_2$$

UNIT - 19

Purification And Characterisation of Organic Compounds

- ORGANIC COMPOUNDS
  - Acyclic or open chain compounds
  - cyclic or closed chain compounds
    - Homocyclic or carbocyclic compounds
      - Alicyclic compounds
      - Aromatic compounds
        - Benzenoid compounds
        - Non-benzenoid compounds
    - Hetrocyclic compounds

➡ IUPAC System of Naming Organic Compounds

(i) Word root

Chain length	Word root	chain length	word root
C_1	Meth	C_8	Oct
C_2	Eth	C_9	Non
C_3	Prop	C_{10}	Dec
C_4	But	C_{11}	Undec
C_5	Pent	C_{12}	Dodec
C_6	Hex	C_{20}	Icosane
C_7	Hept	C_{30}	Triacontane

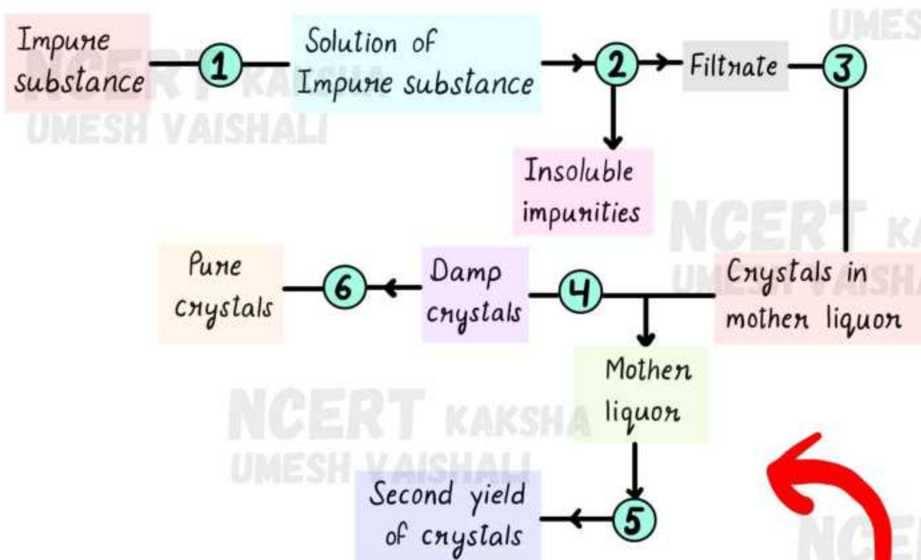
(ii) Suffix

(a) Primary suffix

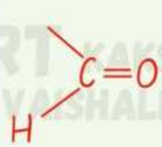
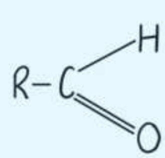
ane — for single bonded compounds, $C-C$
ene — for double bonded compounds, $C=C$
yne — for triple bonded compounds, $C\equiv C$

(b) Secondary suffix

Class of organic compound	Functional group	Secondary suffix
Alcohols	$-OH$	-ol
Aldehydes	$-CHO$	-al
Ketones	$>C=O$	-one
Carboxylic acid	$-COOH$	-oic acid
Esters	$-COOR$	alkyl..... oate
Acid chlorides	$-COCl$	-oyl chloride
Acid amides	$-CONH_2$	-amide
Nitriles	$-C\equiv N$	-nitrile
Amines	$-NH_2$	-amine



Schematic flow sheet for crystallisation

Class of compounds	Functional group	General formula	Suffix or Prefix	Examples
Alkenes	$-\overset{\vert}{C}=C-$	Suffix - ene C_nH_{2n}	Replace 'ane' of alkane by 'ene'	$CH_3CH_2CH=CH_2$ But-1-ene $CH_3CH=CHCH_3$ But-2-ene
Alkynes	$-C\equiv C-$	C_nH_{2n-2}	Suffix - yne Replace 'ane' of alkane by 'yne'	$HC\equiv CCH_2CH_3$ But-1-yne $H_3CC\equiv CCH_3$ But-1-yne
Arenes				 **Benzene**
Haloalkanes	$-X$ $(X=F, Cl, Br, I)$	RX	Prefix - halo named as haloalkanes	$CH_3CH_2CH_2CH_2Cl$ 1-Chlorobutane $CH_3CH(Cl)CH_2CH_3$ 2-Chlorobutane
Alcohols	$-OH$	$R-OH$	Suffix - ol Replace 'e' of alkane by 'ol'	$CH_3CH_2CH_2CH_2OH$ Butan-1-ol $CH_3CH_2CH(OH)CH_3$ Butan-2-ol
Thiols	$-SH$	$R-SH$	Suffix - thiol Replace 'e' of alkane by 'thiol'	$CH_3CH_2CH_2CH_2SH$ Butan-1-thiol
Ethers	$-O-$	$R-O-R'$ (R' may be R)	Prefix - alkoxy named as 'alkoxy' alkane	$CH_3CH_2OCH_2CH_3$ Ethoxy ethane $CH_3OCH_2CH_2CH_3$ Methoxy propane
Aldehydes			Suffix - al Replace 'e' of alkane by 'al'	$CH_3CH_2CH_2CHO$ Butanal

Ketones	$>C=O$	$RCOR'$	Suffix- one Replace 'e' of alkane by 'one'	$CH_3CH_2\overset{O}{\overset{\parallel}{C}}CH_3$ Butan-2-one
Carboxylic acid	$HO-C(=O)-$	$RCOOH$	Suffix-oic acid Replace 'e' of alkane by 'oic' acid	$CH_3CH_2CH_2COOH$ Butanoic acid
Carboxylate ion	$-COO^-$	$RCOO^-$	Suffix-oate Replace 'ie' acid of the	$CH_3CH_2CH_2COO^-Na^+$ Sodium butanoate
Carboxylic acid derivatives				
(i) Acyl halides	$X-C(=O)-$ (X= Cl, Br, I)	$RCOX$	Suffix-oyl halide Replace -ic of the corresponding acid by 'yl' halide	$CH_3CH_2CH_2COCl$ Butanoyl chloride
(ii) Esters	$RO-C(=O)-$	$RCOOR'$	Prefixing name of the alkyl group and replacing '-ic' acid of the corresponding acid by 'ate'.	$CH_3CH_2COOCH_3$ Methyl propenoate
(iii) Amides	$NH_2-C(=O)-$	$RCONH_2$	Suffix— amide Replace 'oic' acid of corresponding acid by 'amide'	$CH_3CH_2CH_2CONH_2$ Butanamide
(iv) Acid anhydrides	$-\overset{O}{\overset{\parallel}{C}}-O-\overset{O}{\overset{\parallel}{C}}-$	$R-\overset{O}{\overset{\parallel}{C}}-O-\overset{O}{\overset{\parallel}{C}}-R$	Add anhydride to the name of corresponding acid	$CH_3\underset{O}{\underset{\parallel}{C}}-O-\underset{O}{\underset{\parallel}{C}}-CH_3$ Ethanoic anhydride
Amines	$-NH_2$	RNH_2	Suffix— amine prefix amino named as 'amino alkane' or 'alkanamine'.	$CH_3CH_2CH_2CH_2NH_2$ Butan-1-amine
Cyanides	$-CN$	RCN	Suffix-nitrile Add nitrile after the name of alkane	$CH_3CH_2CH_2CN$ Butanenitrile
Nitro	$-NO_2$	RNO_2	Prefix nitro Add nitro before the name of alkane	$CH_3CH_2CH_2CH_2NO_2$ 1-Nitrobutane

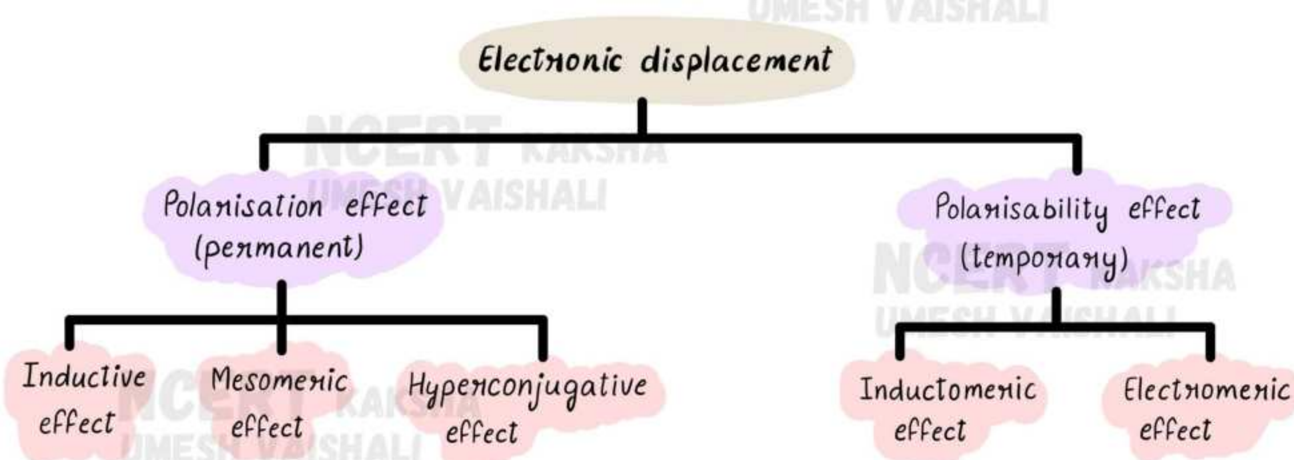
UNIT – 20

Some Basic Principles of Organic Chemistry

Hybridisation

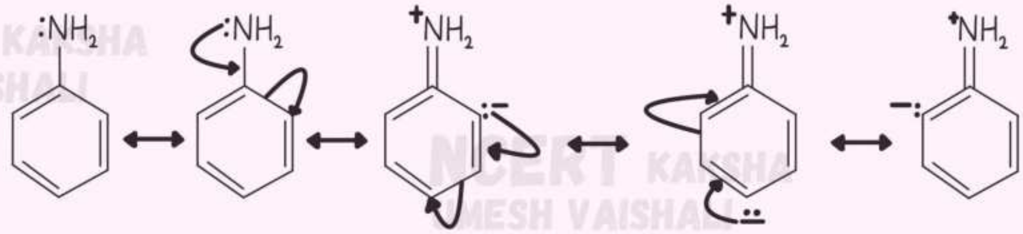
Type of hybridisation	sp^3	sp	sp
Number of orbitals used	1s and 3p	1s and 2p	1s and 1p
Number of unused p-orbitals	Nil	One	Two
Bond	Four - σ	Three - σ One - π	Two - σ Two - π
Bond angle	109.5°	120°	180°
Geometry	Tetrahedral	Trigonal planar	Linear
% s-character	25 or 1/4	33.33 or 1/3	50 or 1/2

Number of π - bond/s	0	1	2
Type of hybridisation	sp^3	sp^2	sp

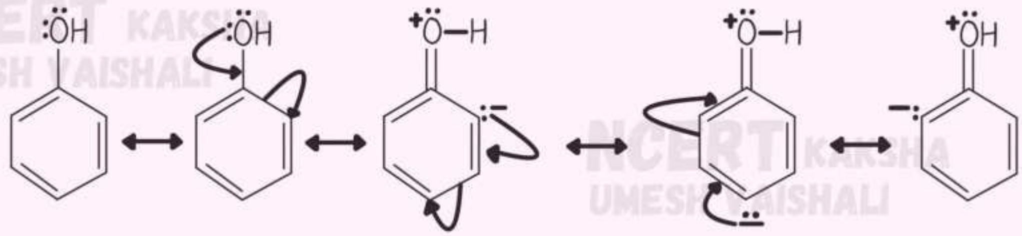


Resonance

Aniline $C_6H_5NH_2$:



Phenol C_6H_5OH :



Estimation of Elements

$$\%C = \frac{12}{44} \times \frac{\text{Mass of } CO_2}{\text{Mass of compound}} \times 100$$

$$\%H = \frac{2}{18} \times \frac{\text{Mass of } H_2O}{\text{Mass of compound}} \times 100$$

$$\%N = \frac{28}{22400} \times \frac{\text{Vol. of } N_2 \text{ at STP}}{\text{Mass of compound}} \times 100 \quad \textbf{(Duma's method)}$$

$$= \frac{1.4 \times \text{Molarity of acid} \times \text{Basicity} \times \text{Vol. of acid used}}{\text{Mass of compound}} \times 100 \quad \textbf{(Kjeldahl's method)}$$

$$\underset{\text{(halogen)}}{\%X} = \frac{\text{At. mass of X} \times \text{Mass of AgX}}{(108 + \text{At. mass of X}) \times \text{Mass of compound}} \times 100$$

$$\%S = \frac{32}{233} \times \frac{\text{Mass of } BaSO_4}{\text{Mass of compound}} \times 100$$

