LAKSHYA JEE 2.0

For JEE 2023

ATOM

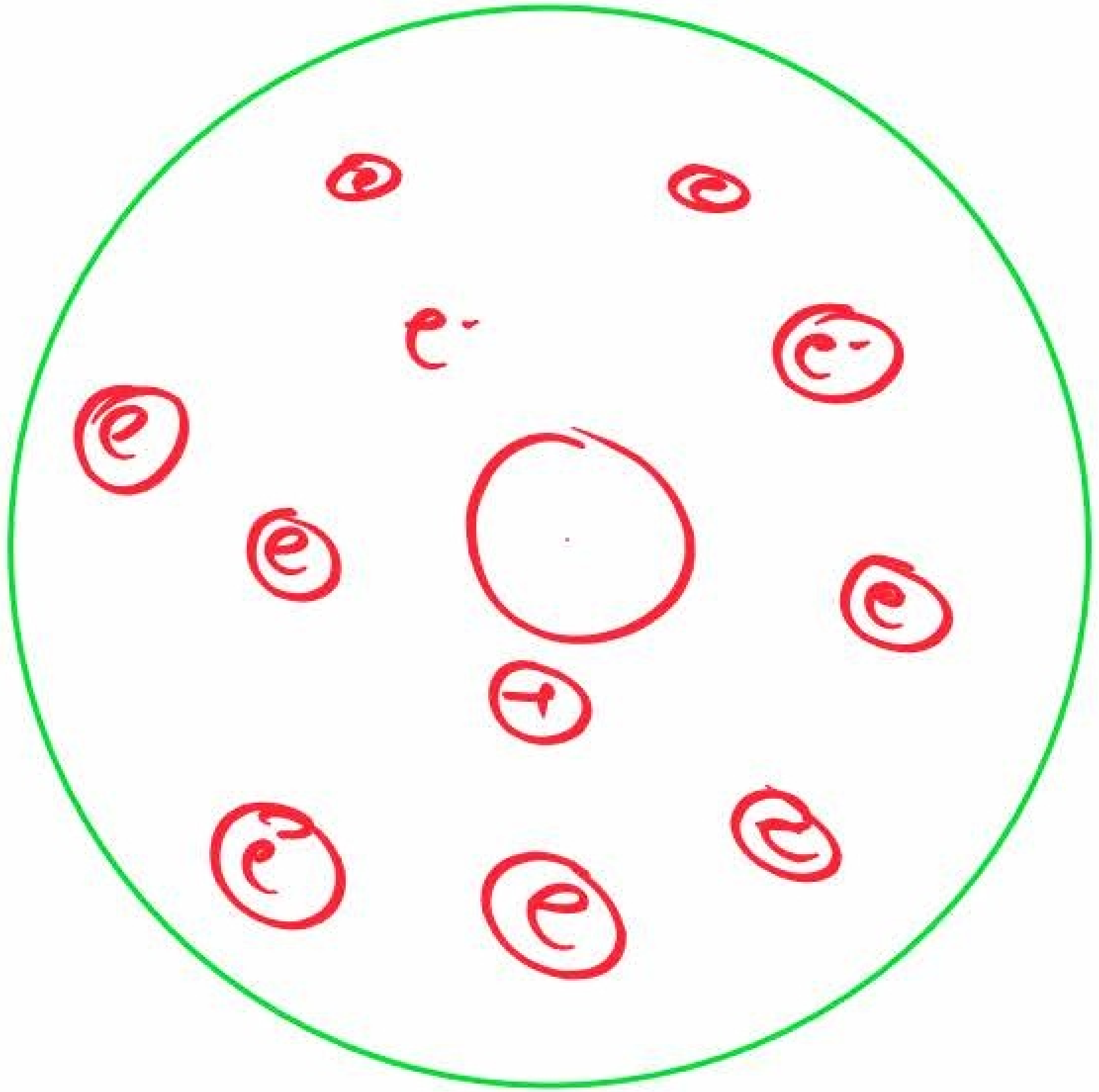
L-1

Shivendu Sir

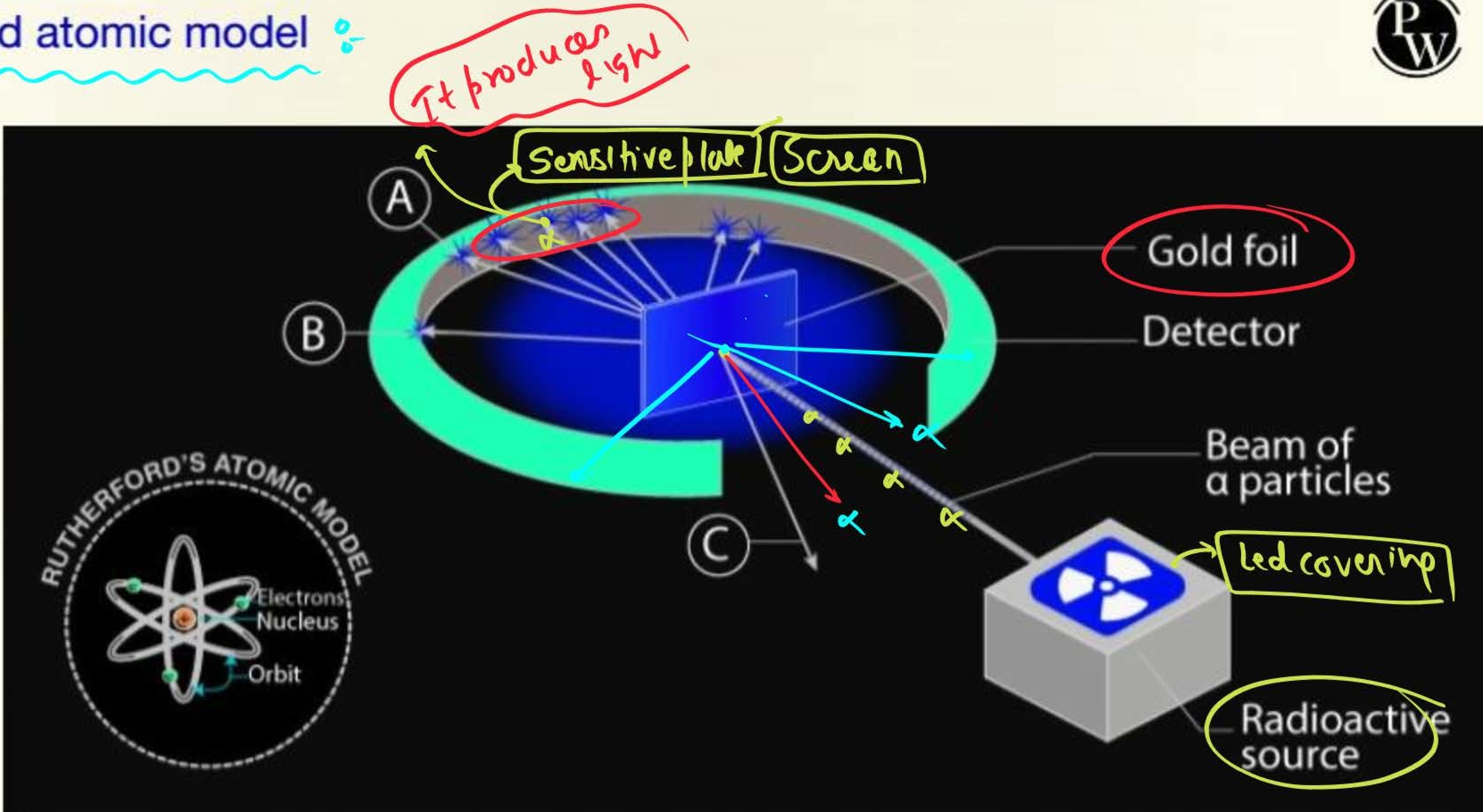
:- Atomic Structure :-

Thomson Baba :- (Plumpudding)

