



ONE PAGE NOTES OF CHEMISTRY



https://t.me/garimagoel007_g2

STRUCTURE OF ATOM

DISCOVERY:-

Cathode Ray - Cause the rays are originating from the cathode plate of glass tube.
 $P \propto \frac{1}{V}$
 → High voltage, very low pressure,
 → -vely charged
 → deflected towards the side of E and B .
Anode Ray - Goldstein
 → +vely charged species, which travel from anode to cathode.
 $Nu \rightarrow e^- + N^{+}$ during cathode Ray
 ↳ Anode Ray

Charge by mass Ratio :- $\frac{e}{m} = 1.7 \times 10^{11} C/kg$
 • $e^- \Rightarrow -1.6 \times 10^{-19} C$
 • $mass\ e^- \Rightarrow 9.1 \times 10^{-31} kg$

→ **Discovery of Neutron = Chadwick**
 ${}_2^4He + {}_4^9Be \rightarrow {}_6^{12}C + {}_0^1n$
 ↳ particles
 ↳ neutron

→ **Representation Atom**;
 $A \rightarrow mass\ no.$
 $Z \rightarrow Atomic\ No$
 $X \rightarrow element$

No. of Neutrons = $A - Z$

Units of distance = $\text{\AA}$ or nm
 $1 \text{\AA} = 10^{-10} m$
 $1 nm = 10^{-9} m$

Some definitions:-

Isotope = same Atomic No. ${}_1^1H, {}_1^2D, {}_1^3T$
 different mass no.

Isobars = diff. Atomic No. ${}_{18}^{40}Ar, {}_{20}^{40}Ca$
 same mass no.

Isoelectronic = same no. of electrons
 Na^+, Mg^{+2}, Al^{+3}
 $10e^-, 10e^-, 10e^-$

Isotones = same no. of neutrons
 $(A - Z)$
 ${}_{14}^{39}K, {}_{20}^{46}Ca$
 $39 - 19 = 20$
 $46 - 26 = 20$

Isodiaphers = same isotopic No.
 isotopic No. = $\{A - 2Z\}$
 ${}_{92}^{238}U, {}_{90}^{234}Th$
 $238 - 2 \times 92 = 54$
 $234 - 2 \times 90 = 54$

Isoelecter = same number of e^- and same number of atom

atom =	Na	CO
e^- =	2	2
	$14e^-$	$14e^-$

ATOMIC MODELS:-

1. **Plum pudding** - JJ-Thomson
 Drawback = did not explained the α -particle scattering experiment

2. **Rutherford** :- α particle Experiment



Atom

Nucleus
 → centre
 → Protons + Neutron

Extra Nuclear part
 → e^- are here
 in the fixed circular orbits

Conclusion:-

Atom = $10^{-10} m$
 volume Atom = $\frac{4}{3} \pi (10^{-10})^3$
 volume Nucleus = $\lambda \times \lambda \times \lambda$
 $R_{Nucleus} = R_0 (A)^{1/3}$
 $R_0 = 1.4 \times 10^{-15} m$
 $A = mass\ No$
 $\rightarrow 10^{-15} m$

DUAL NATURE OF LIGHT:

Wave Nature:-

Wavelength; distance between two consecutive crest and two consecutive trough

wave number; reciprocal of wavelength, defined as no. of waves per unit length.
 $\nu = \frac{1}{\lambda}$

Frequency (f); No. of waves passing a point in one second.
 unit = Hertz (Hz).

Amplitude :- height of crest or depth of trough from the principal axis.

Velocity :- Distance travelled unit time.
 $v = f \times \lambda$

ELECTROMAGNETIC SPECTRUM:-

→ magnetic field and electric field are perpendicular to each.
 → They travel with speed of light = $3 \times 10^8 m/s$
 → They do not required any medium to travel.