UNIT- 21

Hydrocarbons

Hydrocarbons

- **Saturated**
  contain C–C single bond
  - alkanes
    C_nH_{2n+2}
- **Unsaturated**
  contain carbon–carbon single bond
  - Alkenes (double bond) C_nH_{2n}
  - Alkynes (triple bond) C_nH_{2n-2}
- **Aromatic**
  contain benzene ring
  - Benzene, toluene

Note :- Alkanes are also called **Paraffins**
Alkenes are also called **Olefins**

Nomenclature of Alkanes

No. of carbon atoms	Formula	Name
1	CH_4	Methane
2	C_2H_6	Ethane
3	C_3H_8	Propane
4	C_4H_{10}	Butane
5	C_5H_{12}	Pentane
6	C_6H_{14}	Hexane
7	C_7H_{16}	Heptane
8	C_8H_{18}	Octane
9	C_9H_{20}	Nonane
10	$C_{10}H_{22}$	Decane
11	$C_{11}H_{24}$	Undecane
12	$C_{12}H_{26}$	Dodecane
20	$C_{20}H_{42}$	Eicosane
30	$C_{30}H_{62}$	Triacontane

➡ Wurts Reaction :-

$$CH_3CH_2\boxed{I + 2Na + I}CH_2CH_3 \xrightarrow{\text{Dry ether}} CH_3CH_2CH_2CH_3 + 2NaI$$

Ethyl iodide — Butane

Corey - House Reaction :-

$$\underset{\text{Ethyl Bromide}}{CH_3CH_2Br} + 2Li \xrightarrow{\text{Dry ether}} \underset{\text{Ethyl Lithium}}{CH_3CH_2Li} + LiBr$$

$$2CH_3CH_2Li + CuI \longrightarrow \underset{\text{Lithium diethyl copper}}{[(CH_3CH_2)_2Cu]^- Li^+} + LiI$$

$$[(CH_3CH_2)_2Cu]^- Li^+ + \underset{\text{n-propyl bromide}}{CH_3CH_2CH_2Br} \xrightarrow{\text{Dry ether}} \underset{\text{n-pentane}}{CH_3CH_2CH_2CH_2CH_3} + \underset{\text{Ethyl copper}}{CH_3CH_2Cu} + LiBr$$

Decarboxylic Reaction :-

$$\underset{\text{Sodium ethanote}}{CH_3\boxed{COONa + NaO}H} \xrightarrow[\text{Heat}]{CaO} \underset{\text{Methane}}{CH_4} + Na_2CO_3$$

Swarts Reaction :-

$$2CH_3CH_2Cl + \underset{\text{Mercurous Fluoride}}{HgF_2} \longrightarrow \underset{\text{Fluoroethane}}{2CH_3CH_2F} + Hg_2Cl_2$$

Note :- • The reactivity of halogenation is therefore,

fluorine > chlorine > bromine > iodine

- The rate of replacement of hydrogens of alkanes is : **$3^\circ > 2^\circ > 1^\circ$**
- Partially deactivated palladised charcoal is known as **Lindlar's catalyst**.
- Alkaline potassium permanganate solution is known as **Baeyer's Reagent**.

Birch Reduction :-

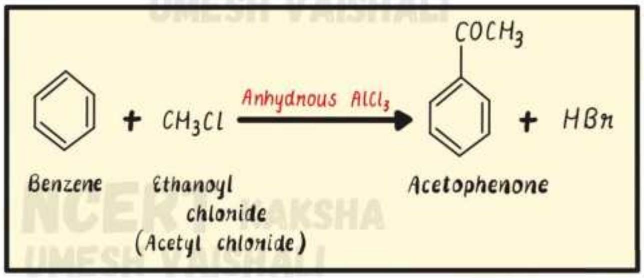
$$\underset{\text{Ethyne}}{HC \equiv CH} \xrightarrow[\text{OR } Na/liq.\, NH_3]{Pd/C,\ H_2} \underset{\text{Ethene}}{H_2C = CH_2}$$

Kolbe's Reaction :-

$$\underset{\text{Potassium succinate}}{\begin{array}{c} CH_2COOK \\ | \\ CH_2COOK \end{array}} + 2H_2O \xrightarrow{\text{Electrolysis}} \underset{\text{Ethylene}}{\begin{array}{c} CH_2 \\ \| \\ CH_2 \end{array}} + 2CO_2 + H_2 + 2KOH$$

➡ Friedal - Crafts Alkylation reaction :-

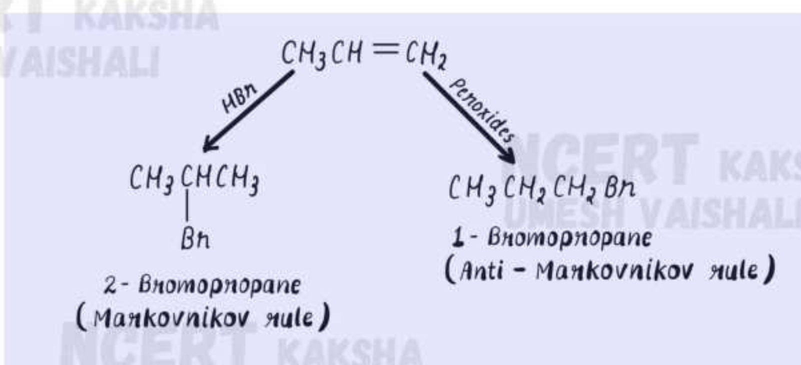
➡ Friedal - Crafts Acylation reaction :-



Note :-

➡ **Markovnikov's Rule** :- During electrophilic addition across unsymmetrical double bond, the negative part of the adding molecule goes to that carbon atom which has lesser number of hydrogen atoms.

➡ **Anti - Markovnikov's Rule OR Peroxide Effect** :- The addition of HBr to unsymmetrical alkene in the presence of organic peroxides such as benzoyl peroxide, ($C_6H_5CO-O-O-COC_6H_5$) takes place opposite to the Markovnikov rule. This is known as **Anti - Markovnikov Rule OR Peroxide Effect.**



Organic Compounds Containing Halogens

R-X An alkyl Halide (Haloalkane)
- X = F, Cl, Br, I
- R = Alkyl or substituted alkyl

Ar-X An aryl Halide (Haloarene)
- X = F, Cl, Br, I
- Ar = Phenyl or substituted Phenyl

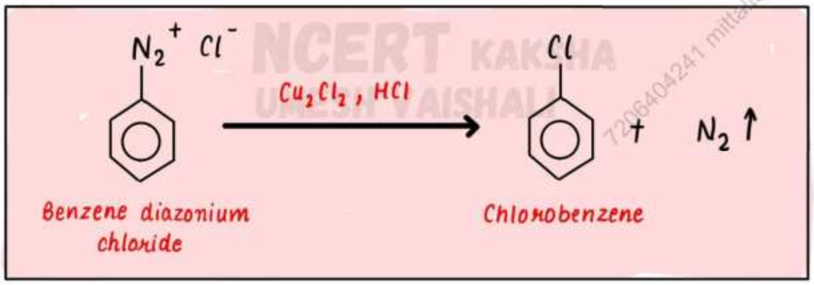
$$\text{Specific rotation } (\alpha) = \frac{\text{Observed rotation } (\alpha_{obs})}{\text{Length of tube (dm)} \times \text{Concentration of solution } (g\,mL^{-1})}$$

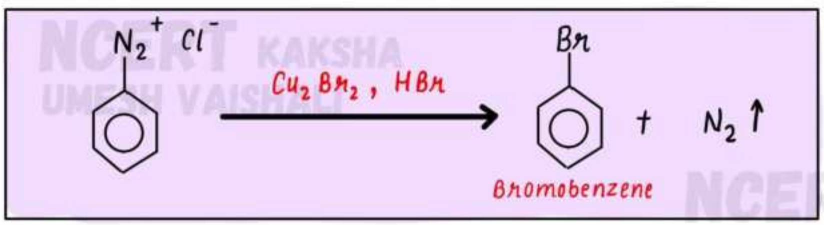
• Naming Reactions —

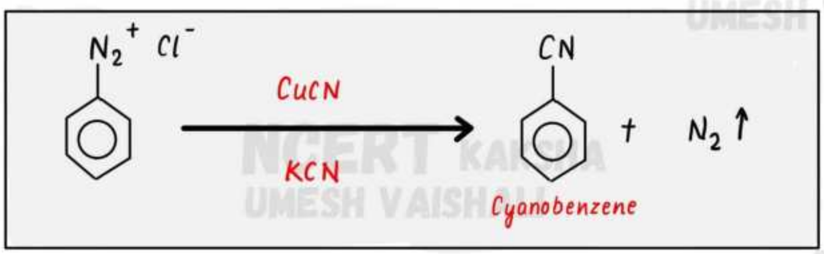
➡ Swarts Reaction

$$3CCl_4 + 2SbF_3 \xrightarrow[SbCl_5]{Heat} \underset{\text{Freon - 12}}{3CCl_2F_2} + 2SbCl_3$$

➡ Sandmeyer's Reaction







➡ Finkelstein Reaction

$$\underset{\text{Ethyl Chloride}}{CH_3CH_2Cl} + NaI \xrightarrow{\text{Dry Acetone}} \underset{\text{Ethyl Iodide}}{CH_3CH_2I} + NaCl$$

$$\underset{\text{Ethyl bromide}}{CH_3CH_2Br} + NaI \xrightarrow{\text{Dry Acetone}} \underset{\text{Ethyl Iodide}}{CH_3CH_2I} + NaBr$$

➡ Wurtz Reaction

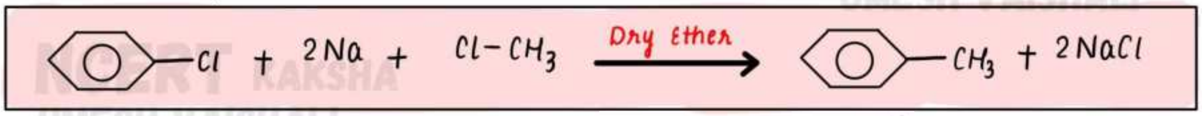
$$CH_3Br + 2Na + Br-CH_3 \xrightarrow{\text{Dry Ether}} CH_3CH_3 + 2NaBr$$

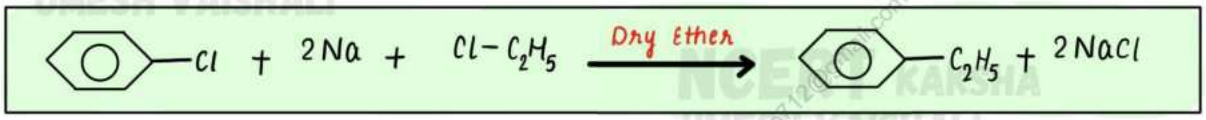
Methyl Bromide — Ethane

$$CH_3-\underset{\displaystyle CH_3}{\overset{|}{CH}}-Br + 2Na + Br-\underset{\displaystyle CH_3}{\overset{|}{CH}}-CH_3 \xrightarrow{\text{Dry Ether}} CH_3-\underset{\displaystyle CH_3}{\overset{|}{CH}}-\underset{\displaystyle CH_3}{\overset{|}{CH}}-CH_3 + 2NaBr$$

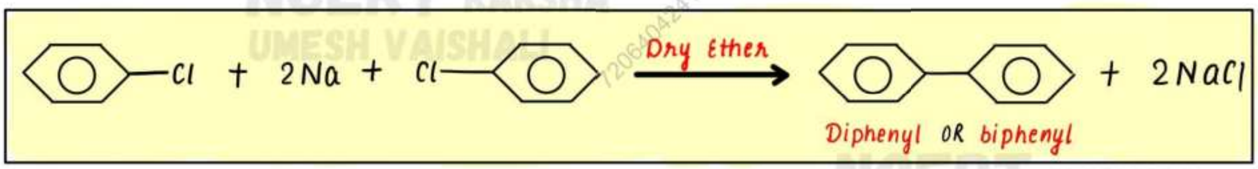
Isopropyl Bromide — 2,3 - Dimethylbutane