Kharboga Model



Rutherford atomic model :



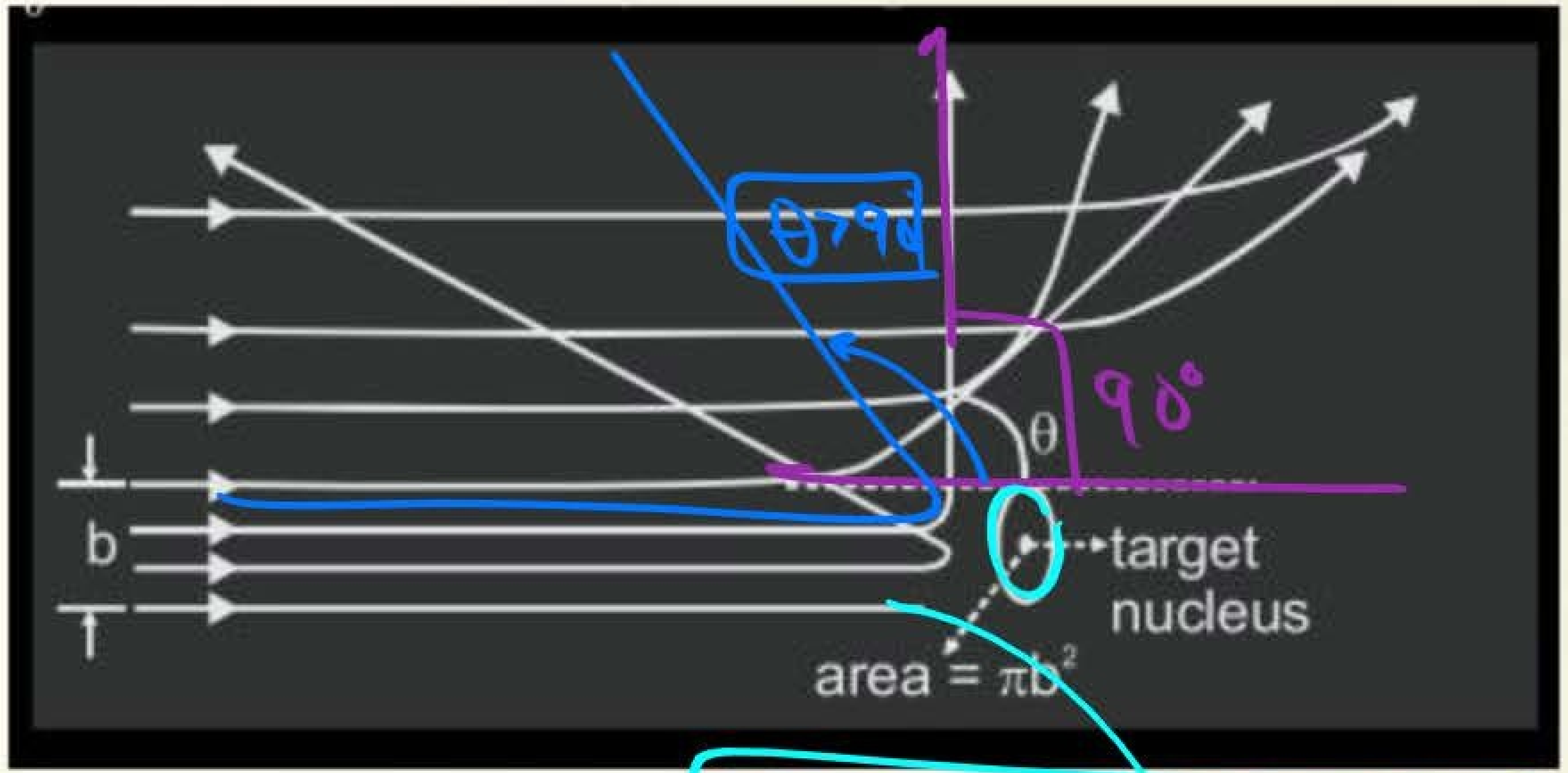
Ⓐ Most α particles travel through the foil undeflected.

Ⓑ Some α particles are deflected by small angles.