Electro-magnetic spectrum:-

Gamma rays, X-Ray, UV, Visible, IR, Micro wave, Radio wave
 Cosmic Ray, γ rays, X-Ray, UV, Visible, IR, Micro wave, Radio wave
 $c = f \times \lambda$
 $f \propto \frac{1}{\lambda}$

PARTICLE NATURE:-

discontinuous nature

1. Planck & quantum Theory:-

→ Black Body - it an ideal body
 → emits or absorbs radiation of a.f.
 → Radiation absorbed are discontinuous in nature.
 → small packets of energy - Photons.
 → Energy of Photon = $E = h\nu$ (h = Planck's constant)
 $E = \frac{hc}{\lambda}$ $f \nu = \frac{c}{\lambda}$ $E = \frac{nhc}{\lambda}$ (n = no. of Photons)

PHOTOELECTRIC EFFECTS:-

→ emission of e^- from lattice due to the striking of photons ($h\nu$) on it.

work function :- (ϕ) minimum energy req. to show photo electric effect is called as work function.
 $\phi > E_p = \times$
 $\phi < E_p = \checkmark$

Threshold frequency :- minimum frequency required to show photoelectric effects.
 $\phi > E_p = \times$
 $\phi < E_p = \checkmark$
 ↳ Threshold frequency

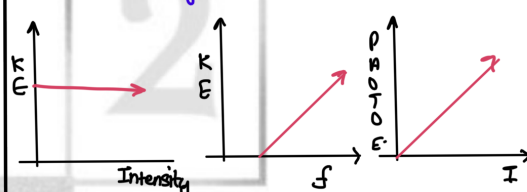
Threshold wavelength :- maximum λ which is the limit to show the photo electric effect.
 $\phi = \frac{hc}{\lambda_0} = hf_0$

→ work function is fixed for every metals.

* **KE of ejected e^-** :- $E = \phi + KE$

Intensity :- No. of photon falling on metal surface per second per unit time.

→ KE depends on f not on intensity
 → No. of e^- ejected depends on intensity not on frequency.



BOHR'S ATOM MODEL

Postulates:-

→ Atom has 2 part (Nucleus = Proton + Neutron)
 ↳ electron = fixed orbital

→ Atoms has ∞ shells/orbits.

→ $mvr = \frac{nh}{2\pi}$ h = Planck's Constant
 n = no. of orbit.

→ Energy of e^- $\propto$ to distance away from nucleus.

$$E_1 < E_2 < E_3 \dots < E_{\infty}$$

→ Absorbing energy → e^- jumps = lower to high orb.

→ Releasing energy → e^- jumps = high to low;
 thus releases the spectrum.

→ ground state = $n=1$

→ 1st excited state = $n=2$

Demerits:-

only applicable on single electronic species. $H, He^+, Li^{+2}, Be^{+3} = 1e^-$ each

Some formulas:-

Radius = $R_n = 0.0529 \frac{n^2}{Z} \text{\AA}$ or $\frac{52.9 n^2}{Z} pm$

Velocity = $\frac{2.18 \times 10^6 \times Z}{n} m/sec.$

Energy = $E_n = -13.6 \times \frac{Z^2}{n^2} eV$

Energy ∞ shells = 0 (zero)

→ Energy diff. b/w two consecutive shells decreases as we move away from nucleus.

$$E_1 = -13.6 \quad E_2 = -3.4 \quad E_3 = -1.5 \quad E_{\infty} = 0.24 \text{ (au in eV).}$$

* Energy difference b/w two shells:-

$$\Delta E = 13.6 Z^2 \left(\frac{1}{n_1^2} + \frac{1}{n_2^2} \right) eV$$

IONISATION ENERGY:-

→ Energy required to move an e^- from its ground state to the ∞ .