➡ Wurtz - Fittig Reaction

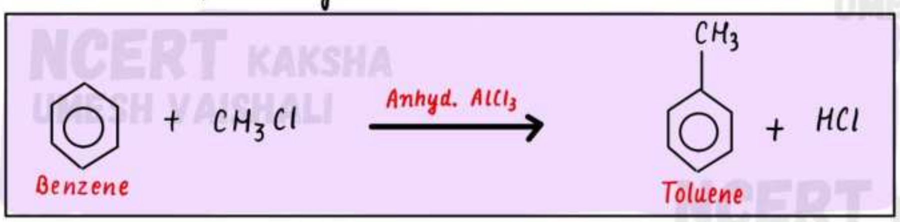


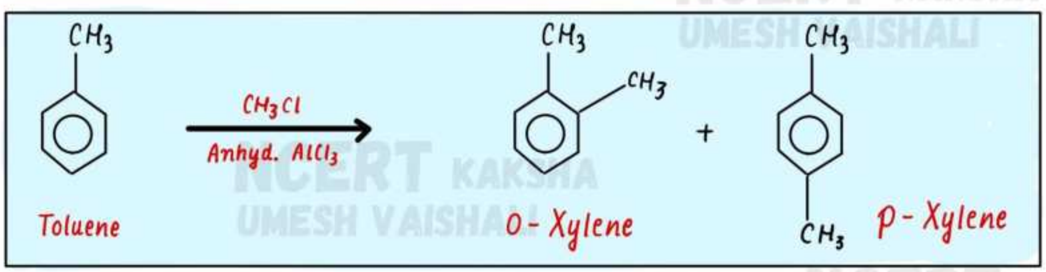


➡ Fittig's Reaction

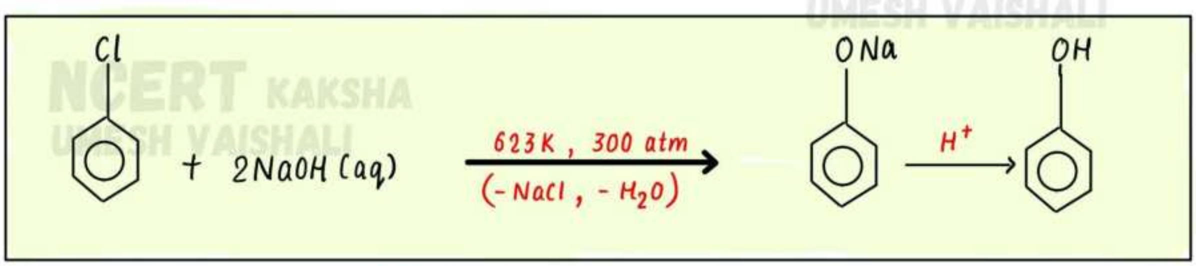


➡ Friedel - Crafts Alkylation





➡ Dow's Process

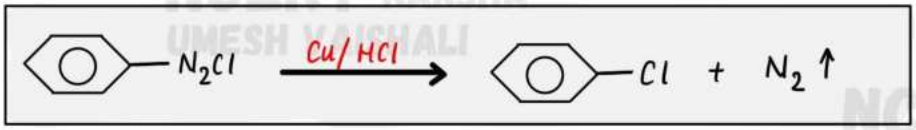


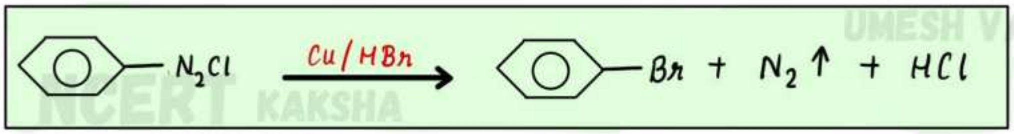
Hunsdiecker's Reaction

$$R-COOAg + Br_2 \xrightarrow[Reflux]{CCl_4} R-Br + AgBr + CO_2 \uparrow$$

$$CH_3CH_2COOAg + Br_2 \xrightarrow[Reflux]{CCl_4} CH_3CH_2-Br + AgBr + CO_2 \uparrow$$

Gatterman's Reaction

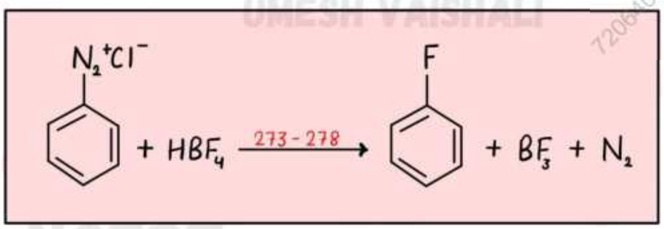




Birnbaum – Simonini reaction

$$2RCOOAg + I_2 \longrightarrow RCOOR + CO_2 + 2AgI$$

Balz-Schiemann reaction



Rasching process

$$2C_6H_6 + 2HCl + O_2 \xrightarrow{CuCl_2,\ \Delta} 2C_6H_6Cl + 2H_2O$$

Mendius reaction

$$CH_3CN \xrightarrow{Na,\ C_2H_5OH} CH_3CH_2NH_2$$

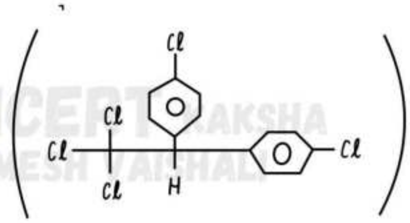
Ullmann reaction

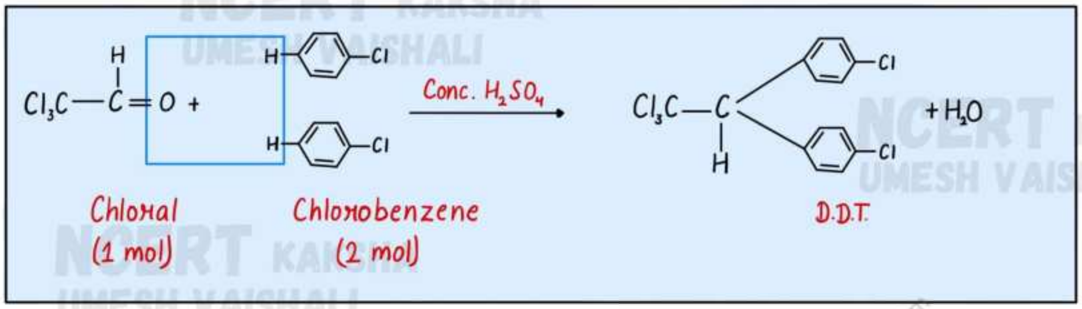
$$C_6H_6I + 2Cu + IC_6H_6 \longrightarrow C_6H_6C_6H_6 \text{ (Diphenyl)}$$

Note :- $SOCl_2$ – thiony chloride

SO_2Cl_2 – sulphury chloride

Note :- DDT (p, p' - Dichlorodiphenyl trichloroethane)



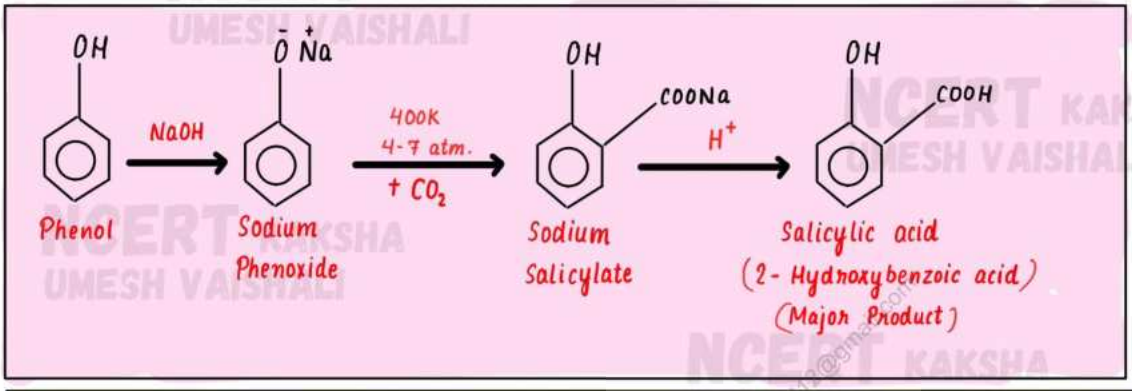


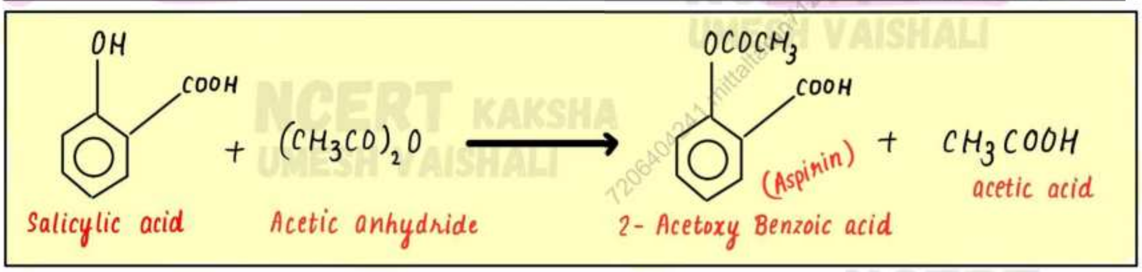
UNIT – 23

Organic Compounds Containing Oxygen

ALCOHOLS, PHENOLS AND ETHERS

➡ **Kolbe's Reaction**





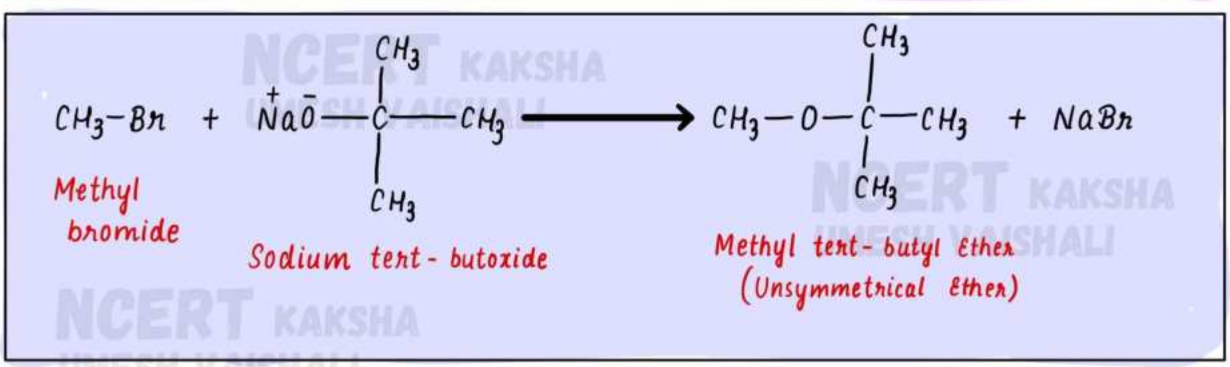
➡ **William Synthesis**

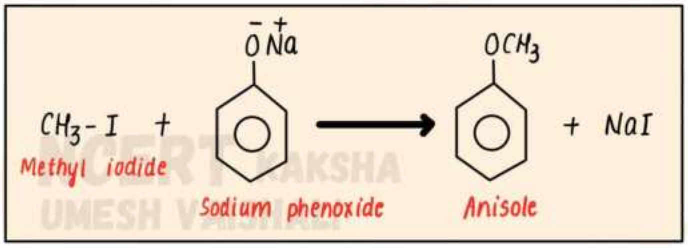
$$R{-}X + \overset{+}{Na}{-}\overset{-}{O}{-}R' \longrightarrow R{-}O{-}R' + NaX$$

Alkyl halide · Sodium alkoxide · Ether

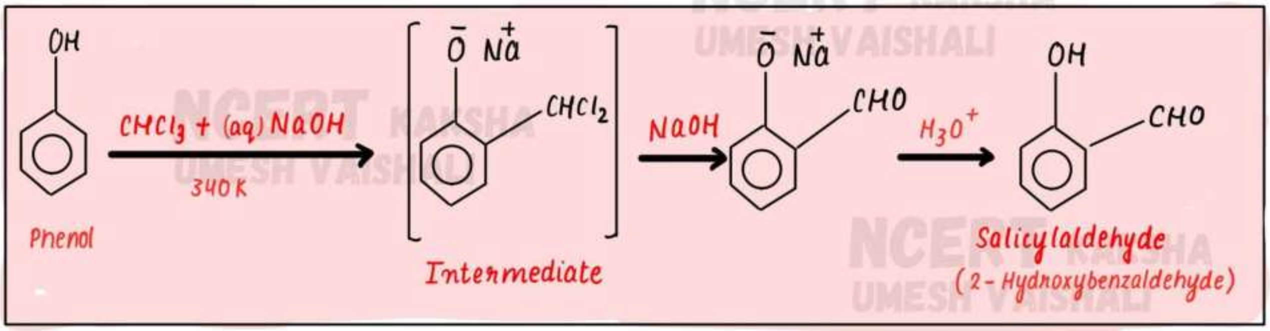
$$CH_3{-}CH_2{-}I + \overset{+}{Na}{-}\overset{-}{O}{-}CH_2{-}CH_3 \longrightarrow CH_3{-}CH_2{-}O{-}CH_2{-}CH_3 + NaI$$