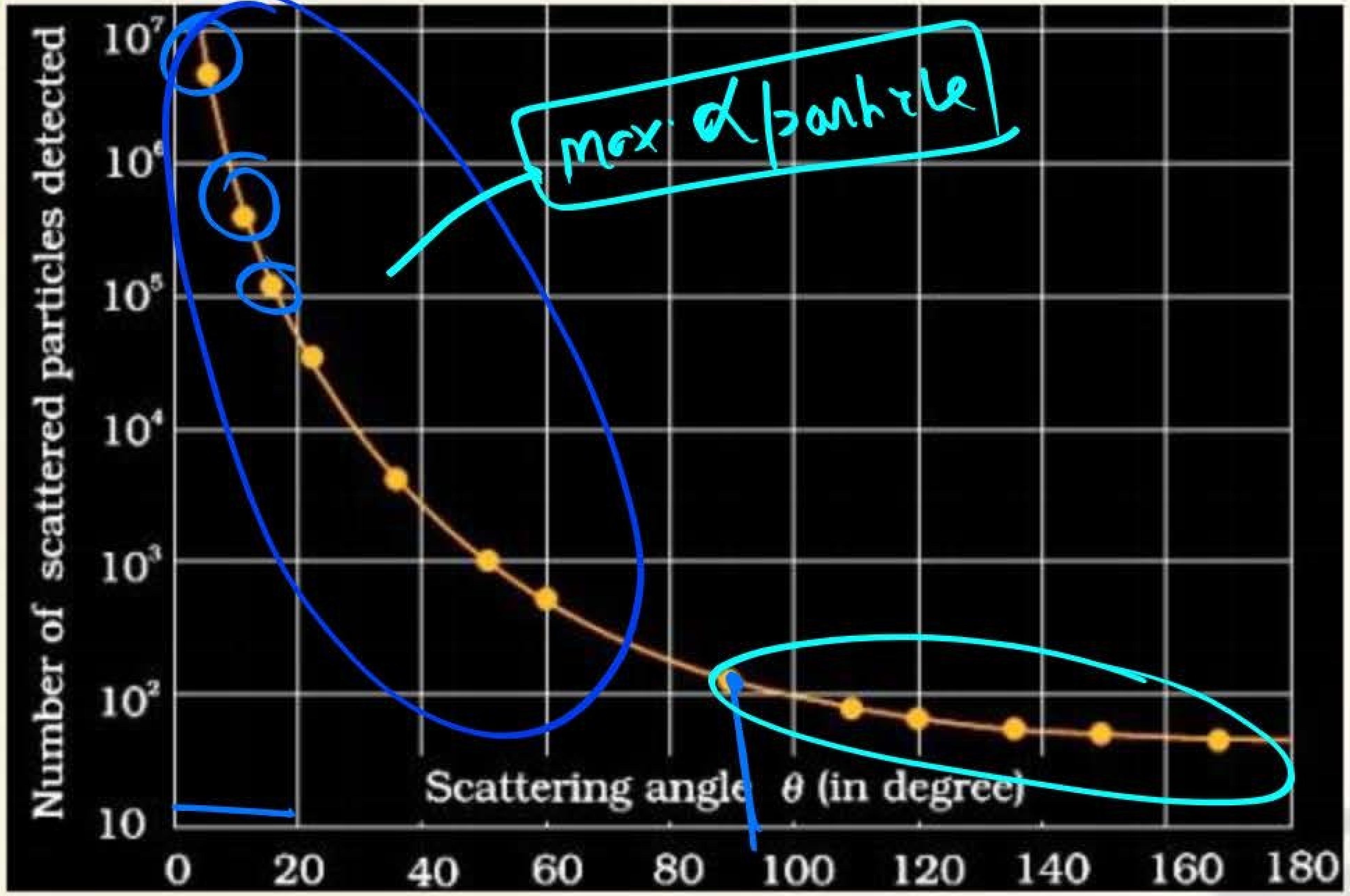
Ⓒ Occasianaly, an α particle travels back from the foil.

There are very less particle who shows deviation greater than $\boxed{90^\circ}$

$$\boxed{N(\theta) \propto \frac{1}{\sin^4(\theta/2)}}$$



$\boxed{\theta = \text{Angle of deviation}}$



Conclusion of Rutherford :-

(ii) "There in Nuclei that is Concentrated (+)ve charge exist inside the atom around which e^- are Revolving in different Radius."

Size of Nuclei is like a football in football ground

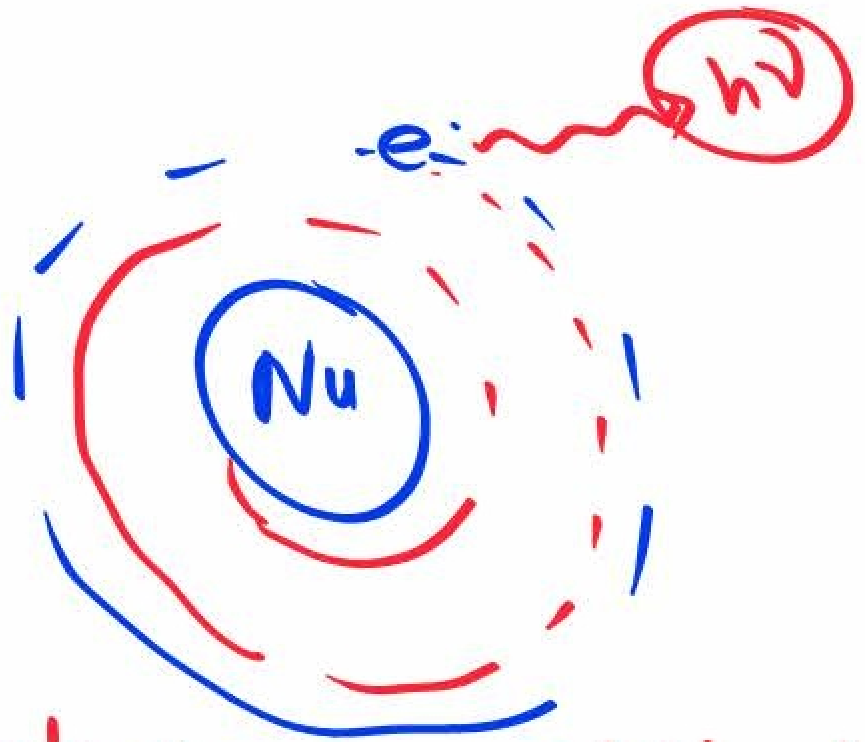
If football ground is space of e^- to Revolve

Size of nu 10^{-15} m

$\boxed{\text{Atom size} :- 10^{-10}\ \text{m}}$

Failure of Rutherford :-

→ e^- is Revolving around Nuclei thus it is an accelerated motion. Thus it should Radiate Energy.