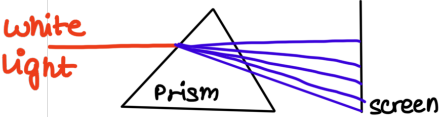
$$n_1 = 1 \quad n_2 \rightarrow \infty$$

$$IE = 13.6 Z^2 eV$$

Ratio $TE : KE : PE = -1 : -2 : 1$

HYDROGEN SPECTRUM

discontinuous spectral line.



continuous - rainbow Band - molecules
discontinuous - H-spectrum line - atom
emission $\rightarrow n_2 \rightarrow n_1$ absorption $= n_1 \rightarrow n_2$

Series	LO	HO	Region
Lyman	1	2, 3, 4... ∞	UV
Balmer	2	3, 4, 5... ∞	V
Paschen	3	4, 5, 6... ∞	IR
Brackett	4	5, 6, 7... ∞	IR
P-fund	5	6, 7, 8... ∞	IR
Humphrey	6	7, 8, 9... ∞	IR

$$\frac{1}{\lambda} = R_H Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

$$R_H = 1.1 \times 10^7$$

Lyman series - $(n+1) \rightarrow 1$ $\Delta E = \frac{hc}{\lambda}$
Balmer series - $(n+2) \rightarrow 2$
Paschen series - $(n+3) \rightarrow 3rd$
Brackett series - $(n+4) \rightarrow 4th$

Total no of spectral lines:-

$$n_2 \rightarrow n_1 \quad \frac{(n_2 - n_1)(n_2 - n_1 + 1)}{2}$$

No of spectral lines for a particular series:-

$$L = n_2 - 1 \quad P = n_2 - 3 \quad P_f = n_2 - 5$$

$$B = n_2 - 2 \quad Br = n_2 - 4 \quad H = n_2 - 6$$

$$\{n_2 = \text{higher orbital}\}$$

Time period:- $T \propto \frac{n^3}{Z^2}$

Free frequency:- $f \propto \frac{Z^2}{n^2}$

DE BROGILE WAVELENGTH

Matter

Particle $\lambda = \frac{h}{p} = \frac{h}{mv}$

wave $\lambda = \frac{h}{\sqrt{2mKE}}$

$\lambda = \frac{h}{\sqrt{2mqV}}$ $\lambda_e = \frac{h}{\sqrt{2meV}}$

$\rightarrow$ de-broglie wavelength is applicable on microscopic particles (e^- , p , α , n) but not for macroscopic.

$$\lambda = \sqrt{\frac{150}{V}} \text{ \AA}$$

HEISENBERG UNCER. PRINC.

$\rightarrow$ it is not possible to find position and momentum of an e^- simultaneously and with 100% accuracy.

$$\Delta x \times \Delta p \geq \frac{h}{4\pi}$$

Δx = uncertainty in position
 Δp = uncertainty in momentum.

$$\Delta x \rightarrow 0 \quad \Delta p \rightarrow \infty$$

$$\Delta p = mv$$

* Drawback of Bohr's Models:-

- $\rightarrow$ Only of single e^- species
- $\rightarrow$ not consistent with de-broglie λ and HUP.
- $\rightarrow$ Can't explain the splitting line of spectrum in presence of $\underline{B}$ and $\underline{E}$.
- Stark!
- Zeeman!

QUANTUM MODEL:-

$\rightarrow$ Derived by Schrodinger

$\rightarrow$ consider e^- waves

ψ = wave function of e^-

ψ^2 = Probability of density of e^- (can never be 100%)

ORBITAL:- region where the probability of finding an e^- is maximum.

$\rightarrow \psi^2$ maximum

NODE:- Place where $\psi^2 = 0$ ie probality of e^- is zero.

ELECTRON:-

Shell $\rightarrow$ sub $\rightarrow$ orbital $\rightarrow$ electrons

Principal QN Azimuthal QN Magnetic QN Spin QN

QUANTUM NUMBERS:-

$\rightarrow$ Set of 4 numbers which tells us about Shells, sub-shells, orbital and spin of e^-