Ethyl iodide · Sodium ethoxide · Diethyl Ether (Symmetrical Ether)

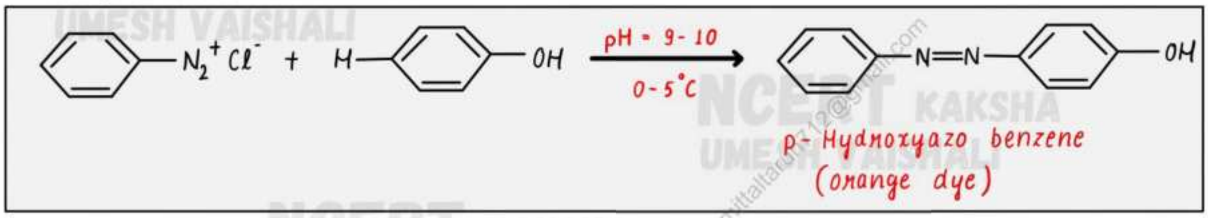




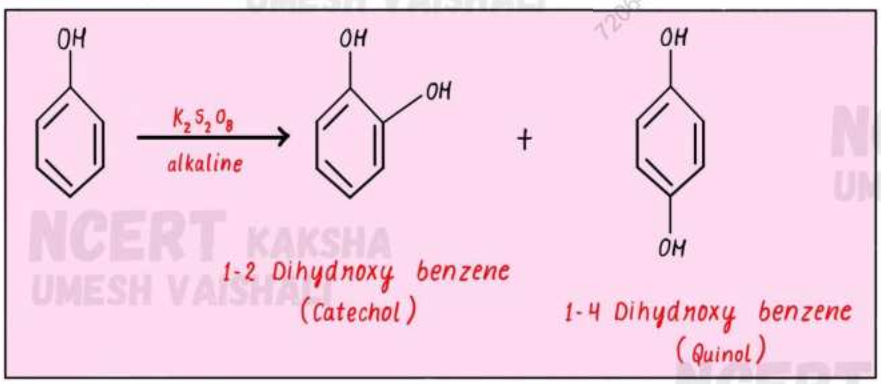
➡ Riemer - Tiemann Reaction



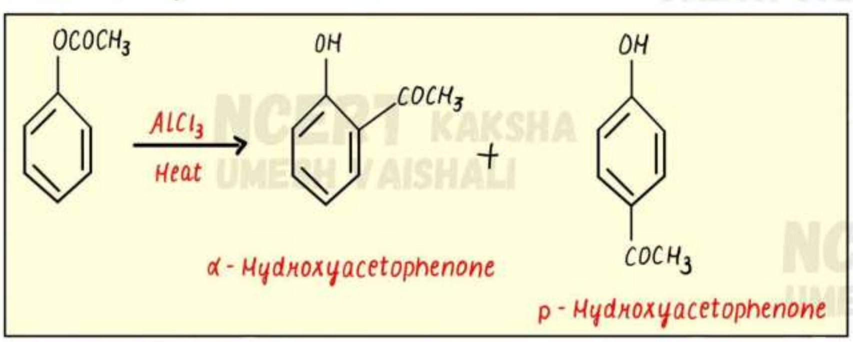
➡ Coupling reactions



➡ Elbs persulphate oxidation



➡ Fries rearrangement

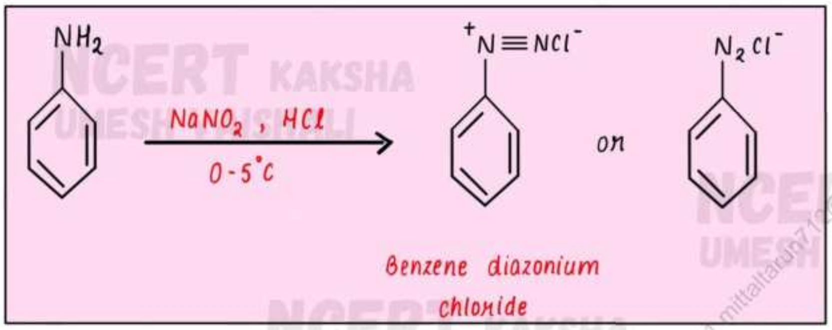


📍 **Note :-** • **Collins reagent** – $CrO_3 \cdot 2C_5H_5N$ [chromium trioxide pyridine]

• PCC – $CrO_3 \cdot C_5H_5N \cdot HCl$ **OR** $(C_5H_5NH)^+ CrO_3Cl^-$ [pyridine chlorochromate] **(Corey's reagent)**

- PDC - $(C_5H_5NH)_2^{2+} Cr_2O_7^{2-}$ [pyridine chlorochromate]
- 2,4,6 - Trinitrophenol is also known as **picric acid**
- Alcohols are weaker acid than water.
- Phenol is more acidic than ethyl alcohol.
- Electron withdrawing groups $(-NO_2, -CN, X)$ increase acidic strength.
- Electron donating groups $(-NO_2, -CN, X)$ decrease acidic strength.

➡ Diazotisation reaction



ALDEHYDE, KETONE, CARBOXYLIC ACIDS

➡ Rosenmund Reaction

$$\underset{\text{Acyl chloride}}{R-\overset{O}{\overset{\|}{C}}-Cl} + H_2 \xrightarrow{Pd/BaSO_4} \underset{\text{Aldehyde}}{R-\overset{O}{\overset{\|}{C}}-H} + HCl$$

$$\underset{\text{Acetyl chloride}}{CH_3-\overset{O}{\overset{\|}{C}}-Cl} + H_2 \xrightarrow{Pd/BaSO_4} \underset{\text{Acetyldehyde}}{CH_3-\overset{O}{\overset{\|}{C}}-H} + HCl$$

$R-\overset{O}{\overset{\|}{C}}-H$ Aldehyde
(where R may be H or any alkyl, aryl or aralkyl group)

$R-\overset{O}{\overset{\|}{C}}-R'$ Ketone
(where R and R' may be same or different alkyl, aryl or aralkyl group)

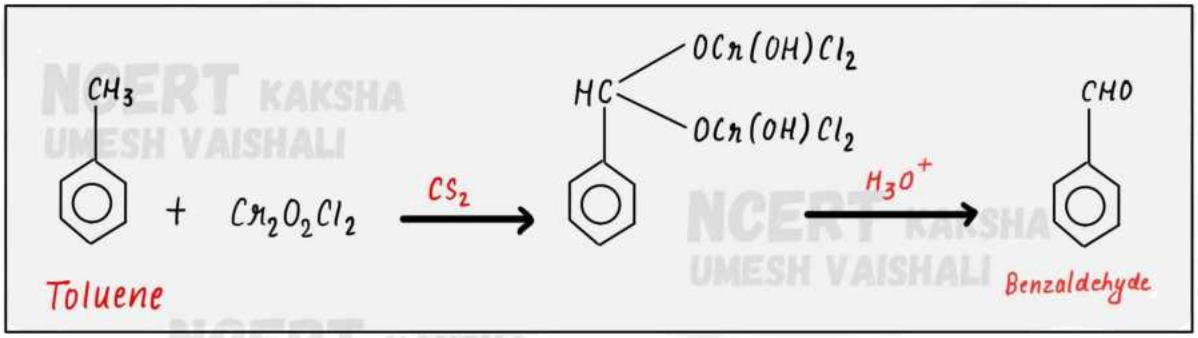
$R-\overset{O}{\overset{\|}{C}}-OH$ Carboxylic Acid
(where R may be H or any alkyl, aryl or aralkyl group)

➡ Stephen Reaction

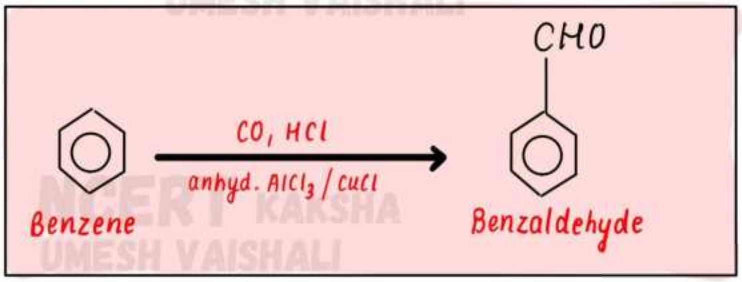
$$SnCl_2 + 2HCl \longrightarrow SnCl_4 + 2[H]$$

$$\underset{\text{Ethanenitrile}}{CH_3-C{\equiv}N} + 2[H] + HCl \longrightarrow \underset{\text{Acetaldoxime hydrochloride}}{CH_3-CH{=}NH.HCl} \xrightarrow{H_2O\ (boil)} \underset{\text{Acetaldehyde}}{CH_3-CHO} + NH_4Cl$$

Etard Reaction



Gatterman - Koch Reaction



Clemmensen Reduction

$$>C=O + 4[H] \xrightarrow[\text{HCl (conc.)}]{\text{Zn-Hg}} >CH_2 + H_2O$$

$$\underset{\text{Butyraldehyde}}{CH_3-CH_2-CH_2-CHO} + [H] \xrightarrow[\text{HCl (conc.)}]{\text{Zn-Hg}} \underset{\text{n-butane}}{CH_3-CH_2-CH_2-CH_3} + H_2O$$

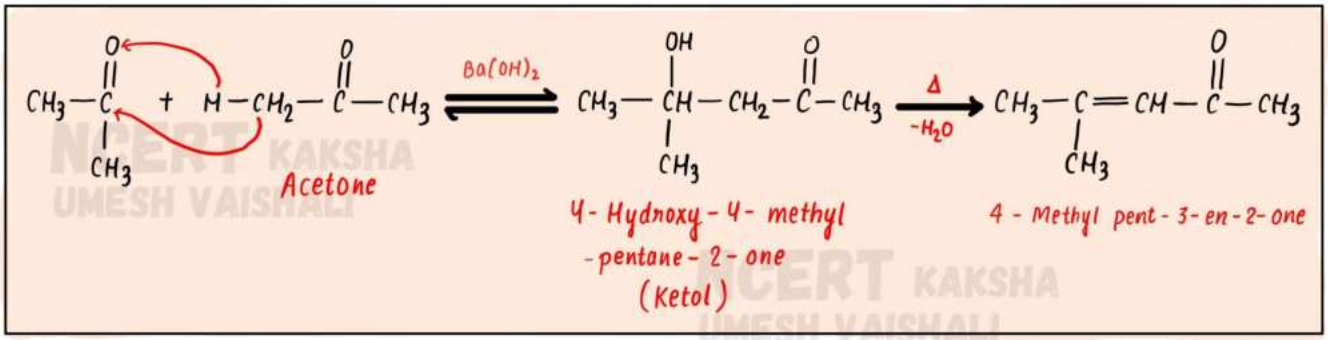
Wolff - Kishner Reduction

$$>C=O \xrightarrow[-H_2O]{+NH_2-NH_2} \underset{\text{Hydrazone}}{>C=N-NH_2} \xrightarrow[\text{Ethylene glycol, }\Delta]{\text{KOH}} >CH_2 + N_2$$

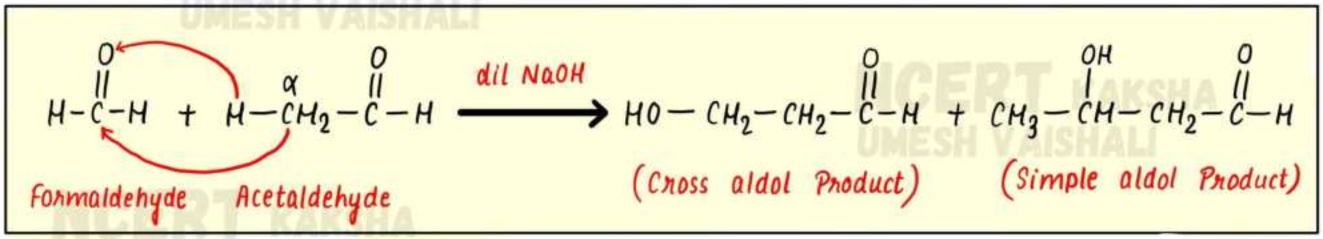
$$\underset{\text{Acetone}}{(CH_3)_2C=O} \xrightarrow[-H_2O]{+NH_2-NH_2} (CH_3)_2C=N-NH_2 \xrightarrow[\text{Ethylene glycol, }\Delta]{\text{KOH}} \underset{\text{Propane}}{(CH_3)_2CH_2} + N_2$$