→ If Energy Radiates then it should slowly fall down to nuclei

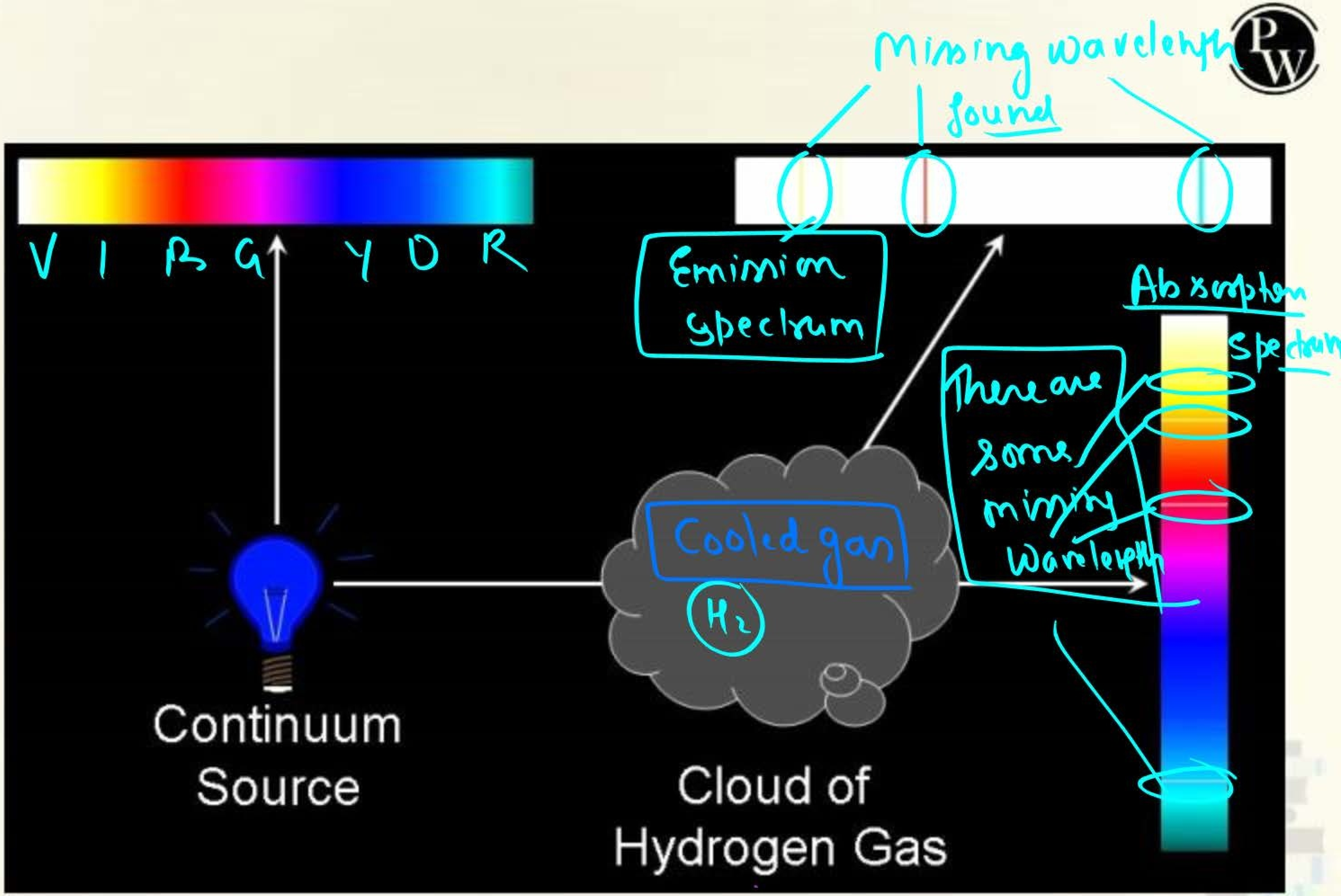
→ Hydrogen Spectrum

- Spectrum of light is not Explained.

