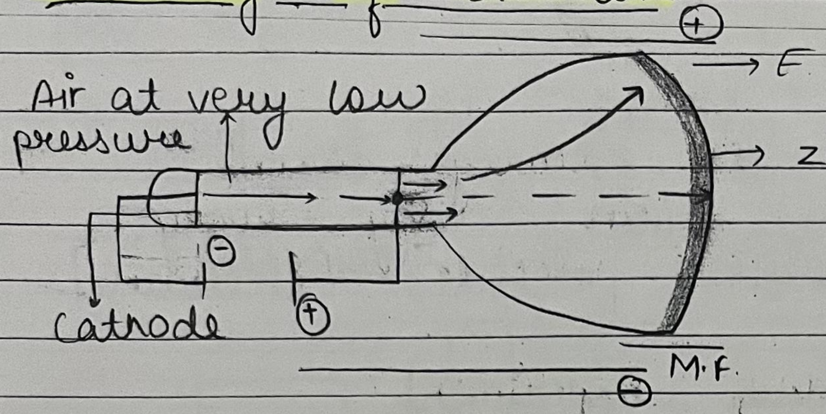
Lecture -1

Structure of Atom

Discovery of Electron



→ Cathode ray's made up by Negatively Charged Particle which were Named
→ as Negatron

Conclusion

1) Some rays initiated from cathode & Revert towards anode and Strikes on zinc Screen. This rays Named as cathode rays.
2) Cathode rays deflected towards positive plate of the external field means Cathode rays must have Negative charge.
3) Cathode rays Rotated in light Paddle wheel which is placed in the path, means cathode rays made up by [particles].
4) This Negative Particles were Named as

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HW → Muliken's oil drop experiment & cathode rays animateted videos (Edupoint)

Negatron by thomson later on Estony Renamed Negatron as Electron.

5) $e/m = 1.76 \times 10^{11}$ C/Kg —— (1)

$e = 1.6 \times 10^{-19}$ C

* e/m value of cathode rays of different gases is Excatly Same that's why we can say Every Element have such particle [Electron]

→ **Muliken's oil drop Experiment:-**

Charge of $\bar{e} = 1.6 \times 10^{-19}$ C —— (2)

Put eqn (2) in eqn (1)

$= \frac{1.6 \times 10^{-19}}{m} = 1.76 \times 10^{11}$ C

$= m = 9.1 \times 10^{-31}$ kg

$= m = 9.1 \times 10^{-28}$ gm

charge of oil drop = $q = 1.6 \times 10^{-19}$ ne

→ **Anode Rays**

1) The ray consisting of postively charged particles and produced due to ionization of gas present in discharge tube is canal rays or Anode rays

2) All remaining property are same as

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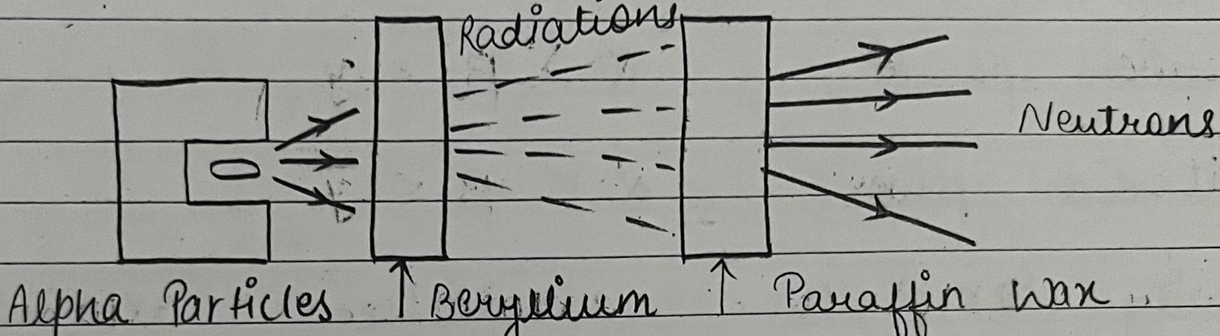
• Cathode rays Except e/m value.

4) e/m value of anode rays is different for different gases. ~~means~~

charge of proton = 1.6×10^{-19} C

[Lecture-2]

→ **Discovery of Neutron**



* ~~$^{4}\alpha_{2} + {}^{9}Be_{4} \rightarrow {}^{12}C_{6} + {}^{1}n_{0}$~~

	e	P	N
Mass	9.1×10^{-28} gm	1.67×10^{-24} gm	1.677×10^{-24} gm
charge	$-e = 1.6 \times 10^{-19}$ C	$+e = 1.6 \times 10^{-19}$ C	zero

$M_e < M_p < M_n$ $M_p \approx M_n$

→ **Radio Activity :-**

1) It is Sponteneous decay of unstable Nucli into stable Nucli by Emsition of α, β & γ particles.

Mass ← $^4\alpha_2$ → charge

	α particles or $^4\alpha_2$ or He^{+2}	β particles or $^0\beta_{-1}$	γ particles or $^0\gamma_0$
Mass	4 Mp $4 \times 1.6 \times 10^{-24}$ gm	$M_\beta \approx M_e$ (Negligible)	zero
Charge	2e $+e = 1.6 \times 10^{-19} C$	e $-e = 1.6 \times 10^{-19} C$	0
Ionisation power	α > β > γ		
Penitration power	α < β < γ		
Velocity	3×10^7 m/sec.	2×10^8 m/sec.	3×10^8 m/sec

* Total charge on a body ~~always~~ or a particle will always be integers multiple of charge of Electron.

→ **Isotopes**

Atoms of same elements with same atomic Number but different mass Number.

$^A X_Z$

A = Mass Number = N + P
X = Symbol of Element
Z = Atomic Number = No. of Proton = No. of $\bar{e}$ (Neutral form)

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(Z) Atomic Number → Niche wala hota hai
(A) mass Number → Upar wala hota hai ☺

$Z = P$			
$A = P + N$			
$N = (A - P) = (A - Z)$			

	$^1H_1$	$^2H_1$	$^3H_1$
Z =	1	1	1
P =	1	1	1
N =	0	1	2
e =	1	1	1

P = Atomic Number (Z)
A = Mass Number (A)
N = Mass - Atomic No.
e = Atomic ± Ions.

$^2H_1$ → Deuterium
$^3H_1$ → Tritium (Radioactive)

Eg → $^{35}Cl_{17}$ = P = 17, A = 35, N = 18

$^{14}N^{-3}_{7}$ = P = 7, N = 7, e = 7 + 3 = 10

$^{27}Al^{+3}_{13}$ = P = 13, N = 14, e = 13 - 3 = 10

[Lecture -3]

→ Isobars

Atoms of different element which have same mass Number but different atomic Number.

Eg → $^{40}Ar_{18}$ & $^{40}Ca_{20}$ and $^{14}C_6$ & $^{14}N_7$

→ Isotones or Isoneutrons

Atoms of different element which have same Number of Neutron but different mass Numbers.

→ $_{14}Si^{30}$, ~~$_{15}$~~ $_{15}P^{31}$, $_{16}S^{32}$

→ $_{19}K^{39}$ & $_{20}C^{40}$

→ $_{1}H^{3}$ & $_{2}H^{4}$ } Neutrons are same

→ $_{6}C^{13}$ & $_{7}N^{14}$

→ **Isodiaphers** [N − Z] or [A − 2Z].

Atoms having same Isotopic Number are called Isodiaphers.