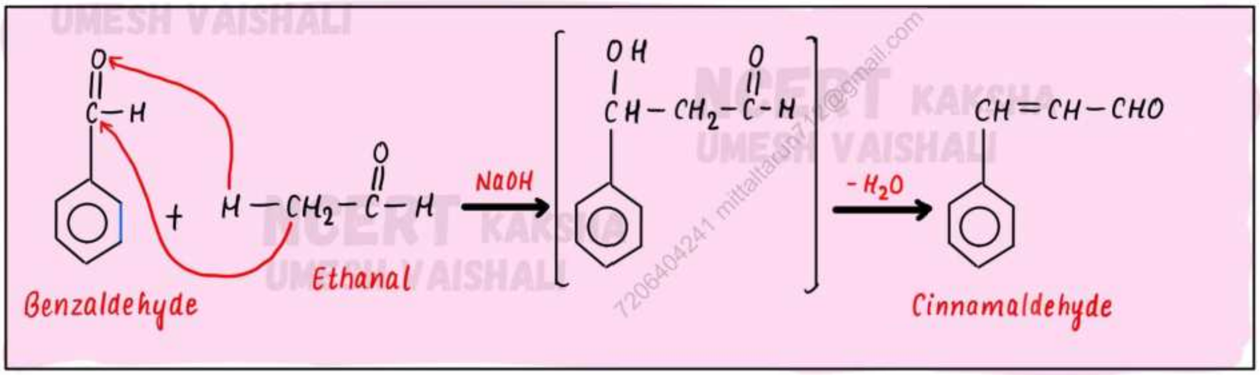
Aldol condensation

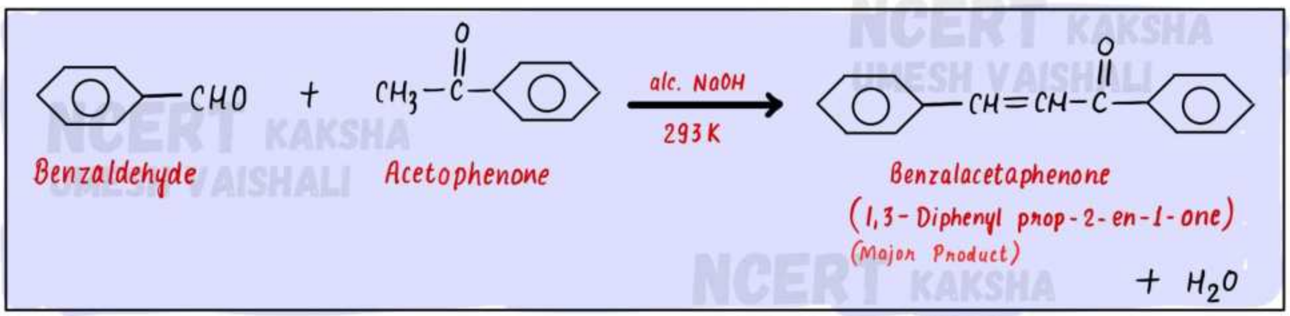
$$\underset{\text{Ethanal}}{CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-H} + H-CH_2-CHO \xrightleftharpoons{\text{dil. NaOH}} \underset{\text{3-hydroxy butanal (aldol)}}{CH_3-\overset{\overset{\displaystyle OH}{|}}{CH}-CH_2-CHO} \xrightarrow[-H_2O]{\Delta} \underset{\text{But-2-enal}}{CH_3-CH=CH-CHO}$$



Cross aldol Condensation







Hell - Volhard - Zelinsky Reaction

$$R-CH_2-COOH \xrightarrow[\text{(ii) } H_2O]{\text{(i) } X_2 / \text{Red P}} R-\overset{\alpha}{C}H(X)-COOH$$

α- Halocarboxylic acid

X = Cl, Br

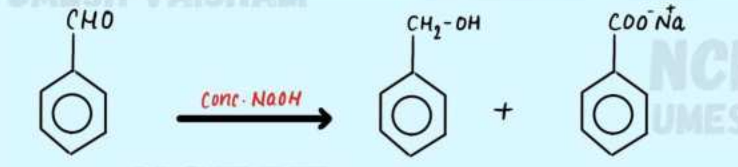
$$CH_3-CH_2-COOH \xrightarrow[\text{(ii) } H_2O]{\text{(i) } Cl_2 / \text{Red P}} CH_3-\overset{\alpha}{C}H(Cl)-COOH$$

Propanoic Acid → 2- Chloropropanoic acid

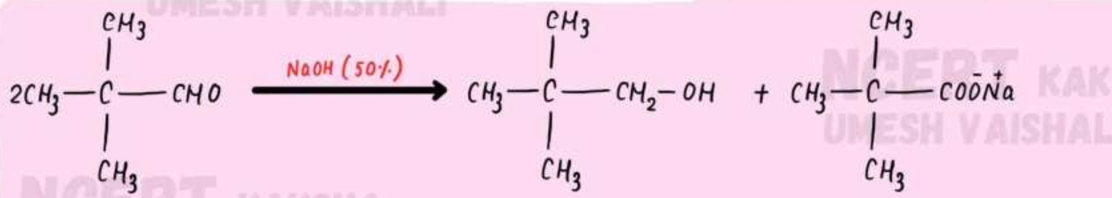
Cannizzaro Reaction

$$2HCHO \xrightarrow{\text{conc. } KOH} CH_3-OH + HCOO^-K^+$$

Formaldehyde — Methyl Alcohol — Potassium formate



Benzaldehyde — Benzyl alcohol — Sodium benzoate



2,2- Dimethylpropanal — 2,2- Dimethylpropanol — Sodium 2,2- dimethylpropanote

Wacker's Process

$$CH_3CH{=}CH_2 + PdCl_2 + H_2O \xrightarrow[\text{Air OR } O_2]{CuCl_2} CH_3COCH_3 + Pd + 2HCl$$

Propene — Acetone

Schiff bases

$$C_6H_5CHO + H_2NC_6H_5 \longrightarrow C_6H_5CH{=}N-C_6H_5 + H_2O$$

Benzaldehyde — Aniline — Benzalaniline Schiff's base

Note :- Tollen's reagent ➡ $[Ag(NH_3)_2]OH$

UNIT – 24

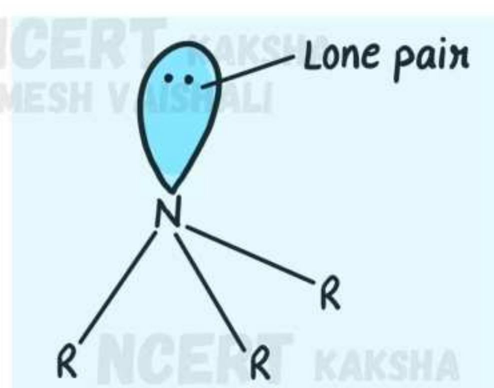
Organic Compounds Containing Nitrogen

Functional group	Class of compounds	General formula
$-NH_2$	(i) Primary amines	RNH_2
$-\underset{\vert}{N}H$	(ii) Secondary amines	R_2NH
$-\underset{\vert}{\overset{\vert}{N}}$	(iii) Tertiary amines	R_3N
$-C\equiv N$	Cyanides	RCN
$-N\equiv C$	Isocyanides	RNC
$-N(=O)-O$	Nitro compounds	RNO_2
$-O-N=O$	Nitrites	$RONO$
$-N_2^+X^-$	Diazonium salts	$ArN_2^+X^-$

Amines

- **Primary Amine (1°)**: $\left(R-\overset{H}{\overset{\vert}{N}}-H\right)$
- **Secondary Amine (2°)**: $\left(R-\overset{R'}{\overset{\vert}{N}}-H\right)$
- **Tertiary Amine (3°)**: $\left(R-\overset{R'}{\overset{\vert}{N}}-R''\right)$

where R, R' and R'' are alkyl groups



➡ Characteristic group in 1°, 2° and 3° amine

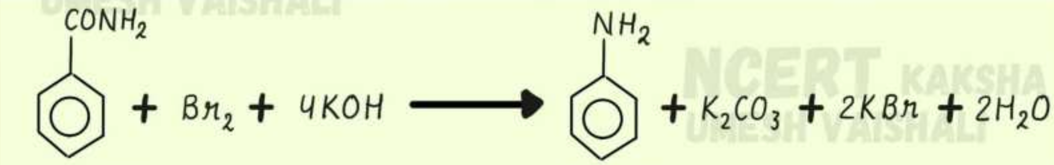
$-NH_2$	$-\overset{\vert}{N}H$	$-\underset{\vert}{\overset{\vert}{N}}$
(amino)	(imino)	(tert Nitrogen)

Note :-
- $C_6H_5NH_2$ is known as **aniline** OR **Benzenamine**
- **Order of Reactivity of halides** – $RI > RBr > RCl$

➡ Hoffmann Bromide Reaction :-

$$R-CONH_2 + Br_2 + 4NaOH \longrightarrow R-NH_2 + Na_2CO_3 + 2NaBr + 2H_2O$$

Acid Amide → 1° Amine



Benzamide → Aniline

➡ Mendius Reaction :-

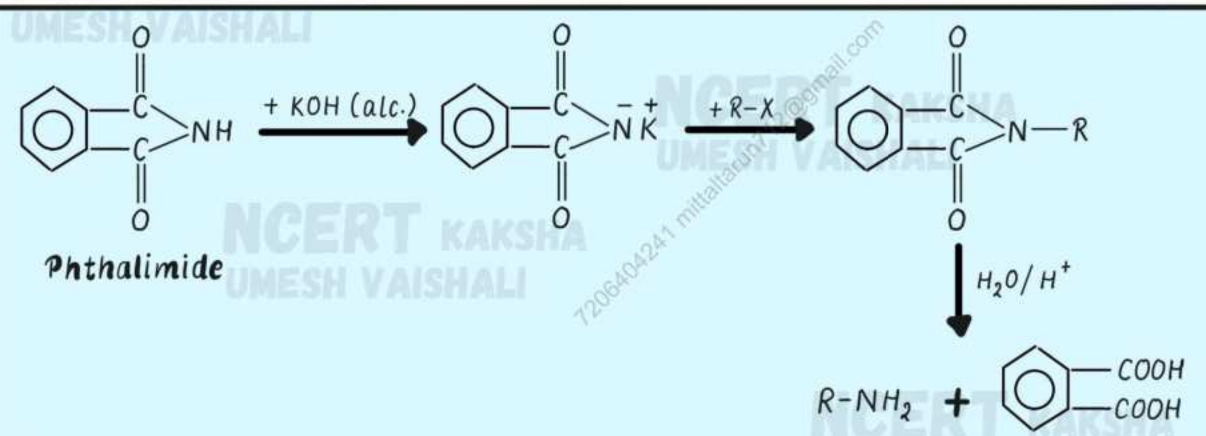
$$CH_3CN \xrightarrow[C_2H_5OH]{Na(Hg)} CH_3CH_2NH_2$$

➡ Schmidt Reaction :-

$$R-\overset{\overset{O}{\|}}{C}-OH \xrightarrow[\text{conc. } H_2SO_4]{N_3H} R-NH_2 + CO_2 + N_2$$

1° Amine

➡ Gabriel phthalimide Synthesis :-



Phthalimide

$R-NH_2$ + Phthalic acid

1° Amine, Phthalic acid

➡ Sabatier and Mailhe method :-

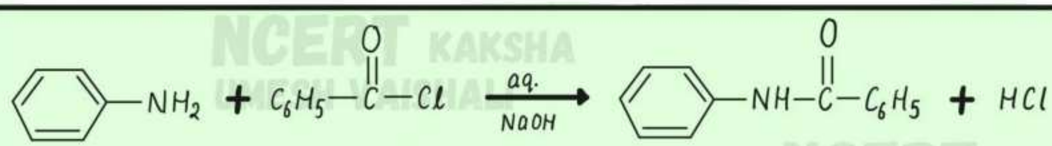
$$C_2H_5OH + NH_3 \xrightarrow[Al_2O_3]{723K} C_2H_5NH_2 \xrightarrow[Al_2O_3]{C_2H_5OH} (C_2H_5)_2NH \xrightarrow[Al_2O_3]{C_2H_5OH} (C_2H_5)_3N$$