PRINCIPLE QN:-

- $\rightarrow$ denoted by n .
- $\rightarrow$ tell us about the no of shells.
- $\rightarrow$ maximum no of e^- $2n^2$

$$n=1 \rightarrow 1^{st} \text{ shell} \rightarrow 2(1)^2 = 2e^-$$

$$n=2 \rightarrow 2^{nd} \text{ shell} \rightarrow 2(2)^2 = 8e^-$$

AZIMUTHAL QN:-

- $\rightarrow$ Denoted by l
- $\rightarrow$ It tells us about sub-shell.
- $l=0 \rightarrow s$ subshell $l=2 \rightarrow d$ subshell
- $l=1 \rightarrow p$ subshell $l=3 \rightarrow f$ subshell

$$n=1 \rightarrow 0$$

$$n=2 \rightarrow 0, 1$$

$$n=3 \rightarrow 0, 1, 2$$

MAGNETIC QN:-

- $\rightarrow$ denoted by M
- $\rightarrow$ for any value l , m can have value ranging from $-l$ to $+l$ including zero.

$$l=0 (s\text{-subshell}) \rightarrow 0$$

$$l=1 (p\text{-subshell}) \rightarrow -1, 0, +1$$

Total no of orbitals $= (2l + 1)$

Total no of orbital in a shell $= n^2$

SPIN QN:-

- $\rightarrow$ Denoted by s
- $\rightarrow$ tells about the spin of e^-
- $\rightarrow$ can have only two values.

$$s = -\frac{1}{2} \quad s = +\frac{1}{2}$$

$\rightarrow$ Can accommodate maximum 2 e^- of opposite spin.

* Energy of electrons:-

CASE I $\rightarrow$ Single electronic species (H like)
 $\rightarrow$ Lower the value of n lower will be the energy.

$$1s < 2s = 2p < 3s = 3p = 3d$$

CASE II $\rightarrow$

energy depends on $n+l$
if $n+l$ is same, then lower the value of n lower is the energy.

ELECTRONIC CONFIGURATION

1. Aufbau Rule:- e^- are filled always in the increasing order of their energy.

$$1s \rightarrow 2s \rightarrow 2p \rightarrow 3s \rightarrow 3p \rightarrow 4s \rightarrow 3d$$

2. Pauli Exclusion principle:-

no e^- can have all same, four value of the Quantum number.

3. Hund Rules:-

$\rightarrow$ Pairing of e^- is done, only when each orbital is half filled or have atleast one e^- in them.

Electronic Configuration:-

$$H \rightarrow 1 = 1s^1 \quad 2 = 2e^-$$

$$He \rightarrow 2 = 1s^2 \quad p = 6e^-$$

$$Li \rightarrow 3 = 1s^2 2s^1 \quad d = 10e^-$$

$$Be \rightarrow 4 = 1s^2 2s^2 \quad f = 14e^-$$

$$B \rightarrow 5 = 1s^2 2s^2 2p^1$$

$$Na \rightarrow 11 = 1s^2 2s^2 2p^6 3s^1$$

* Half filled and full filled stable?

$\rightarrow$ more the no of exchanges $\rightarrow$ more energy is released, therefore stability increases.

MAGNETIC MOMENT:- $\mu = \sqrt{n(n+2)} \text{ BM}$
 n = no of unpaired e^-

NODES:- Radial Node $= n - l - 1$

Angular node $= l$

Total Node $= n - 1$

Nodal Plane $= l$

line (2D):-
 xy, yz, zx
Plane (3D):-
 x, y, z

ORBITALS:-

s orbital:- Spherical ($1s^1$)

$$RN = 1 - 0 - 1 = 0$$

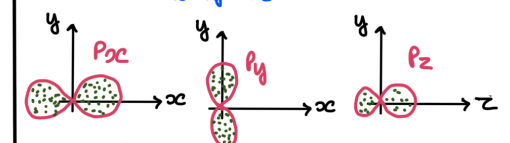
$$AN = 0$$

p orbital:-

dumb bells

$$NP = 1$$

$$p_x, p_y, p_z$$



d-orbitals:-

$\rightarrow$ double dumb bells

$\rightarrow$ 5 orbital

* Axial orbitals:-

$$d_{z^2} \quad NP = 2 \quad d_{x^2-y^2} \quad NP = 0$$

* Non-Axial Orbital:-