E.g. → (i) $_{92}U^{235}$ & $_{90}Th^{231}$ (→ thoreum) = A = 235, Z = 92

235 − 2 × 92 = 235 − 184 = 51

231 − 2 × 90 = 231 − 180 = 51

(ii) $_{19}K^{39}$ & $_{9}F^{19}$ = 39 − 2 × 19 = 39 − 38 = 1

19 − 2 × 9 = 19 − 18 = 1

(iii) $_{29}Cu^{65}$ & $_{24}Cr^{55}$ = 65 − 2 × 29 = 65 − 58 = 7

55 − 2 × 24 = 55 − 48 = 7

→ Isosteres

*Isosteres is the property of molecule not atom

Molecules having same Number of atoms as well as same Number of Electrons are called Isosteres

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E.g. → N_2 & CO ⇒ A = 14 = N
A = C = 6 & O = 8 = 14

CO_2 & N_2O = A = C = 6 & O = 8 × 2 = 16 = 22
A = N = 7 × 2 = 14 & O = 8 = 22

CaO & MgS = A = Ca = 20 & O = 8 = 28
Mg = 12 & S = 16 = 28

C_6H_6 & B_6N_6 = C = 6 × 6 = 36 & H = 6×1 = 42
B = 5 × 6 = 30 & N = 6 × 7 = 42
Not Same

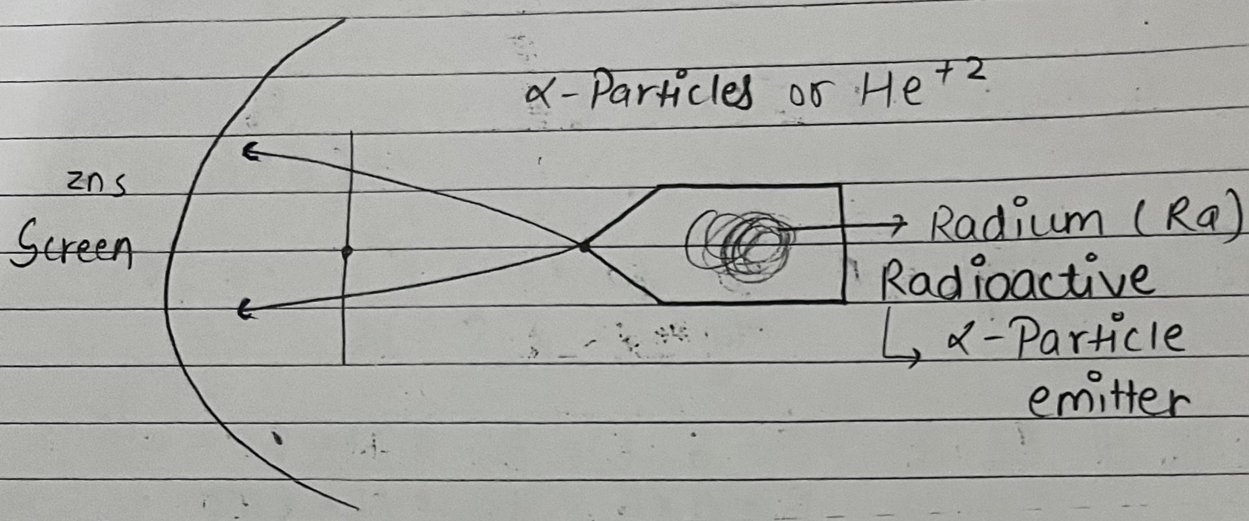
→ Isoelectronic Species

Species (atoms, Ions & Molecules) having same Number Electrons Irrespective of No. of atoms are Known as Isoelectronic Species.

E.g. → N^{3-}, O^{2-}, F^-, Ne, Na^+, Mg^{2+}, Al^{3+}, ~~CH_4~~ CH_4, NH_3, H_2O & HF have 10 Electrons Each

Eg. → H^-, He, Li^+ and Be^{2+} have 2 Electrons Each
CO, CN^- & N_2 have 14 Electrons each.
N_2O, CO_2 and CNO^- have 22 Electrons Each.

→ Rutherford Gold foil Experiment :-



Observations :-

(1) Most of the α-Particles Passed without any deflection.

Conclusion :-
Most of the Space of atom is empty.

(2) Few of α-Particles are deviated from their own path by a Small angle.

Conclusion :- Their Should be Some Positive Charge in the atom

3) Very few α-Particles return back on its own path.

Conclusion :- Most of the mass & +ve charge present at the centre of atom which is Known as Nucleus.

(4) Size (Radius) of atom is Nearly, order of 10^{-10} meter

(5) Size (Radius) of Nucleus is Near Equals to 10^{-15} meter order. 10^{-10} m $= 10^{-8}$ cm $= 1 \mathring{A}$ (Angstrong)

10^{-15} m = 1 fm (fermi)

$$\frac{R_{atom}}{R_{Nucleus}} = \frac{10^{-10}}{10^{-15}} = 10^5$$

$R_{atom} = 10^5 R_{Nucleus}$

(6) $V_{atom} = \frac{4}{3}\pi (r_1^3)$

$V_{Nucleus} = \frac{4}{3}\pi (r_2^3)$

$$\frac{V_{atom}}{V_{Nucleus}} = \frac{(10^{-10})^3}{(10^{-15})^3} = \frac{10^{-30}}{10^{-45}} = 10^{15}$$

$R_{Nucleus} \propto (A)^{1/3}$ → Mass Number of the atom

$R = R_0 \cdot (A)^{1/3}$ → Rutherford Constant

$R_0 = 1 \times 10^{-15}$ to 1.5×10^{-15}

$R_0 \approx 1.25 \times 10^{-15}$

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[Lecture - 4]

Q. What should be Radius of 'A' Nucleus? According to Rutherford (Mass Number of Al = 27)

$R_0 = 1.25 \times 10^{-15} m$

Sol. $R = R_0 (A)^{1/3}$

$= 1.25 \times 10^{-15} (27)^{1/3}$

$= 3.75 \times 10^{-15}$ meter.

Some Important Points :-

① like Charge repel each other

$f_{21} = \frac{K q_1 q_2}{r^2}$ ← $+q_1$ —— r —— $+q_2$ → $f_{12} = \frac{K q_1 q_2}{r^2}$

$f = \frac{K q_1 q_2}{r^2}$ (MTK)

$K = 9 \times 10^9 \frac{N\text{-}M^2}{C^2}$

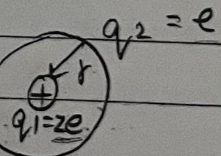
② Unlike charge attract each other

$+q_1$ ← $-q_2$ $f = \frac{K q_1 q_2}{r^2}$

Imp.

③ Charge on Nucleus = $(ze) = q$

Force of Nucleus on e^-



$f = \frac{K q_1 q_2}{r^2}$

$f = \frac{K (ze) e}{r^2} = \frac{K z e^2}{r^2}$

Charge on Proton $= +e = 1.6 \times 10^{-19} C$

Charge on electron $= -e = 1.6 \times 10^{-19} C$

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④ $F = \frac{Kq_1q_2}{r^2} = q \times E$ (MTR)

↳ Electric field

$f = \frac{Kq_1q_2}{r^2}$ If $q_1 = 1C$

$E = \frac{Kq}{r^2}$ (MTR)

Electric field → Electric field is force experiencend by 1 columb charge or unit charge from other charge.