Ethyl Amine, Diethyl Amine, Triethyl Amine

N_3H → hydrazoic acid

N_3^- → Azide ion

➡ Schotten Baumann Reaction :-



Aniline + Benzoyl chloride → N-Phenylbenzamide (Benzanilide) + HCl

➡ Schiff's Base OR Anils :-

$$R-\underset{\underset{H}{|}}{C}=O + H_2NR \longrightarrow R-CH=NR + H_2O$$

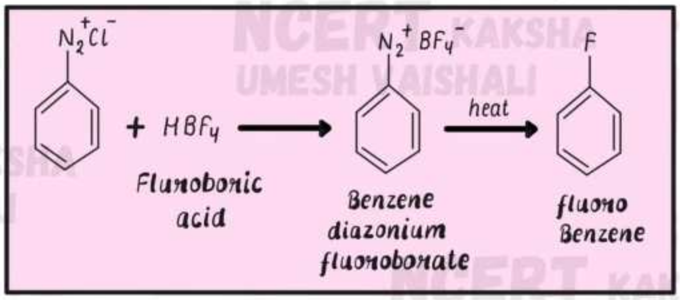
Schiffs Base
OR
Anil

➡ Carbyl amine Reaction (Isocyanide Test) :-

$$R-NH_2 + CHCl_3 + 3KOH\,(alc) \xrightarrow{\Delta} R-NC + 3KCl + 3H_2O$$

1° Amine — Alkyl isocynaide

➡ Balzschiemann Reaction :-



• ($C_6H_5SO_2Cl$) Benzene sulphonyl chloride which is known as **Hinsberg Reagent.**

➡ Hoffmann mustard oil Reaction :-

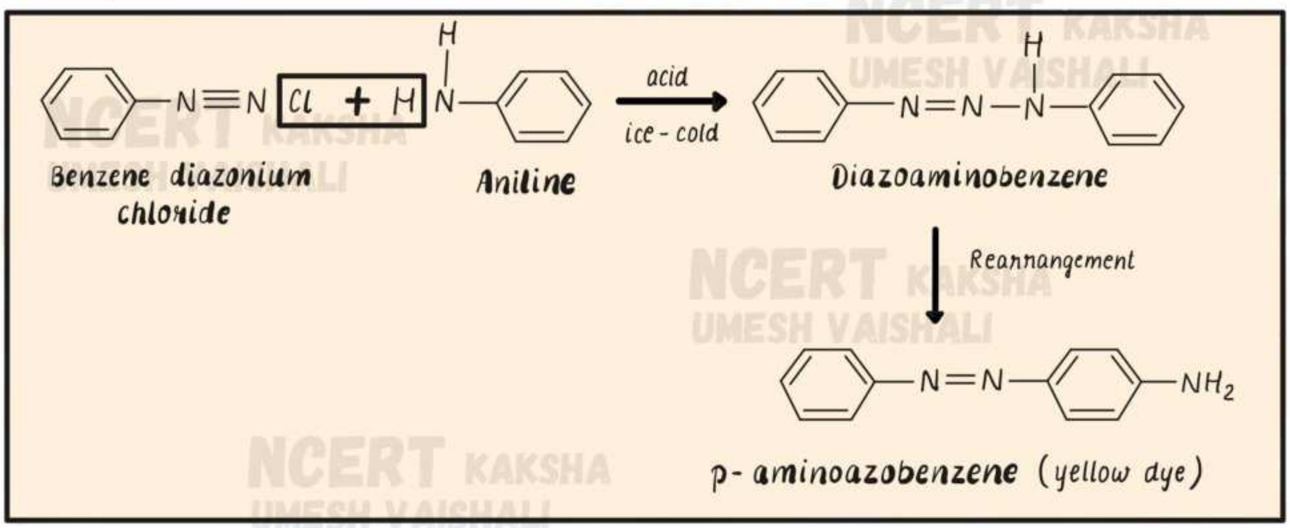
$$R-\ddot{N}H_2 + S=C=S \xrightarrow{\text{warm}} RNH-\overset{\overset{\Large S}{\|}}{C}-SH \xrightarrow[HgCl_2]{\text{Heat}} R-N=C=S + HgS + 2HCl$$

Carbon Sulphide — Dithoalkylcarbamic acid — Alkyl isocyanate

Note :- Basic characten of Amines in tenms of K_b and pK_b $\quad \boxed{pK_b = -\log K_b}$

Langen the value of K_b on smallen the value of pK_b stnongen is the base.

➡ Coupling **OR** diazo reaction :-



➡ Diazonium Salt :- General formula – $ArN_2^+X^-$

where X^- may be an anion like Cl^-, Br^-, HSO_4^-, BF_4^- etc.

➡ Diazonium group **OR** diazo group :- $(-N\equiv N^+)$

Note :- Gattermann reaction is modification of Sandmeyer reaction.

UNIT- 25

Polymers

Polymers
Large molecules formed by monomers

Natural
- Starch, rubber, cellulose

Synthetic
- Nylon, terylene, PVC

Semi synthetic
- Cellulose diacetate, vulcanised rubber

Homopolymers
one type of monomers
- Polythene, PVC

Copolymers
different monomers
- Buna-S, nylon 6,6

On the basis of structure

▫ Linear Polymers
Monomers are joined together to from straight chains.
- PVC. nylon, Polythene, polyesters.

▫ Branched chain polymers
Monomers are joined irregularly to form branches along the main chain.
- Glycogen, amylopectin

▫ Cross linked polymers
Initially formed linear polymer chains are joined together to from three dimensional network.
- Bakelite, melamine formaldehyde

On the basic of mode of synthesis

Addition polymers
formed by addition of monomers without elimination of water
- Buna-S, polythylene

Condensation polymers
formed by combination of monomers with elimination of water, alcohol, CO_2, etc.
- Nylon 6,6; bakelite

• In terms of intermolecular forces thermosetting > Thermoplastic > fibres > Elastomers

Natural rubber is a polymer of isoprene (2-methylbuta-1,3-diene)
It is cis-polyisoprene having cis-configuration about the double bond.

On the basic of intermolecular forces

- **Elastomers**
  Rubber like solids with elastic properties having weakest intermolecular forces.
  ▸ Buna-S, Buna-N, Neoprene

- **Fibres**
  Thread forming solids possessing high tensile strength and high modulus. These have strong intermolecular forces like hydrogen bonds
  ▸ Nylon 6,6; terylene

- **Thermoplastics**
  Have intermolecular forces between those of elastomers and fibres. Hard at room temperature, become soft and viscous on heating.
  ▸ Polythene, polystyrene, teflon

- **Thermosetting**
  Cross linked and heavily branched which on heating undergo permanent change by extensive cross linking in moulds.
  ▸ bakelite, urea-formaldehyde

Note :-

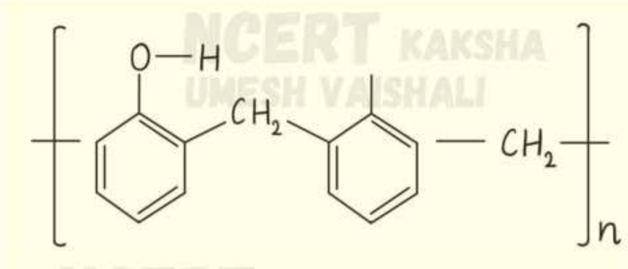
- Poly means **many and mer means anit or part**
- **Very high molecular mass** of the order **$10^3 - 10^7 u$**
- They are also called **macromolecules**.
- The simple molecules which combine to give polymers are called **monomers**
- The process by which the simple molecules are converted into **polymer** is called **polymerization**

$$nCH_2=CH_2 \xrightarrow{\text{Polymerization}} -\!\!(CH_2-CH_2)\!\!-_n$$

Ethylene (monomers) → polyethylene or polythene (polymer)

$-\!\!(CH_2-\underset{\underset{CH_3}{|}}{C}=CH-CH_2)\!\!-_n$ ⇒ **Natural rubber (elastomer)**

$-\!\!\left(\overset{\overset{H}{|}}{N}-(CH_2)_6-\overset{\overset{H}{|}}{N}-\overset{\overset{O}{\|}}{C}-(CH_2)_4-\overset{\overset{O}{\|}}{C}\right)\!\!-_n$ ⇒ **Nylon 6,6 (fibre)**



⇒ **Bakelite thermosetting polymer**

$-\!\!(CH_2-\underset{\underset{Cl}{|}}{CH})\!\!-_n$ ⇒ **(Polyvinyl chloride) PVC (thermoplastic)**

$-\!\!(CH_2-\overset{\overset{CH}{|}}{CH})\!\!-_n$ ⇒ **Orlon (polyacrylonitrile)**

$-\!\!(CF_2-CF_2)\!\!-_n$ ⇒ **Teflon**

➡ **Polyethylene OR Polythene**

(a) Law density polythene (LDP)

$$nCH_2=CH_2 \xrightarrow[\text{High pressure (1000 - 2000 atm)}]{350-570\,K} -\!\!(CH_2-CH_2)\!\!-_n$$

Polythene

(b) High density polythene (HDP)

$$nCH_2=CH_2 \xrightarrow[\text{Ziegler - Natta catalyst}]{333-343\,K,\ 6-7\,atm} -\!\!(CH_2-CH_2)\!\!-_n$$

Polythene

➡ (Teflon or PTEE) Polytetrafluoroethylene

$$nF_2C = CF_2 \xrightarrow[\text{high pressure}]{\text{Catalyst, Heat}} -\!\!\left(F_2C - CF_2\right)\!\!-_n$$

Tetrafluoroethane — Teflon

➡ Polyacrylonitrite (PAN) **OR** Orlon **OR** acrilan

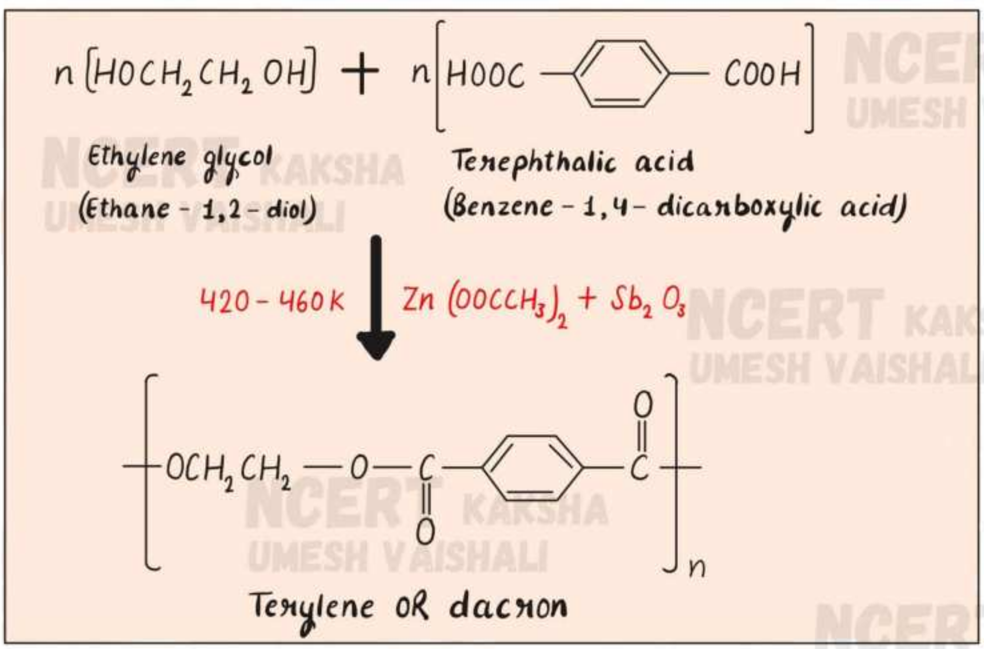
$$nCH_2 = CHCN \xrightarrow{\text{Peroxide (catalyst)}} \left[-CH_2 - \underset{\displaystyle CH}{\underset{|}{CH}} -\right]_n$$

Vinyl cyanide (acrylonitrite) — Polyacrylonitrile

➡ Polyesters $\left[-\underset{\displaystyle O}{\underset{\|}{C}}-O-\right]$

📍 **Note :-** Zinc acetate – antimony trioxide $[Zn(OOCCH_3)_2 + Sb_2O_3]$

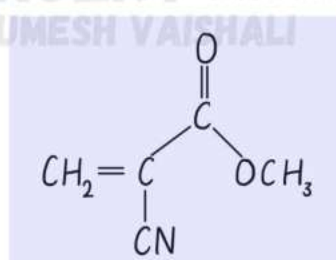
➡ Terylene **OR** dacron



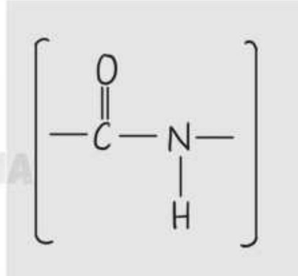
➡ **Learning plus**

- Super glue **OR** crazy glue

(polymer of methyl α - cyanoacrylate)