Most Important discovery of Rutherford

→ Nuclei :- Concentrated (+)ive charge

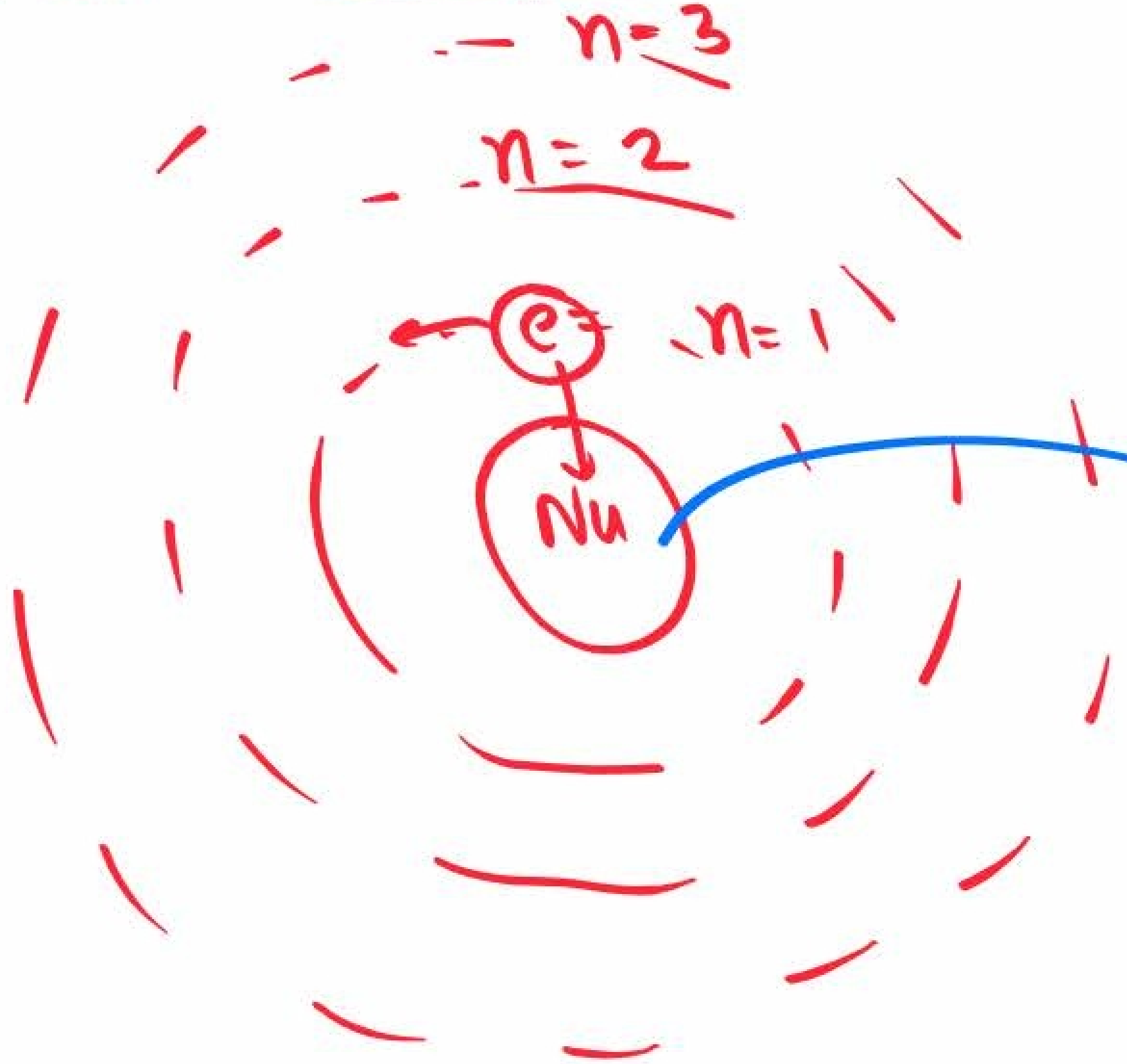
→ $\boxed{\text{Proton}}$


Missing wavelength found
V I B G Y O R
Emission spectrum
Absorption spectrum
There are some missing wavelength
Cooled gas
H_2
Continuum Source
Cloud of Hydrogen Gas

Bohr Atomic Model :- (only Applicable for single e^- Atom)

① → Inside atom Nuclei is Concentrated (+ive charge and e^- are Revolving around it. In specific Radius. There are Called as Principle Quantum Number :-

$$\boxed{(F_{c.p}) \Rightarrow \frac{mv^2}{R} = \frac{K.(Ze).e}{R^2}}$$



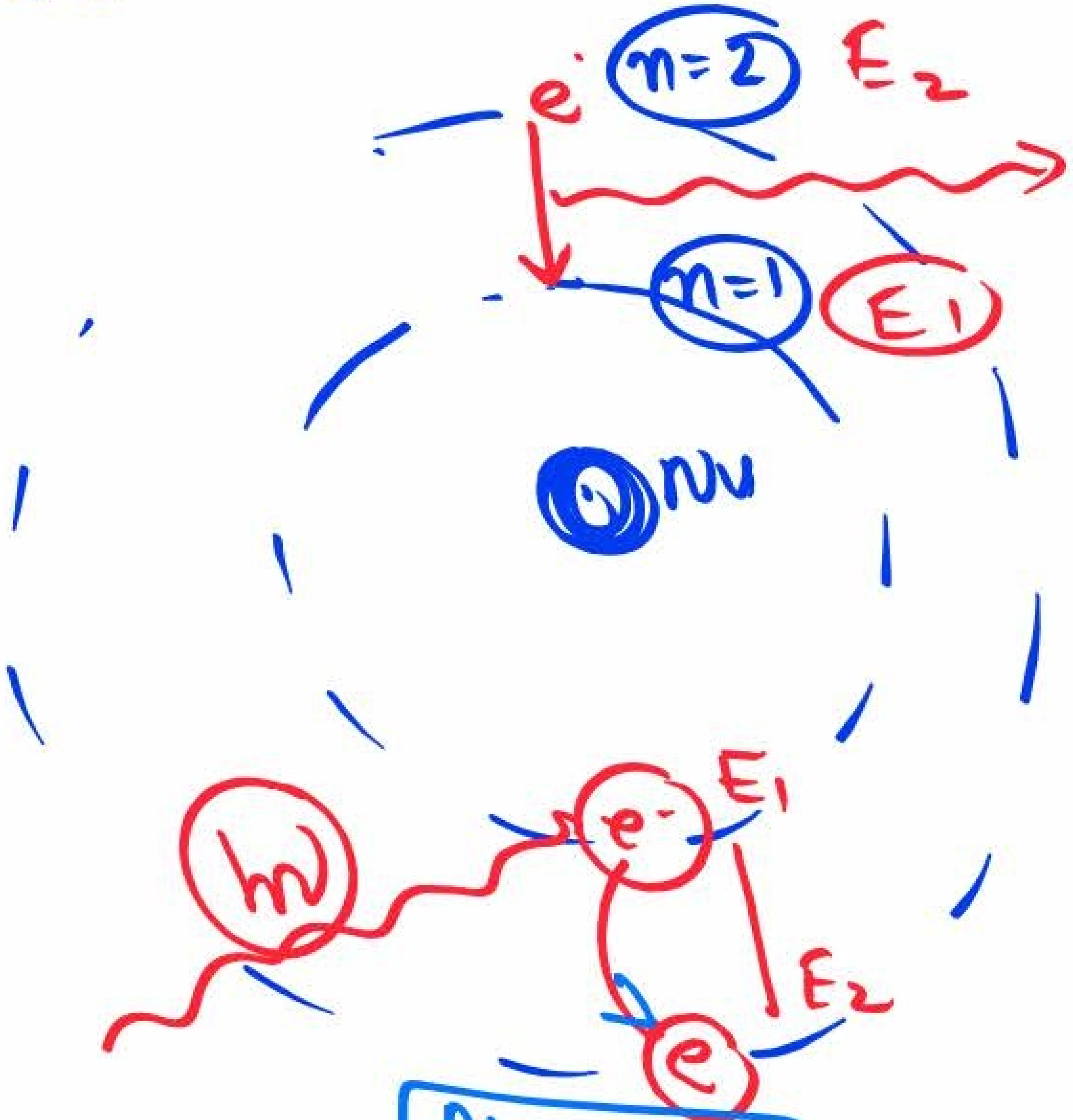
Z proton

$Q_{Nuclei} = Ze$

2nd postulates:- Angular momentum of Revolving e^- must be the Integral multiple of $\left(\frac{h}{2\pi}\right)$ or $\hbar$

$$\boxed{mvr = \frac{nh}{2\pi}}$$

3rd postulate :- Explainatan of Spectrum :- There in a Energy level of Each Orbital (in which e^- in Revolving)