⑤ **Potential Energy (PE) :-**

→ $P_E = \frac{Kq_1q_2}{r}$

→ Potential (V) $= \frac{Kq}{r}$

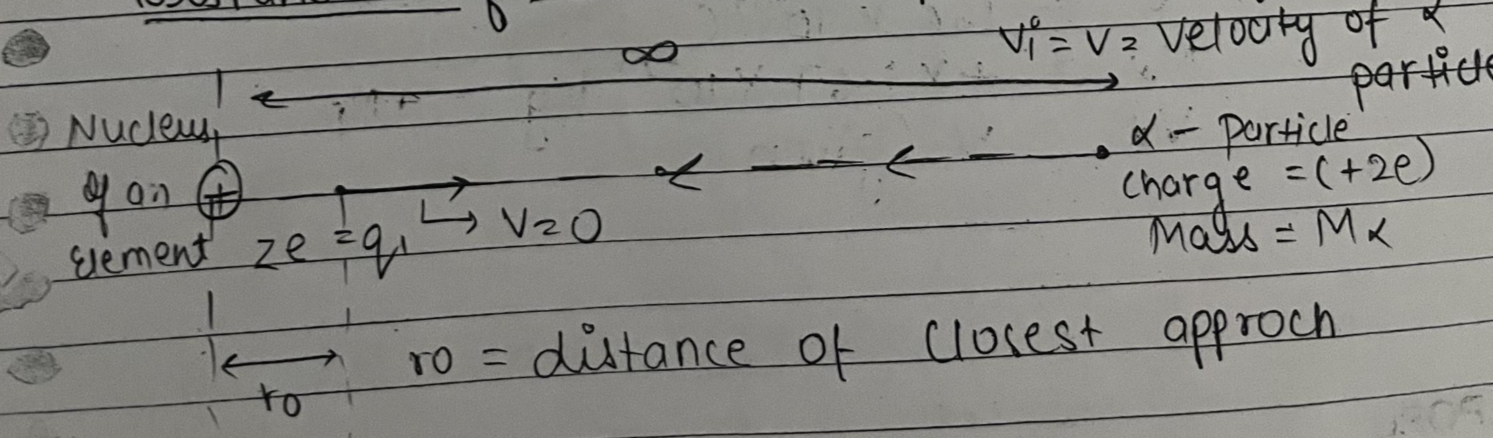
→ $PE = q \times V$

q ↓ Coloumb, V ↳ Volt

→ C · Volt = Joule

Imp.

Distance of closest approch :-



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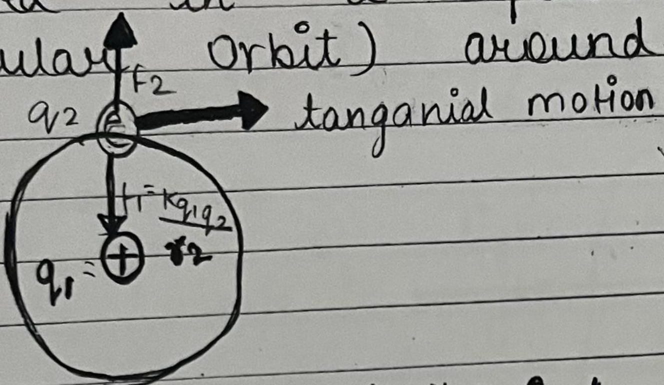
[Lecture - 5]

→ Rutherford Atomic Model

According to Rutherford Electron must be revolved in a particular orbit (circular Orbit) around the Nucleus.



→ Failure of Rutherford Model

1) According to Max - Plank an accelerated charge particle produce Electro magnetic waves or radiation by which Electron Should lose its Energy continously, Should revolve Spiraly and finally fall into Nucleus and Extence of atom should over, Rutherford Can't Explain it.

2) Rutherford Could'nt Explain Hydrogen ~~Sep~~ Spectrum.

→ Electromagnetic wave :-

1) They have both Electric as well as magnetic field in perpendicular direction.

2) All EM waves travel with Speed of light.

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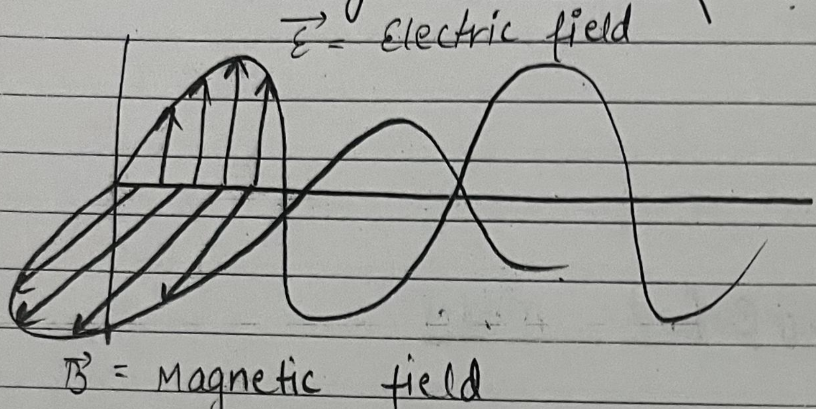
3) They No Need of medium to propogate.

Example :- Sunlight is an Example of EM field.

→ Electromagnetic wave ← wavelength, frequency, wavenumber

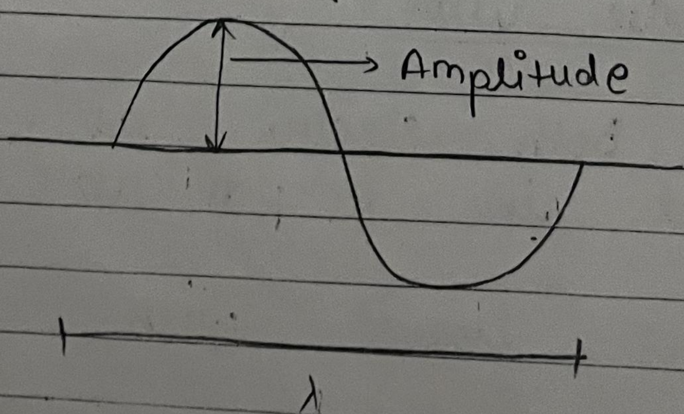


Wavelength
Distance Between two Consecutive Crest or tough.

Unit's of wavelength = meter (SI)
= nm (Neno meter)
= A°
= Pm (Pico meter)

1 meter = 10^{+9} nm
= 10^{+10} A°
= 10^{+12} pm

1 A° = 10^{-10} m
1 nm = 10^{-9} m
1 pm = 10^{-12} m



Frequency (ν)

It is Number of waves passed through a point per second

$$\boxed{\nu = \frac{c}{\lambda}}$$ sec^{-1} or Hz

c = Speed of light = 3×10^8 m/sec

λ = wave length

$$V = \frac{3 \times 10^8}{10 A^\circ} \qquad 1m = 10^{-10} A^\circ$$

$$V = \frac{3 \times 10^8}{10 \times 10^{+10}} = 3 \times 10^{17} \text{ Hertz}$$

Wavenumber ($\bar{\nu}$) = $1/\lambda$

It is Number of waves present per unit length.

$$\text{Wave number} = \frac{1}{\lambda}$$

unit = $(meter)^{-1}$

= cm^{-1}

= nm^{-1}

= $A^{\circ -}$

= pm^{-}

If wavelength is in nm

$$E = \frac{1240 \text{ eV}}{\lambda (nm)}$$

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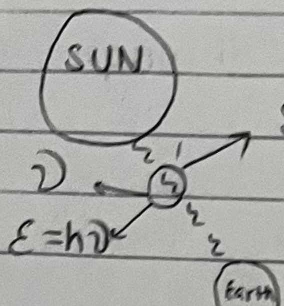
[Lecture-6]

→ Plank's Quantum theory :-



[Discontinously]

Smallest Pocket of Energy = Quanta

→ Quanta of visible region = photone

$\lambda = \approx (3800 A^\circ - 7600 A^\circ)$

order of wavelength

↳ Conclusion of plank's theory

$E_{photone} \propto \nu$

$$E = h\nu = \frac{hc}{\lambda} = \frac{2 \times 10^{-25}}{\lambda\,(m)}\ J\text{-}m$$

(c → speed of light)

↓ Energy of single photone / Quanta

$$\frac{N}{t} = 5 \times 10^{24}\ P_x$$

$E_{Total} = n \cdot h\nu$

↳ No. of photones

$E = hc\bar{\nu}$

plank's Constant

↳ $h = 6.62 \times 10^{-34}$ J. sec.