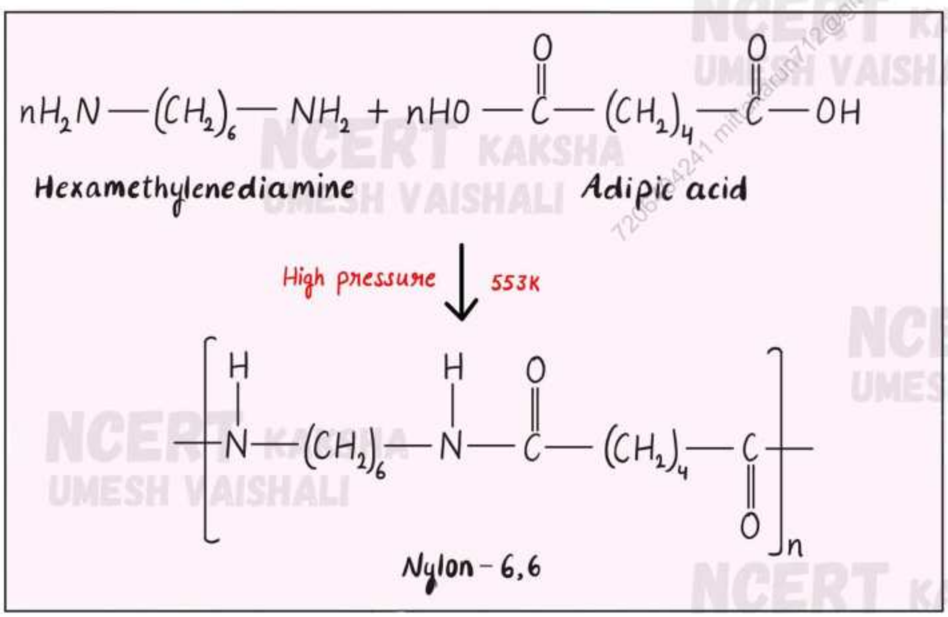


- Polyamides **OR** Nylons



Different structures of Polymers

➡ Nylon – 6,6



📍 **Note** :-
- Styrene Butadiene Rubber (SBR) **OR** Buna - S
- Polymer acid (PGA)
- Polylactic acid (PLA)
- Poly (E - caprolactone) (PCL)

➡ Number average molecular mass ($\overline{M}_N$)

$$\overline{M}_N = \frac{\sum N_i M_i}{\sum N_i}$$

where N_i = number of molecules of the i^{th} type
M_i = molecular mass

➡ Weight average molecular mass ($\overline{M}_w$) $\overline{M}_w = \frac{\sum m_i M_i}{\sum m_i}$

$$\overline{M}_w = \frac{\sum N_i M_i^2}{\sum N_i} \qquad [m_i = N_i M_i]$$

➡ Polydispersity index PDI $\boxed{PDI = \frac{\overline{M}_w}{\overline{M}_N}}$

- monodisperse polymers $\overline{M}_w = \overline{M}_N$ (PDI is one)
- polydisperse polymers $\overline{M}_w > \overline{M}_N$ (PDI is greater the one)

UNIT – 26

Biomolecules

➡ Carbohydrates – Monosaccharides / Oligosaccharides / Polysaccharides

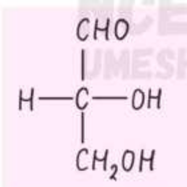
Important Rxn :-

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 2832\ KJ$$

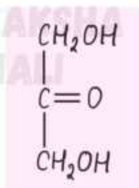
➡ Carbohydrates General formula $\Rightarrow C_x(H_2O)_y$

Note :- • The sugar that we most commonly use is called **Sucrose**.
• The sugar present in milk is known as **Lactose**.

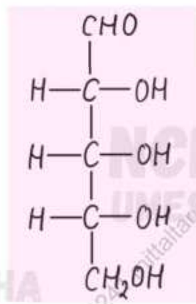
➡ Some structures of Monosaccharides



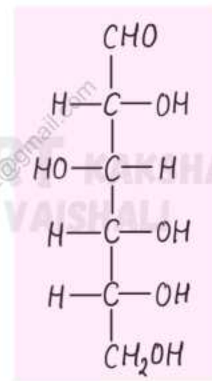
Glyceraldehyde



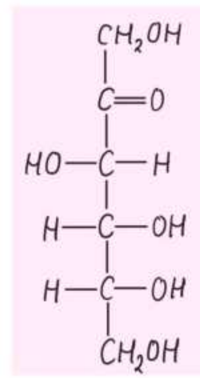
Dihydroxyacetone



Ribose (Aldopentose)



Glucose (Aldohexose)



Fructose (Ketohexose)

➡ Glucose :-

- It is also known as **Grape Sugar**.
- Glucose is an **Aldohexose**.
- It is also known as **Dexotrose**.
- **Molecular formula** – $C_6H_{12}O_6$

➡ Preparation of Glucose :-

1. From Sucrose (Cane Sugar) :-

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

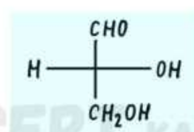
2. From Starch :-

$$\underset{\text{Starch}}{(C_6H_{10}O_5)_n} + nH_2O \xrightarrow[393K,\ 2\text{-}3\ atm]{H^+} \underset{\text{Glucose}}{nC_6H_{12}O_6}$$

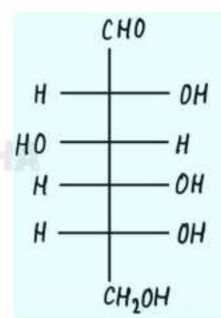
➡ Fructose (Fruit Sugar)

- **Molecular formula** – $C_6H_{12}O_6$
- It is also called **Laevulose**.
- D-Glucose and D-Fructose is called **invert sugar**.

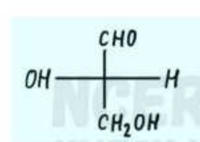
➡ Structure of Glucose



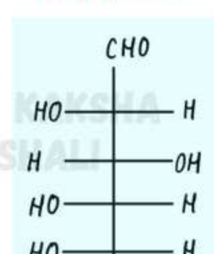
D (+) Glyceraldehyde



D (+) Glucose

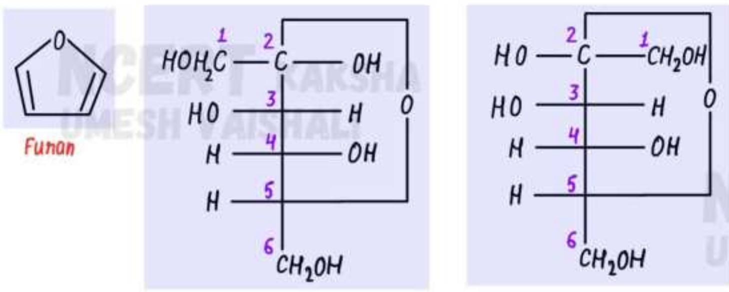


L (–) Glyceraldehyde



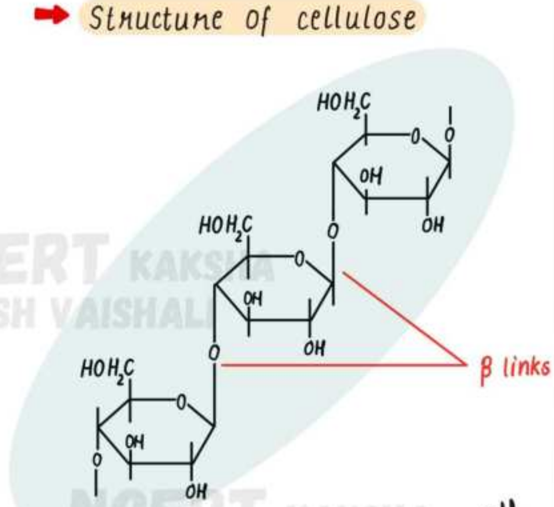
L (–) Glucose

Structure of fructose



α - D (-) fructofuranose   β - D (-) fructofuranose

Structure of cellulose



Note :- The linkage between two monosaccharide units through oxygen atom is called **Glycosidic Linkage**.

Maltose :- It is known as **malt sugar**

$$2\,(C_6H_{10}O_5) + nH_2O \xrightarrow{\text{Diastease}} nC_{12}H_{22}O_{11}$$

Lactose :- It is known as **milk sugar**

Fructose is the **sweetest** of all the natural sugars.

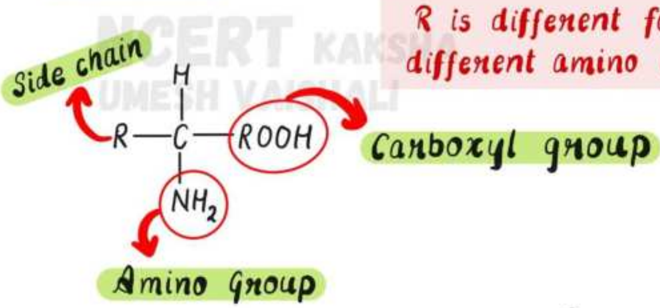
Glycogen $(C_6H_{10}O_5)$ also known as animal starch.

Note :-

- ATP (**Adenosine triphosphate**)
- ATP is an energy rich molecule and acts as a **source of energy**.
- ATP acts as a **centre of all activities of cell.**
- During synthesis of 1 molecule of glucose in photosynthesis **18 molecules of ATP are consumed**.
- ATP is known as **energy currency** of the cell.

Amino acids

R is different for different amino acides



Sugar	Relative sweetness
Lactose	16
Maltose	32
Galactose	32
Glucose	74
Sucrose	100
Fructose	173

Peptide bond OR Peptide linkage $\left(-\underset{\underset{O}{\|}}{C}-NH- \right)$

- DNA (Deoxyribonucliec acid)
- RNA (Ribonucliec acid)

Deficiency of Enzyme

- Insulin protein contains 51 amino acids.
- Phenyl alanine hydroxylase causes disease **Phenyl Ketone urea**.
- Tyrosinase causes disease **albinism**.

Note :-

- The condition of Vitamin deficiency is **avitaminoses**
- The condition of excess intake of Vitamin is **hypervitaminoses**

Nucleosides

Base + Sugar = **Nucleosides**

Nucleotides

Base + Sugar + Phosphate = **Nucleotide**

Hormone	Organ of secretion	Functions
		STEROID HORMONES
(a) Sex Hormones		
1. Testosterone	Testes	Regulates the development and normal functioning of male sex organs.
2. Estrogens (Estrone or Estradiol)	Ovary	Control the development and normal functioning of female sex organs.
3. Progesterone	Corpus luteum	Controls the development and maintenance of pregnancy.
(b) Adrenal cortex hormones		
4. Cortisone	Adrenal cortex	Regulate the metabolism of fats proteins and carbohydrates; control the balance of water and minerals in the body.
		PEPTIDE HORMONES
5. Oxytocin	Posterior pituitary gland	Controls the contraction of the uterus after child birth and release milk from the mammary glands.
6. Vasopressin	Pituitary glands	Controls the reabsorption of water in the kidney.
7. Insulin	Pancress	Controls the metabolism of glucose, maintains glucose level in the blood.
		AMINE HORMONES
8. Adrenaline **OR** Epinephrine	Adrenal medulla	Increases pulse rate and controls blood pressure. It releases glucose from liver glycogen and fatty acids from fat in emergency.
9. Thyroxine gland	Thyroid gland	Controls metabolism of carbohydrates, lipids and proteins.

Enzyme	Reaction catalysed
Maltase	Maltose $\longrightarrow$ Glucose + Glucose
Lactace	Lactose $\longrightarrow$ Glucose + Galactose
Amylase	Starch $\longrightarrow$ n × Glucose
Invertase	Sucrose $\longrightarrow$ Glucose + Fructose
Urease	Urea $\longrightarrow$ $CO_2 + NH_3$
Carbonic anhydrase	$H_2CO_3 \longrightarrow CO_2 + H_2O$
Pepsin	Proteins $\longrightarrow$ Amino acids
Trypsin	Proteins $\longrightarrow$ Amino acids
Nucleases	DNA, RNA $\longrightarrow$ Nucleotides
RNA Polymerase	Ribonucleotide triphosphates $\longrightarrow$ RNA
DNA Polymerase	Deoxynucleotide triphosphates $\longrightarrow$ DNA

Vitamin	Chemical name	Deficiency Disease	Sources of Vitamin
A	Retinol (bright eye vitamin)	Xerophthalmia i.e., hardening of cornea of eye or night blindness.	Cod liver oil, shark liver oil, correct rise polishing, liver, kidney, butter, milk, etc.
B_1	Thiamine	Beri-beri (loss of appetite, retarded growth); disease of nervous system	Milk, rise, yeast, nuts, eggs, green vegetables, liver, kidney
B_2	Riboflavin	Glossitis (dark red tongue), dermatitis and cheilosis (fissuring at corners of mouth and lips).	Turnip, milk, eggs, yeast, vegetables, liver, kidney.
B_6	Pyridoxine	Dermatitis and convulsions.	Yeast, milk, meet, fish, egg yolk, whole cereal, grams.
B_{12}	Cyanocobalamine	Pernicious anaemia (RBC deficiency in haemoglobin), inflammation of tongue and mouth.	Meat, eggs, liver of ox, sheep, pig, fish, curd, etc.
C	Ascorbic acid	Scurvy (bleeding of gums), pyorrhea (loosening and bleeding of teeth).	Citrus fruits like orange, lemon, amla, tomato, green vegetables.
D	Ergocalciferol	Rickets (bone deformities in children) and osteomalacia (soft bones and joint pains in adults).	Milk, egg yolk, cod liver oil, exposure to sunlight.
E	Tocoferol	Sterility	Oils like cotton seed oil, soyabean oil, wheat gram oil, sunflower oil.
K	Phylloquinone	Haemophilia (haemorrhagic condition), increased blood clothing time.	Cereals, green leafy vegetables.
H	Biotin	Dermatitis, loss of hair and paralysis.	Yeat, liver, kidney and milk
Q_{10}	Coenzyme	Low order of immunity of body against many disenses.	Chloroplasts of green plants and mitochondria of animals.