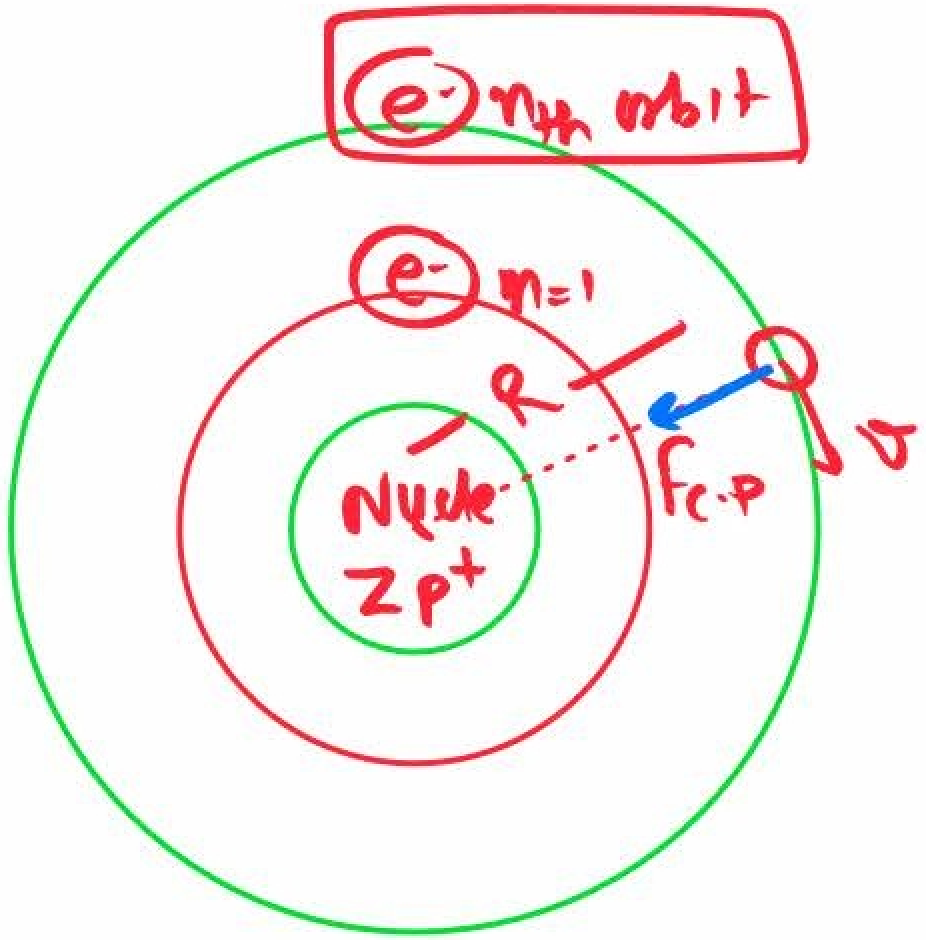
$$\boxed{\Delta E = E_2 - E_1}$$

When e^- Jumps from one orbit to another it Release / absorb the Energy difference b/w Orbitals

Absorption

$$\boxed{\frac{hc}{\lambda} = E_2 - E_1}$$ or

Calculation of Bohr model :-



by Postulate 1 :- $\left[\frac{mv^2}{\cancel{R}} \Rightarrow \frac{1}{4\pi\varepsilon_0} \cdot \frac{(Ze)\cdot e}{R^2} \right]$ —(i)

2nd postulate :- $mvR = \frac{nh}{2\pi}$ —(ii)

$$\left.\begin{aligned} (mv^2)\cdot R &= \frac{1}{4\pi\varepsilon_0}\cdot\frac{(Ze)\cdot e}{} \\ mvR &= \frac{nh}{2\pi} \end{aligned}\right\} \text{Dividing both}$$

$$V = \frac{Z\cdot e^2 \cdot 2\pi}{4\pi\varepsilon_0 \cdot nh}$$

$$= \frac{Ze^2}{2\varepsilon_0 nh}$$

$$\boxed{V \Rightarrow \frac{Z}{n}\left(\frac{e^2}{2\varepsilon_0 h}\right)}$$

$= Z/n \times 2.18 \times 10^{+6}$ m/s

TOPICS TO BE COVERED

1. **Photon Theory of Light**
2. **Photo electric effect**
3. **Radiation pressure**

$$mvR = \frac{nh}{2\pi}$$

$$R = \frac{nh}{2\pi m \cdot v} = \frac{nh}{2\pi m \cdot \frac{Z e^2}{n 2 \varepsilon_0 h}} = \frac{n^2}{Z}\left(\frac{\varepsilon_0 h^2}{\pi m \cdot e^2}\right)$$

$$\boxed{R = \frac{n^2}{Z}\left(\frac{\varepsilon_0 \cdot h^2}{\pi m e^2}\right)}$$

$$\frac{\varepsilon_0 \cdot h^2}{\pi m e^2} \rightarrow \boxed{0.529\,\mathring{A}}$$