$c = 3 \times 10^{8}$ m/sec [Speed of light]

$hc = 19.86 \times 10^{-26}$ J.m

$\approx 20 \times 10^{-26}$ J.m

$\approx 2 \times 10^{-25}$ J.m

Finally :- $$E_{(J)} = \frac{hc}{\lambda} = h\nu = \frac{2 \times 10^{-25}}{\lambda(m)}$$

$$E_{(eV)} = \frac{12400}{\lambda(A^\circ)}$$

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②

Ques Frequency of a photone is given $\nu = \frac{10^{15}}{6.62}$ Htz, then Calculate energy of the photone.

$E = h\nu = 6.62 \times 10^{-34} \times \frac{10^{15}}{6.62} = 10^{-19}$ J

Q Wavelength of a photone emittied by a light source is 2pm, then Calculate Energy of the photone?

$\lambda = 2pm$

$E = \frac{hc}{\lambda} = \frac{2 \times 10^{-25}}{2(pm)} = \frac{2 \times 10^{-25}}{2 \times 10^{-12} m} = 10^{-13}$ J.

Q Calculate No. of photones emittied by a 100 watt bulb in 10 sec. of frequency $\frac{10^{15}}{6.62}$ Htz.

watt = J / sec

Power = $\frac{\text{Energy}}{\text{Time}}$ $E = P \times t$

$E = \left(100 \frac{J}{sec} \times 10 \text{ Sec.}\right)$

$= 1000$ J

$E = nh\nu$

$1000 J = n \times 6.62 \times 10^{-34} \times \frac{10^{15}}{6.62}$

$10^{3} J = n \times 10^{-19}$

$n = 10^{22}$ Protones.

$\frac{hc}{\lambda}$, $\frac{2 \times 10^{-25}}{2 \times 10^{-12}}$, 10^{-13} J.

$P = \frac{E}{t}$, $E = Pt = 100 \times 10 = 1000$ J

$E = nh\nu$, $1000 = n \times 6.62 \times 10^{-34} \times \frac{10^{15}}{6.62}$, $10^{3} = n \times 10^{-19}$, $10^{22} = n$

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= 792 J

→ **Electro - volt (ev) :-**

It is Smallest unit of Energy.

Electronvolt :- Electronvolt is the energy of an electron which accelerated under the potential of one volt from rest.

$$1\,ev = 1.6 \times 10^{-19}\ C \cdot Volt$$
$$= 1.6 \times 10^{-19}\ J / atom$$

$$1\,eV = (1.6 \times 10^{-19} \times 6 \times 10^{23})\ J/mole$$
$$\approx 96500\ J/mole$$

$$E_{(J)} = \frac{hc}{\lambda (m)} \qquad h = 6.62 \times 10^{-34}\ J \cdot sec.$$

$$E_{(ev)} = \frac{12400}{\lambda (A^{\circ})}$$

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→ **Dual Nature of light :-**

Wave Nature
- → Refraction
- → Reflection

Particle Nature
- → Black Body Radiation
- → Photoelectric effect

→ **Black Body Radiation**

An Ideal Body which can absorb or emmit all possible wavelengths or frequency of light.

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$\lambda = 10^{-10} m - 10^{-12} m$
γ-rays

U.V.

Radiowave

IR

Cosmic rays $< 10^{-19}$ m — X-Rays — Visible — Microwave

(3800 Å – 7600 Å) White Light

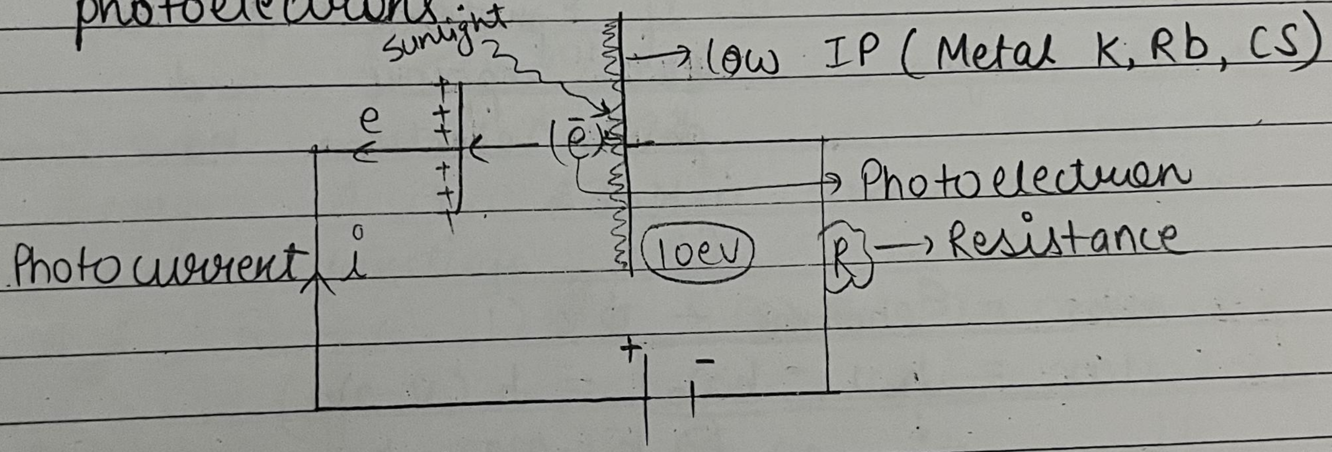
✓(4000 Å – 7600 Å NCERT)

$\lambda = 10 km - 10^{7} km$
$= 10000 m - 10^{10} m$

[Lecture - 8]

→ **Photoelectric effect**

★ Phenomenon of ejection of electrons from the surface of metal when light of suitable frequency strikes it is called Photoelectric effect and the electrons so ejected, are termed as photoelectrons.



Some Basic terms to understand Photoelectric effect.

Work function (ϕ) :- It is minimum amount of energy of photon required to ~~ejecte~~ ~~an~~ eject an Electron from metal surface.

$(\phi \text{ or } w) = h\nu_0$

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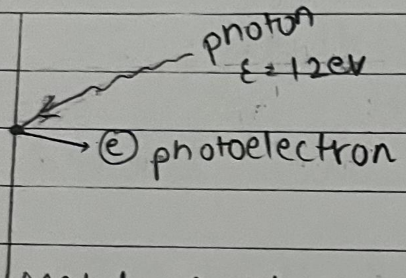
Threshold frequency

It is ~~min~~ minimum frequency of light to eject electron (photoelectron) from metal surface.

Threshold wavelength (λ_0)

It is maximum wavelength of light Needed to eject an Electron from metal surface.



Metal surface
$\phi = 10eV$

① $E_{photone} < \phi$ then no photoelectric effect (PEE) appear.