UNIT-27

Chemistry in Everyday Life

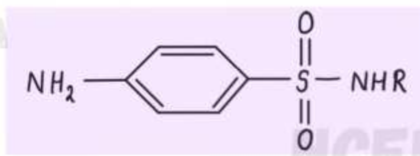
➡ **Drugs** :- A substance (chemical compound) used for the purpose of **diagnosis**, **prevention**, **relief** or **cure** of a **disease**.

📍 **Note** :- The word 'drug' is derived from the french word **'drogue'** meaning herb.

➡ **Medicine** :- When the drug has useful action as in the diagonsis, prevention, treatment and cure of a disease (called **therapeutic Effect**) it is called **medicine**.

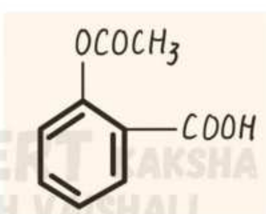
➡ **Chemotherapy** :- The use of chemicals for the therapeutic effect is called **Chemotherapy**.

➡ **Structure of sulphonamides**

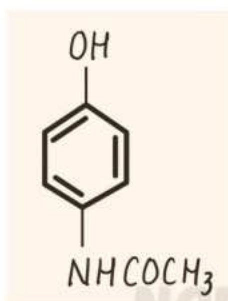


📍 **Note** :-
- The proteins which perform the role of biological catalyst are called **Enzymes**.
- The proteins which are very vital for communication system in the body are called **receptors**.
- The proteins which carry the polar molecules across the cell membrans are called **carrier protiens**.

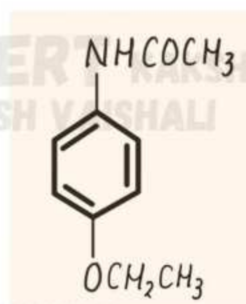
📍 **Note** :-



Aspirin
(2-Acetoxy Benzoic acid)



Paracetamol
(4-Aceta-midphenol)

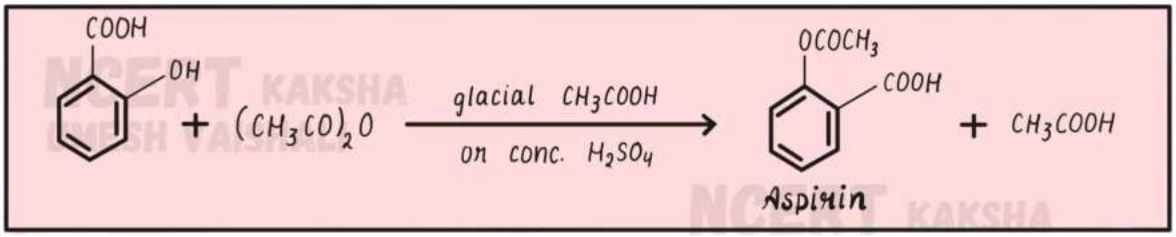


Phenacetin
(4-Ethoxy acetanilide)

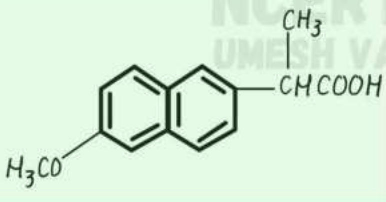
Non-narotic drugs
(Non-addictive drugs)

📍 **Note** :-
- Narotic drugs known as **habit forming OR Addictive drugs**.
- The word tranquilizer is derived from the word **tranquillus** meaning **calm**.
- Tranquilizers are essential component of **Sleeping pills**.
- A dilute aqueous solution of **Boric Acid** is used as a weak antiseptic for eyes. It also forms a part of antiseptic baby Talcum powder.
- CMC **(Carboxy Methyl Cellulose)**

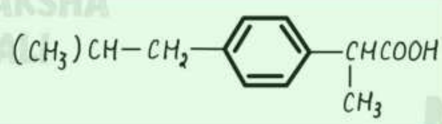
➡ **Aspirin :-**



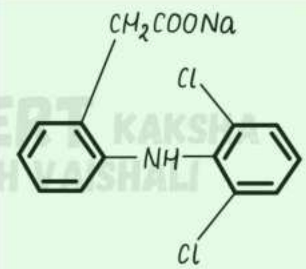
Note :- Because of shortcoming of aspirin other analgesics like



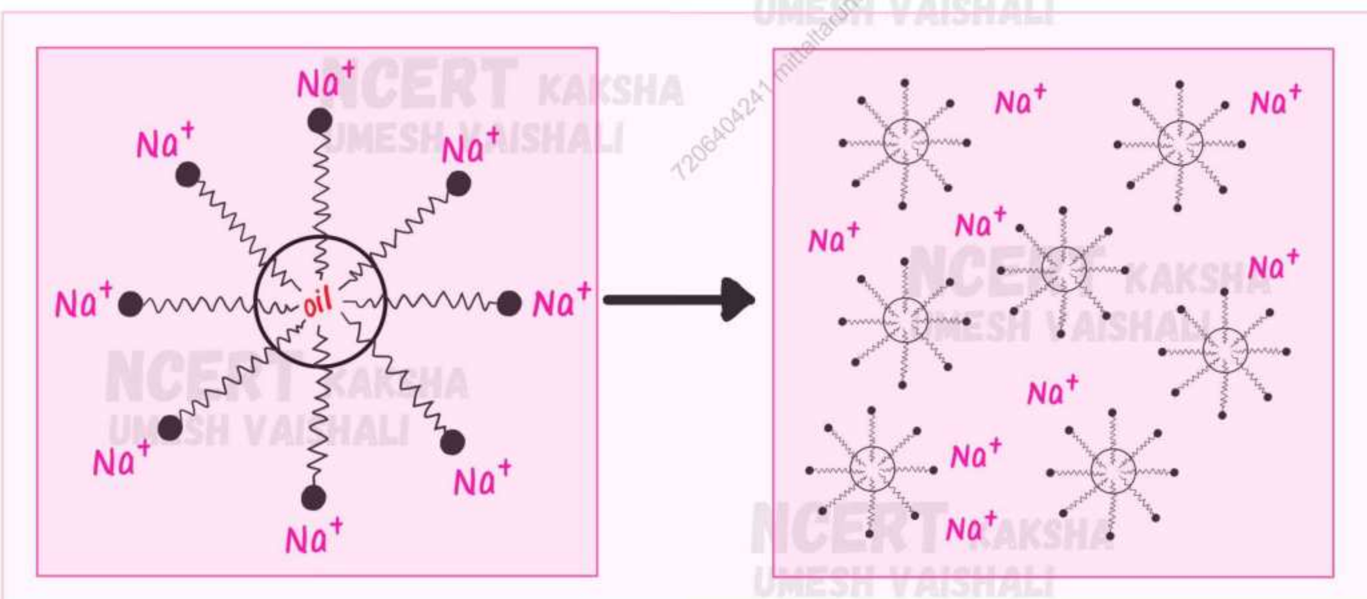
Naproxen



Ibuprofen

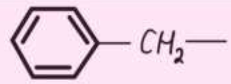
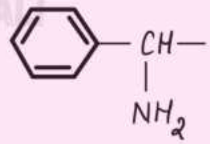


Diclofenac sodium
OR
Potassium



Cleansing soap of action

Bactericidal	Bacteriostatic
Penicillin Aminoglycosides (Streptomycin) Ofloxacin	Erythromycin Tetracycline Chloramphenicol

Penicillin	Nature of R
Penicillin G **OR** Benzyl penicillin	
Penicillin F	$CH_3-CH_2-CH=CH-CH_2-$
Penicillin K	$CH_3-(CH_2)_5-$
Penicillin V	$C_6H_5OCH_2-$
Ampicillin	

Chemicals in Medicines

Analgesics	Relieve pain	Aspirin, ibuprofen, diclofenac sodium, naproxen, narcotics (morphine, codeine, heroin).
Antipyretics	Lower body temperature	Aspirin, paracetamol, phenacetin.
Antiseptics	Kill or prevent the growth of microorganisms (not harmful for living tissues)	Furacin, soframicin, dettol (chloroxylenol and terpineol). 0.2 % phenol
Disinfectants	Kill or prevent the growth of microorganisms (harmful for living tissues and can be used on non-living objects; clothes, floors, utensils etc).	1% phenol, Cl_2, cresols

* The same substance acts as disinfectant and antiseptic. e.g., 0.2% phenol is antiseptic and 1% phenol is disinfectant

Tranquilizers	Treatment of stress, mental diseases	Derivatives of barbituric acid (veronal, amytal, luminal, seconal), chlordiazepoxide, meprobamate, valium, serotonin.
Antimicrobials	Cure infections due to microorganisms (microbes)	Antibiotics, sulphonamides.
Antifertility drugs	Birth control	Oral contraceptives, estrogen (ethynylestradiol) and progesterone (norethindrone) mifepristone
Antibiotics	Produced by microorganisms and can inhibit the growth of other microorganisms.	Penicillin, tetracycline, chloramphenicol ampicillin, amoxycillin sulpha drugs (sulphanilamide, sulphadiazine sulphaguanidine)

* Penicillin G has a narrow spectrum.
* Ampicillin and amoxycillin are its synthetic modifications.
* Chloramphenicol is a board spectrum antibiotic.

Antihista ines	Anti-allergic	Diphenhydramine (benadryl), brompheniramine (dimetapp) pheniramine maleate (avil), chloropheniramine maleate (zeet)
Antacids	Remove excess acid in stomach	Magnesium hydroxide, magnesium, carbonate, magnesium trisilicate, aluminium hydroxide gel, sodium bicarbonate aluminium phosphate, ranitidine, cimetidine.

Some Chemical Compouds names & Molecular Fomulas

Compound Name	Molecular Formula	Compound Name	Molecular Formula
Acetic acid	CH_3COOH	Potassium Nitrate	KNO_3
Hydrochloric acid	HCL	Ammonium chloride	NH_4Cl
Sulfuric acid	H_2SO_4	Ammonium hydroxide	NH_4OH
Acetate	CH_3COO^-	Calcium nitrate	$Ca(NO_3)_2$
Ammonia	NH_3	Hydrogen Peroxide	H_2O_2
Nitric acid	HNO_3	Silver Chloride	$AgCl$
Phosphoric acid	H_3PO_4	Barium Sulphate	$BaSO_4$
Sodium Phosphate	Na_3PO_4	Magnesium Sulphate	$MgSO_4$
Calcium carbonate	$CaCO_3$	Sodium Sulphite	Na_2SO_3
Sodium Bicarbonate	$NaHCO_3$	Oxalic acid	$H_2C_2O_4$
Sodium Hydroxide	$NaOH$	Potassium dichromate	$K_2Cr_2O_7$
Calcium Hydroxide	$Ca(OH)_2$	Zinc Chloride	$ZnCl_2$
Ethanol	C_2H_5OH	Zinc hydroxide	$Zn(OH)_2$
Nitrous Acid	HNO_2	Zinc Sulphate	$ZnSO_4$
Potassium Hydroxide	KOH	Phosphorus Pentachloride	PCl_5
Silver nitrate	$AgNO_3$	Sodium nitrite	$NaNO_2$
Sodium carbonate	Na_2CO_3	Potassium Permagnate	$KMnO_4$
Magnesium Hydroxide	$Mg(OH)_2$	Boric acid	H_3BO_3
Methane	CH_4	Potassium nitrite	KNO_2
Sodium chloride	$NaCl$	Tartaric acid	$C_4H_6O_6$
Carbon tetra chloride	CCl_4	Aluminium Hydroxide	$Al(OH)_3$
Sodium Sulphate	Na_2SO_4	Iron oxide	Fe_2O_3