$$\boxed{R = \frac{n^2}{Z}\left(0.529\,\mathring{A}\right)}$$

$Z = 1 \Rightarrow$ Hydrogen

$n = 1 \Rightarrow$ 1st orbit

Ground state

$$\boxed{R_{\text{G.State of Hydrogen}} \Rightarrow 0.529\,\mathring{A}}$$

$$R \Rightarrow \frac{n^2}{Z}\cdot(0.529\,Å)$$

$$v = \frac{Z}{n}\left(2.18\times10^{6}\ m/s\right)$$

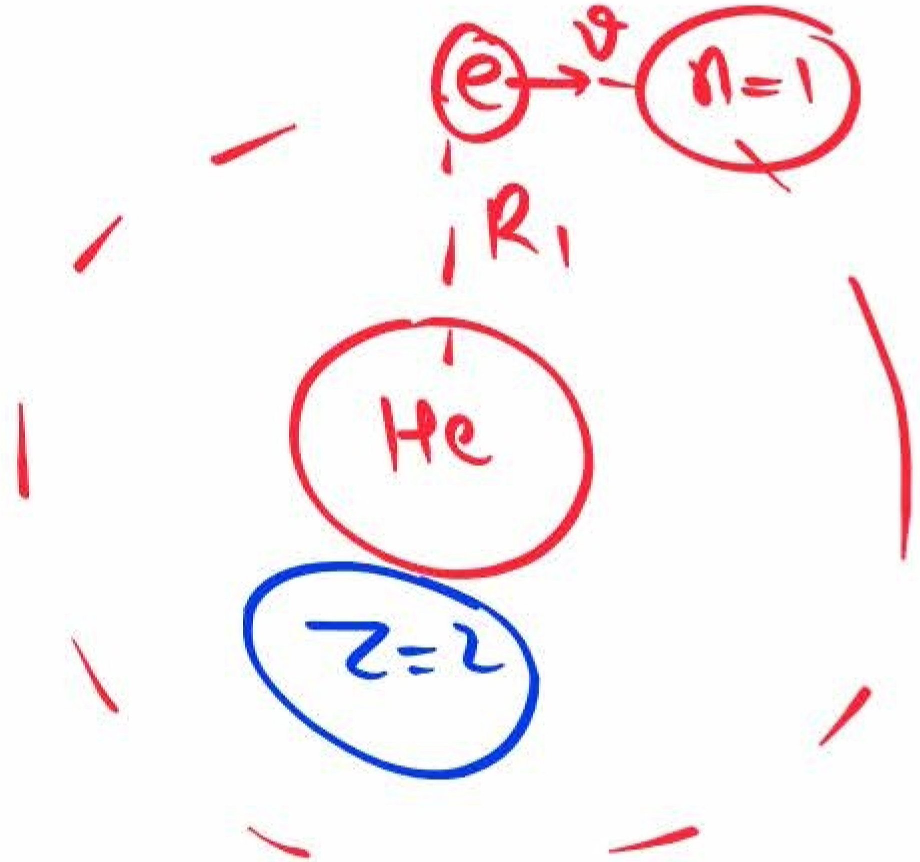
Question

$$R = \frac{(2)^2}{1}(0.529)$$
$$= 4\times0.529$$
$$= 2.1\,Å$$

$$v = \left(\frac{1}{2}\right)\times 2.18\times10^{6}$$

$$\boxed{v \Rightarrow 1.09\times10^{6}}$$

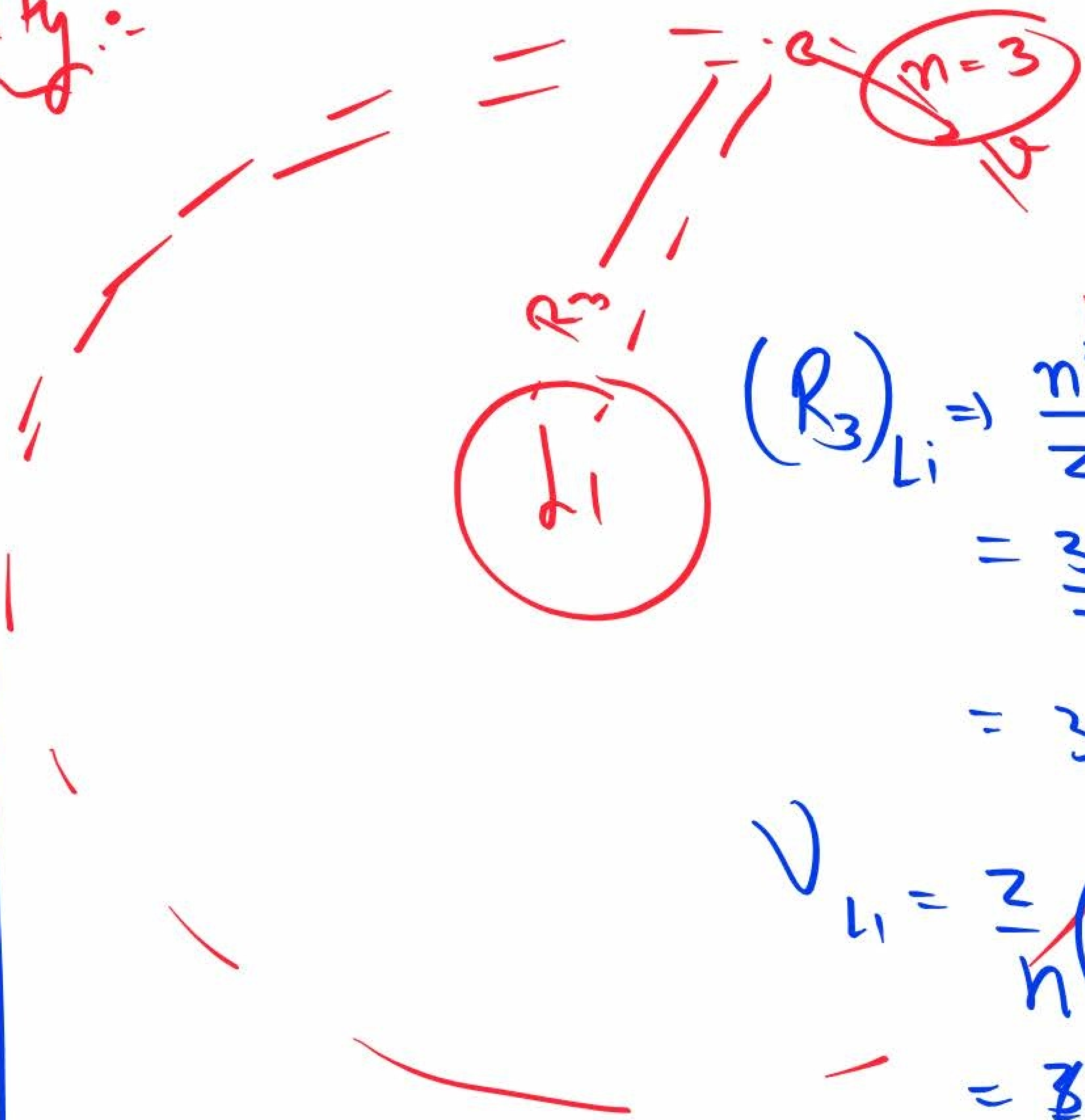
Find Radius and Velocity :-



$$(R_1)_{He} = \left(\frac{1^2}{2}\right) \cdot (0.529)$$

$$(v_{He}) = \left(\frac{Z}{n}\right)(2.18 \times 10^6)$$

$$\Rightarrow \left(2/1\right) \times (2.18 \times 10^6)$$



$$(R_3)_{Li} \Rightarrow \frac{n^2}{Z}(0.529)$$

$$= \frac{3^{\cancel{2}}}{\cancel{3}} \times 0.529$$

$$= 3 \times 0.529$$