② If $E_{photone} > \phi$ then (PEE) appear, and photo electron have some K.E.

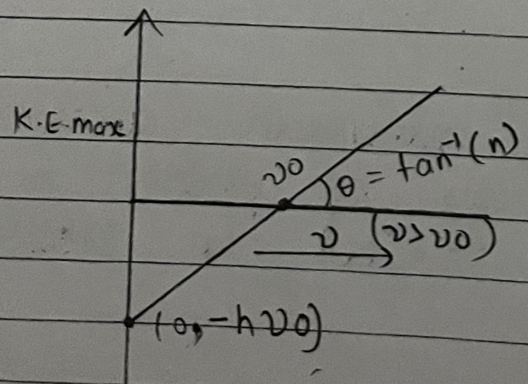
$K.E._{Max} = E_{photone} - \phi$

$$\boxed{K.E._{Max} = h\nu - h\nu_0} = h(\nu - \nu_0)$$

$y \qquad mx - c$

$\hookrightarrow K.E._{max} = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$

$$\boxed{K.E._{max} = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)}$$



ν_0 = Is when $K.E. = 0$
$\nu = \nu_0$

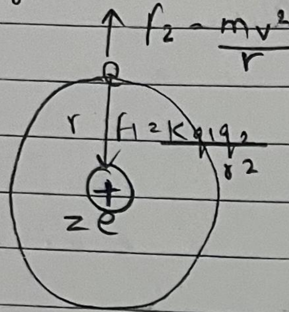
$m = \tan\theta = h$
(slope)

$\theta = \tan^{-1}(h)$

③ Electron will only revolve in those circular orbits in which the angular Momentum is Integral multiple of $\frac{h}{2\pi}$.

Angular Momentum $= mvr = \frac{nh}{2\pi}$ {n = Integer, n = No. of shell}

④



$f_1 = f_2$ (condition to revolve on circular path)

$$\frac{Kze^2}{r^2} = \frac{mv^2}{r}$$

$$\frac{Kze^2}{r} = mv^2 \quad \text{---- (1)}$$

$$mvr = \frac{nh}{2\pi} \quad \text{---- (2)}$$

$$v = \frac{nh}{2\pi mr}$$

Eq (2) → (1)

$$\frac{Kze^2}{r} = m\left(\frac{nh}{2\pi mr}\right)^2$$

$$Kze^2 = \frac{m \cdot n^2 h^2}{4\pi^2 m^2 \cdot r}$$

$$\boxed{r = \frac{n^2 h^2}{4\pi^2 Kze^2 \cdot m}}$$

$h = 6.62 \times 10^{-34}$ J·sec

$\pi \simeq 3.14$, $e = 1.6 \times 10^{-19} C$

$k = 9 \times 10^9 \frac{Nm^2}{C^2}$, $m_e = 9.1 \times 10^{-31} Kg$

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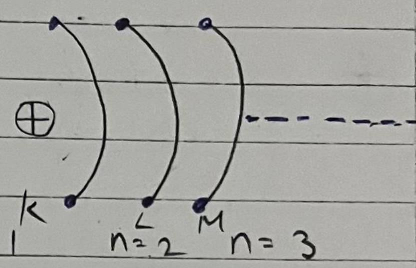
[Lecture-9]

→ **Bohr's Atomic Model :-**

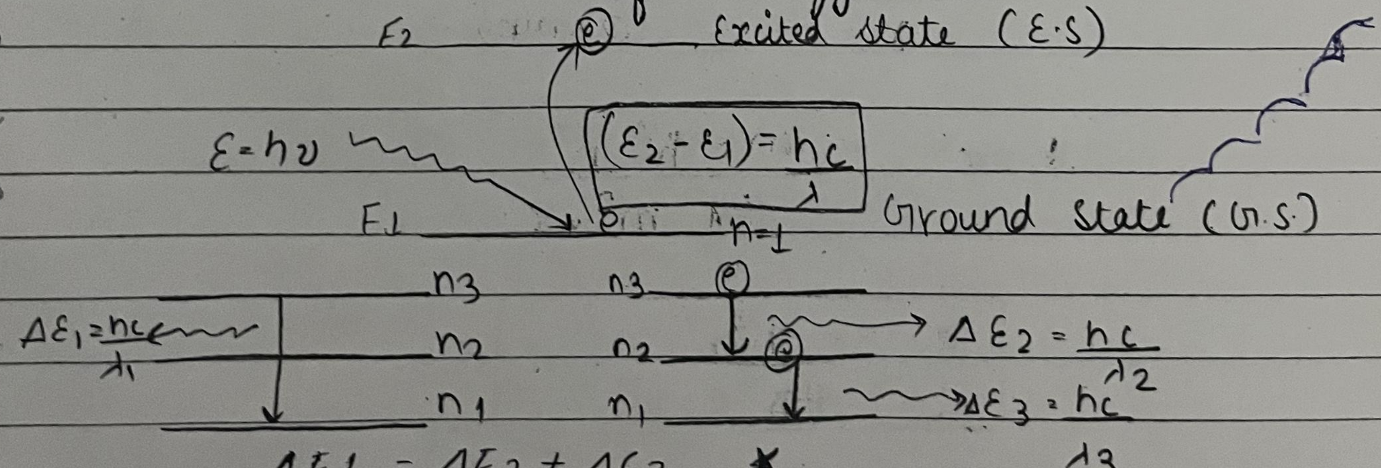
Postulates of Bohr's theory.

① Electron is revolve around a Nucleus in fixed [constant] energy levels which were Known as Shells / orbit



N = no. of shell

② Electron can Jump to higher Energy orbit from any lower orbit by absorbing suitable amount of Energy. Electron can return to any of the lower state from the higher state by the release of Energy.



$\Delta E_1 = \Delta E_2 + \Delta E_3$ ✶

$\frac{hc}{\lambda_1} = \frac{hc}{\lambda_2} + \frac{hc}{\lambda_3}$ = $\boxed{\frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3} + \ldots}$

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$$r = 0.529 \times \frac{h^2}{z} A^\circ$$

Put value of r Put in Eq (2)

$$m \cdot v \cdot \left(\frac{n^2 h^2}{4\pi^2 k z e^2 m} \right) = \frac{nh}{2\pi}$$

$$V = \frac{2\pi K z e^2}{nh}$$

$$V = (2.188 \times 10^6) \times \frac{Z}{n} \ m/sec$$

$$V \propto \frac{1}{n}$$

$$V \propto Z$$

$$r = 0.529 \frac{h^2}{Z} A^\circ$$

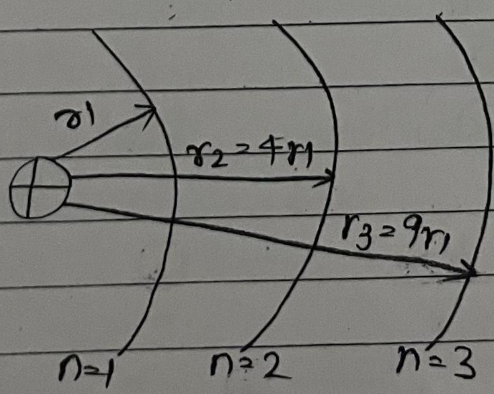
$$r \propto h^2$$

$$r \propto \frac{1}{Z}$$

for H- atom

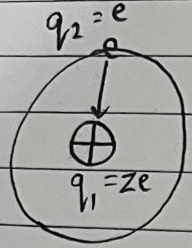
$Z = 1$

$n = 1$ (1st Shell)



[Lecture - 10]

⑤ Energy of e^- :-



Total Energy (T.E.) = P.E. + T.E.

$q_1 \qquad q_2$

$$P.E. = \frac{K q_1 q_2}{r}$$

$$P.E. \text{ of } \bar{e} = \frac{K(ze)(-e)}{r} = -\frac{Kze^2}{r} \quad \text{— ①}$$

$$K.E. = \frac{1}{2} m v^2 = +ve$$
$(+)(+)$

$$\therefore \frac{Kze^2}{r^2} = \frac{mv^2}{r}$$

$$\frac{1}{2} mv^2 = \frac{1}{2} \frac{Kze^2}{r} = K.E. \quad \text{— ②}$$

$$\therefore T.E. = P.E. + K.E.$$
$$= \frac{-Kze^2}{r} + \frac{1}{2} \frac{Kze^2}{r}$$

$$\boxed{T.E. = \frac{-1}{2} \frac{Kze^2}{r} = \mathcal{E}}$$

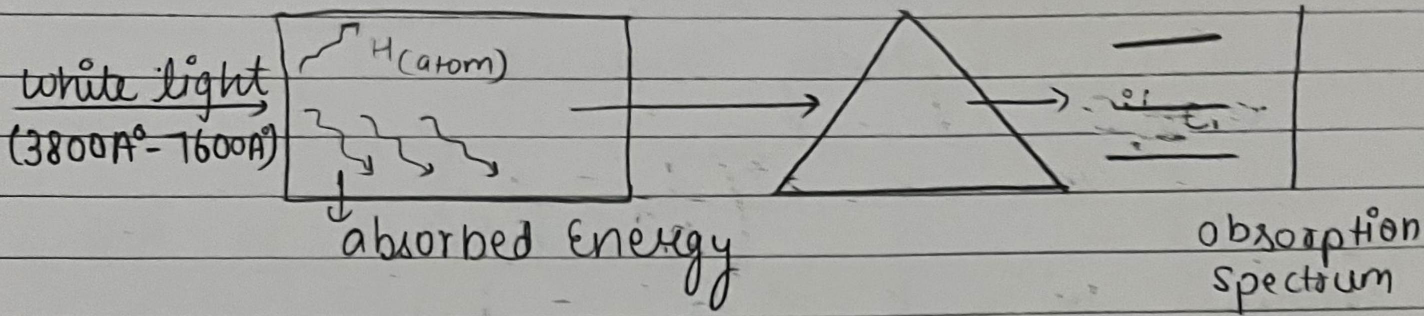
Note: $|T.E.| = K.E.$ — ①
$P.E. = 2T.E.$ — ②
$|P.E.| = 2K.E.$ — ③

$$\mathcal{E} = T.E. = \frac{-1}{2} \frac{Kze^2}{r} \quad \text{— ③}$$

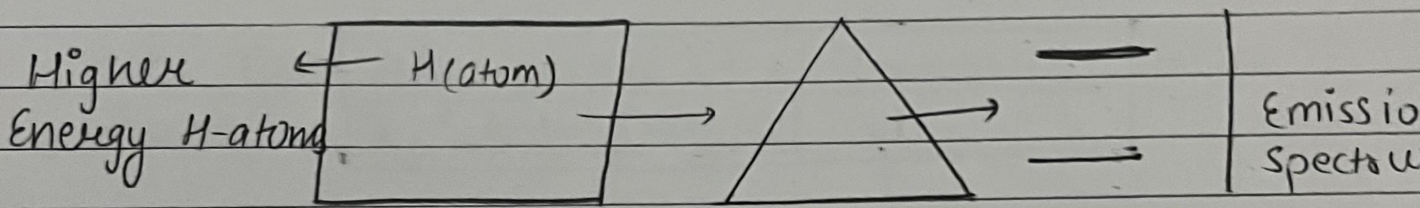
$$r = \frac{n^2 h^2}{4\pi^2 K z e^2 \cdot m} \quad \text{— ④}$$

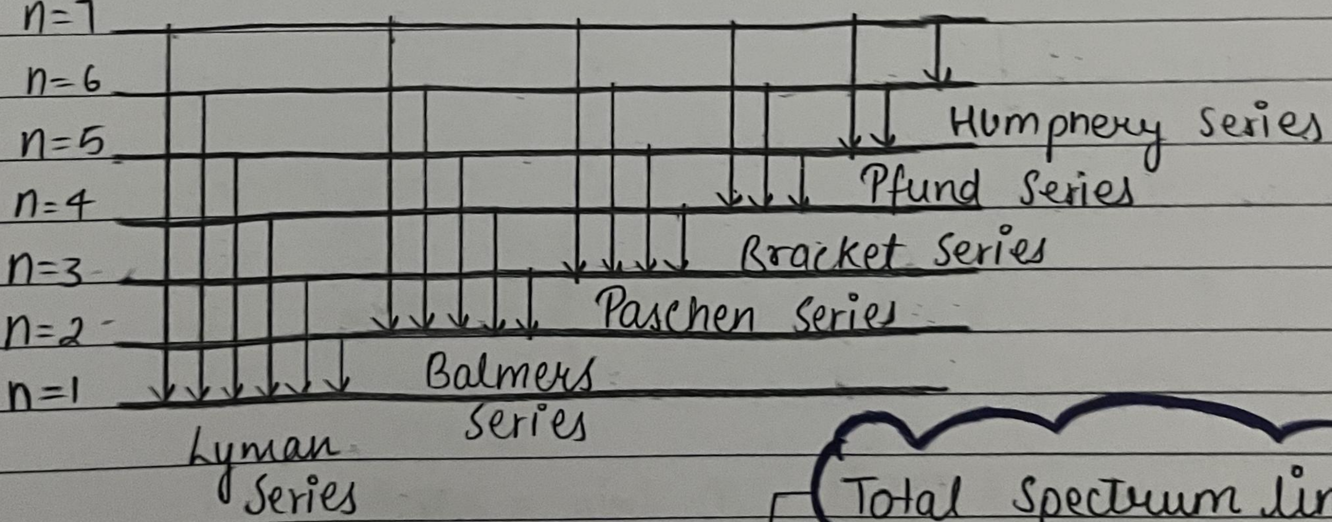
H- Spectrum

Absorption Spectrum :-



Emission Spectrum :-





No. of Spectrum lines = $\frac{\Delta n(\Delta n+1)}{2}$

If n = 7
Spectrum line
$= \frac{7(7-1)}{2} = 21$

Total Spectrum lines = $\frac{n(n-1)}{2}$

→ n = no. of shell

→ formula is applicable when e^- Jump from higher Energy level to g.s

POPU

OPP → 1 to 4

Rydberg work

$$\frac{1}{\lambda} = R_H \cdot z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \Rightarrow \lambda_{(A^\circ)} = \frac{912}{z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)}$$

R_H → Rydberg constant

Bohr's theory

$$\Delta E = K' z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

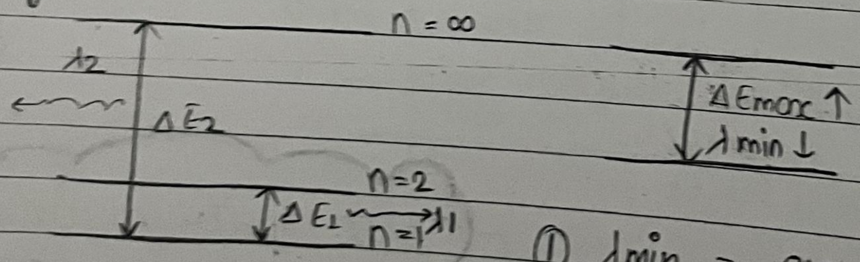
$$\frac{hc}{\lambda} = K' z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\frac{1}{\lambda} = \frac{K'}{hc} z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$\frac{K'}{hc}$ → RH

[Lecture - 12]

Lyman Series :-



For H-atom $z = 1$

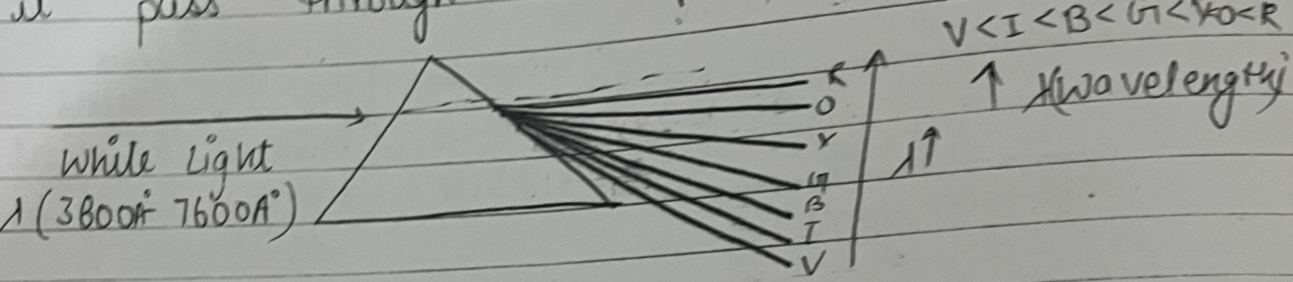
$n_1 = 1$

$n_2 = \infty$

① $$\lambda_{min} = \frac{912}{z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)} = \frac{912}{(1)^2(1-0)} = 912\ A^\circ$$

[Lecture - 11]

Spectrum :- Spectrum is Splitting of white light into seven colour when it pass through a prism.



$\delta \propto \frac{1}{\lambda}$

Deviation angle

Sepctrum

- Contineous Sepctrum
  Eg. Rainbow
- Discontineous Sepctrum
  - Molecullar Sepctrum
  - (line Sepctrum) Atomic Sepctrum
    - Absorption Sepctrum
    - Emission Sepctrum

POPU

* for same transition, ... gives a single ...

② $n_2 = 2$
$\downarrow$ ΔE_{min}, λ_{max}
$n_1 = 1$

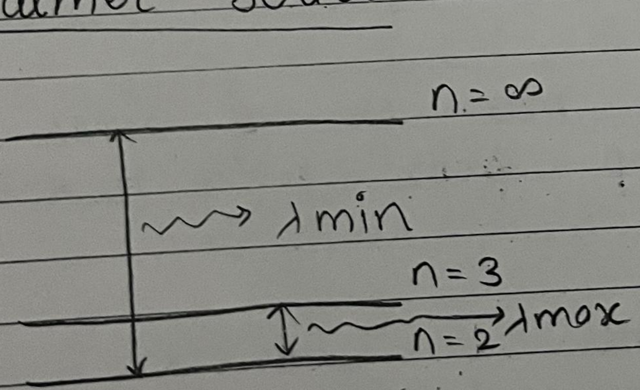
$$\lambda_{max} = \frac{912}{\left(\frac{1}{1} - \frac{1}{4}\right)} = \frac{912 \times 4}{3} = 304 \times 4 = 1216\ A^\circ$$

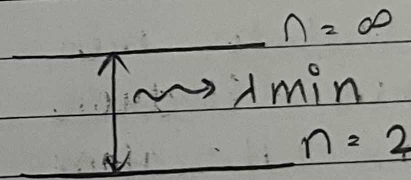
Limit of Lyman series

$$912\ A^\circ \leq \lambda \leq 1216\ A^\circ$$

All spectral lines of Lyman series found in U.V. Region.

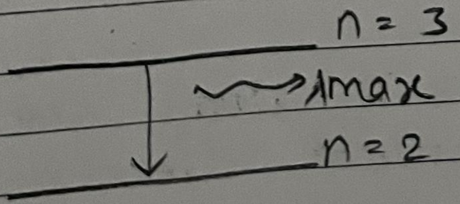
Balmer Series :-



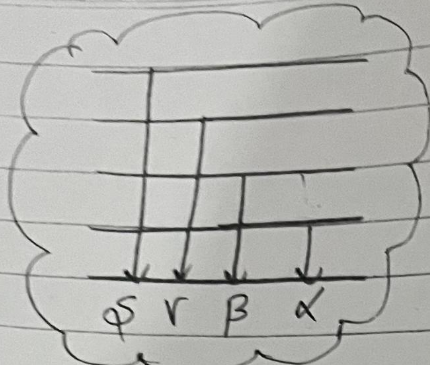


$$\lambda_{min} = \frac{912}{\left(\frac{1}{4} - 0\right)} = 3648\ A^\circ$$

$$3648 \leq \lambda \leq 6566\ A^\circ$$

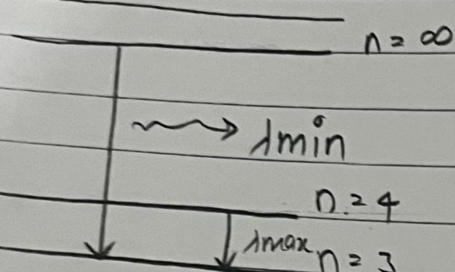


$$\lambda_{max} = \frac{912}{\left(\frac{1}{4} - \frac{1}{9}\right)} = \frac{912 \times 36}{5} = 6566\ A^\circ$$



Note :- Some lines of Balmer series found U.V. and Remaining in visible region.

Paschen Series :-



$8208 A^\circ \leq \lambda \leq 18761 A^\circ$

$\lambda_{min} = \dfrac{912}{\left(\frac{1}{9} - 0\right)} = 8208 A^\circ$ (IR Region)

$\lambda_{max} = \dfrac{912}{\left(\frac{1}{9} - \frac{1}{16}\right)} = \dfrac{912 \times 144}{7} = 18761 A^\circ$

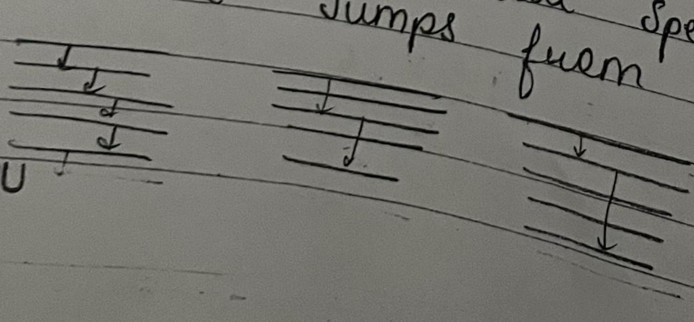
Q Calculate min. and max. No. of lines when Electron Jump from $n = 5$ to $n = 1$ for 2 H - atom.

Minimum Spectral lines = 1

Maximum Spectral lines = 4 + 2 = 6

$\lambda_1 = \lambda_2$

Q In a container only 3 H - atoms are present then calculate Spectral lines when electron Jumps from $n = 5$ to $n = 1$



Max. SL = 4 + 2 + 1 = 7

POPU

6 H-atom $n_2 = 5 \longrightarrow 10$
600 cr - H atom $n_1 = 1$

[Lecture-13]

→ **Ionisation energy :-**

It is amount of Energy required to completely remove an Electron from Isolated gaseous atom / ion from its ground state.

n = 1 (G.S.)
↓ IE
n = ∞

$H_{(g)} \xrightarrow{IE} H^+ + e$

$Na_{(g)} \xrightarrow{I.E.} Na^+ + e$

$$\Delta E = 13.6\, z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$n_1 = 1$
$n_2 = \infty$

$\Delta E = 13.6\, z^2$ eV   for z = 1
↳ Ionisation Energy

$I.E = 13.6$ eV

for He^+ z = 2.

$I.E = 13.6 \times 4 = 54.4$ eV.

$\Delta E = x z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) J$ $n_1 = 1$, $n_2 = \infty$ } I.E

$\Delta E = IE = x z^2$ J.

z = 1

$I.E = xJ$

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→ Seperation Energy :-

It is amount of Energy required to completely remove an electron from any shell ($n \neq 1$) to Inifinte ($n_2 = \infty$)

$n_1 = n \neq 1$
↓
$n_2 = \infty$

$$S_E = 13.6 \frac{z^2}{n^2}$$

→ Binding Energy :- n_1 = finite
n_2 = finite

$$B_E = \Delta E = 13.6 z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

→ Failure of Bohr's Model :-

① Bohr's Model is only applicale on single electron species like H, He^+, Li^{+2} etc.

② Bohr Colld'nt Explain why he used $mvr = \frac{nh}{2\pi}$

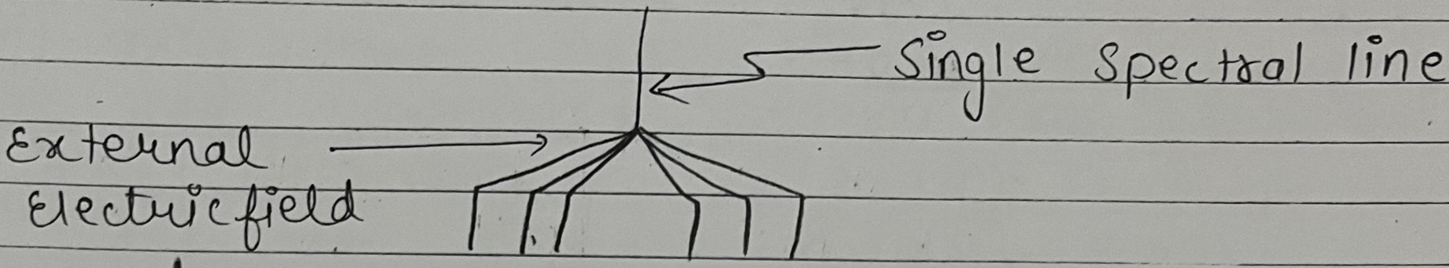
③ According to ~~Sotter~~ Sonnerfeld orbitals are Eliptical rather than circular

④ Bohr Could'nt explain Stark and zemman effect

POPU

→ **Stark effect :-**

It is spilliting of a single spectral line into many In electric line.

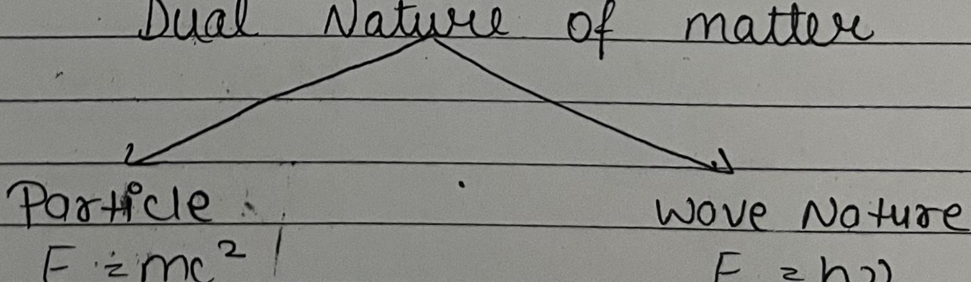


→ **Zemman effect :-**

It is spilliting of a single Spectral line into many External magnetic field.

→ **Dual Nature of Matter :-**

De - brogly hypothesis



According to de - Brogly

$E = mc^2 = h\nu$

$mc^2 = h\frac{c}{\lambda}$

$$\lambda = \frac{h}{mc}$$

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

$$\lambda_{(m)} = \frac{h}{mv} = \frac{h}{p} = \frac{h}{\sqrt{2mK.E.}} = \frac{h}{\sqrt{2mqV}}$$

↓ charge ↳ Potential

[for Proton = $\frac{0.286}{\sqrt{V}}$]

→ $K.E. = \frac{1}{2}\frac{m^2v^2}{m}$

→ $KE = qV$

$(mv)^2 = 2KEm$

$mv = \sqrt{2K.E.m}$

$$\lambda_{(A^\circ)} = \frac{0.101}{\sqrt{V}}$$ for α particle

For e^- only

$h = 6.62 \times 10^{-34}$

$m_e = 9.1 \times 10^{-31}$ Kg

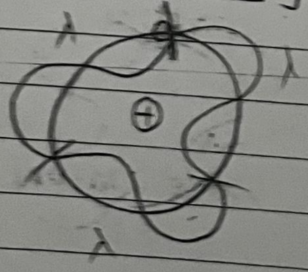
$q_e = 1.6 \times 10^{-19}$ C

Potential at which e^- is accelerated ~~from rest~~

$$\lambda_{(A^\circ)} = \sqrt{\frac{150}{V}}$$ V → volt

← specially for e^- accelerated under a Potential of V-Volt.

[Lecture-14]



$2\pi r = n\lambda$ —(1)

$\lambda = \frac{h}{mv}$ —(2)

$2\pi r = n \cdot \frac{h}{mv}$

$mvr = n\frac{h}{2\pi}$

POPU

Ques Calculate ratio of wavelength of Proton ($m = M_p$, e) to alpha particle ($4m_p$, $2e$) if :-

(i) They have same momentum.
(ii) They have same velocity.
(iii) They have same Kinetic Energy.
(iv) They accelerated under same potential difference.

Ans (i) $\lambda = \frac{h}{p}$ $\qquad \lambda \propto \frac{1}{p}$

$$\frac{\lambda_p}{\lambda_\alpha} = \frac{\frac{h}{p}}{\frac{h}{p}} = 1 : 1$$

(ii) $\lambda = \frac{h}{mv} = \frac{\lambda_p}{\lambda_\alpha} = \frac{\frac{h}{M_p}}{\frac{h}{4m_p}} = \frac{4m_p}{m_p} = 4 : 1$

(iii) $\lambda = \frac{h}{\sqrt{2mK.E.}} = \frac{\lambda_p}{\lambda_\alpha} = \frac{\frac{h}{\sqrt{2M_pKE}}}{\frac{h}{\sqrt{8M_pKE}}} = \frac{\sqrt{8M_pKE}}{\sqrt{2m_pKE}} = \frac{2\sqrt{2}\sqrt{M_pKE}}{\sqrt{2}\sqrt{M_pKE}}$

$= 2 : 1$

(iv) $\lambda = \frac{h}{\sqrt{2mqV}} = \frac{\lambda_P}{\lambda_\alpha} = \frac{\frac{h}{\sqrt{2m_peV}}}{\frac{h}{\sqrt{8m_p2eV}}} = \frac{\sqrt{16m_peV}}{\sqrt{2m_peV}} = \frac{4\sqrt{m_peV}}{2\sqrt{m_peV}}$

$= 2 : 1$

$\frac{\sqrt{8}\sqrt{m_peV}}{\sqrt{m_peV}} = 2\sqrt{2} : 1$