$$V_{Li} = \frac{Z}{n}(2.18 \times 10^6)$$

$$= \frac{\cancel{3}}{\cancel{3}}(2.18 \times 10^6)$$

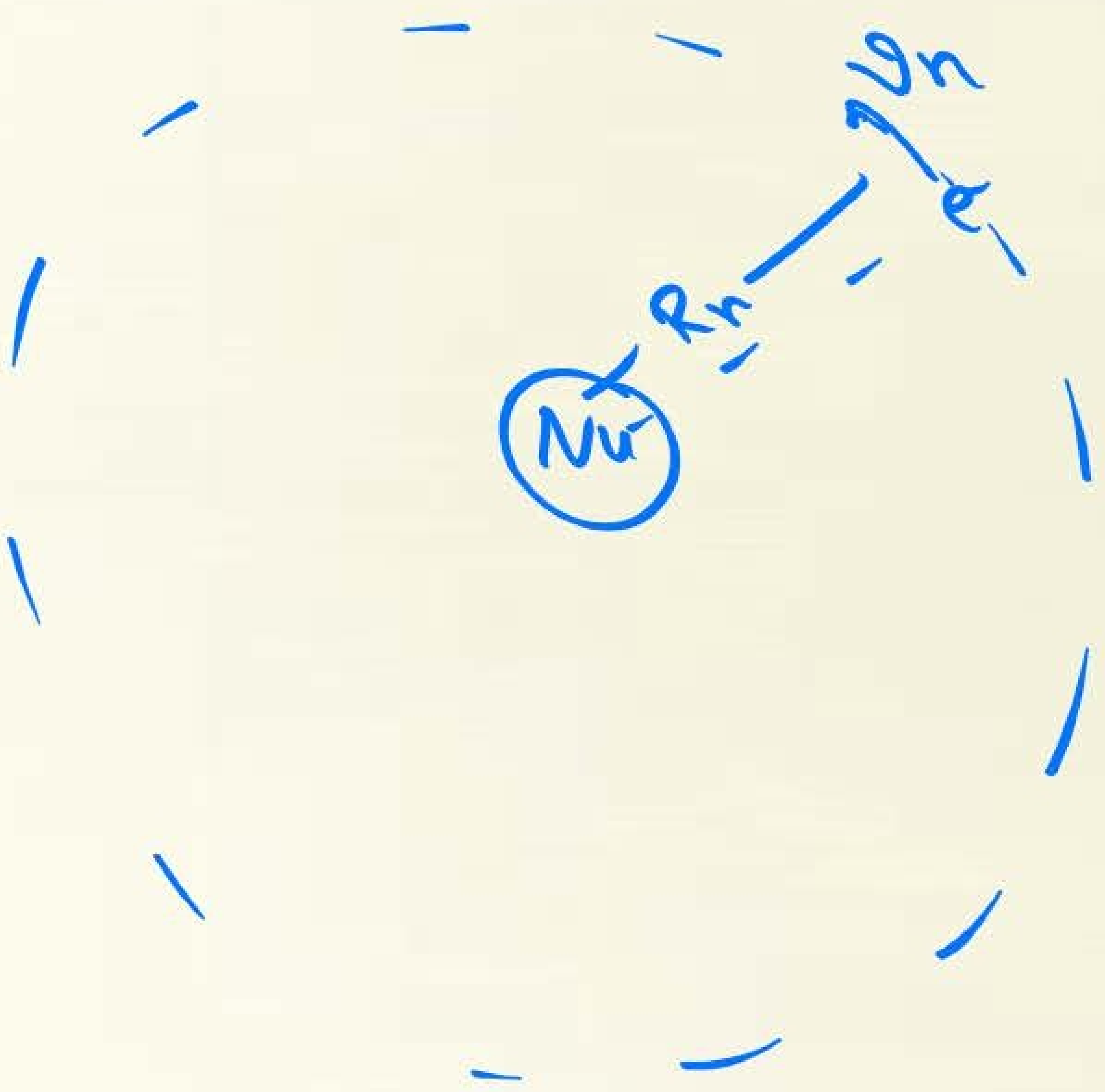
(ii) Max Radius of 1st orbit is :- of Hydrogen - $\boxed{0.529}$ Å

$$R = \left(\frac{n^2}{Z}\right)(0.529)$$

Frequency and Timeperiod of e^- :-

R_n = Radius of n^{th} orbit

V_n = Velocity of e^- in n^{th} orbit



$$T = \frac{2\pi R_n}{V_n}$$

$$T = \frac{2\pi\left(\frac{n^2}{Z}\right)(0.529\times10^{-10})}{\left(\frac{Z}{n}\right)(2.18\times10^{6})\,m/s}$$

$$\boxed{T = \frac{n^3}{Z^2}\left(C_0\right)}$$

$$\boxed{f \Rightarrow \frac{1}{T} \propto \frac{Z^2}{n^3}}$$

Debroglie in Bohr model :

Q. Ration of wavelength of e^- in 1st and 3rd orbit of Helium

$$\lambda = \frac{h}{mv} = \frac{h}{m\left(\frac{Z}{n}\cdot(2.18\times10^{6})\right)}$$

$$\boxed{\lambda_{e^-} \propto \frac{n}{Z}}$$

$$\boxed{\frac{(\lambda)_1}{(\lambda_3)} = \frac{n_1/Z}{n_3/Z} = \frac{1}{3}}$$

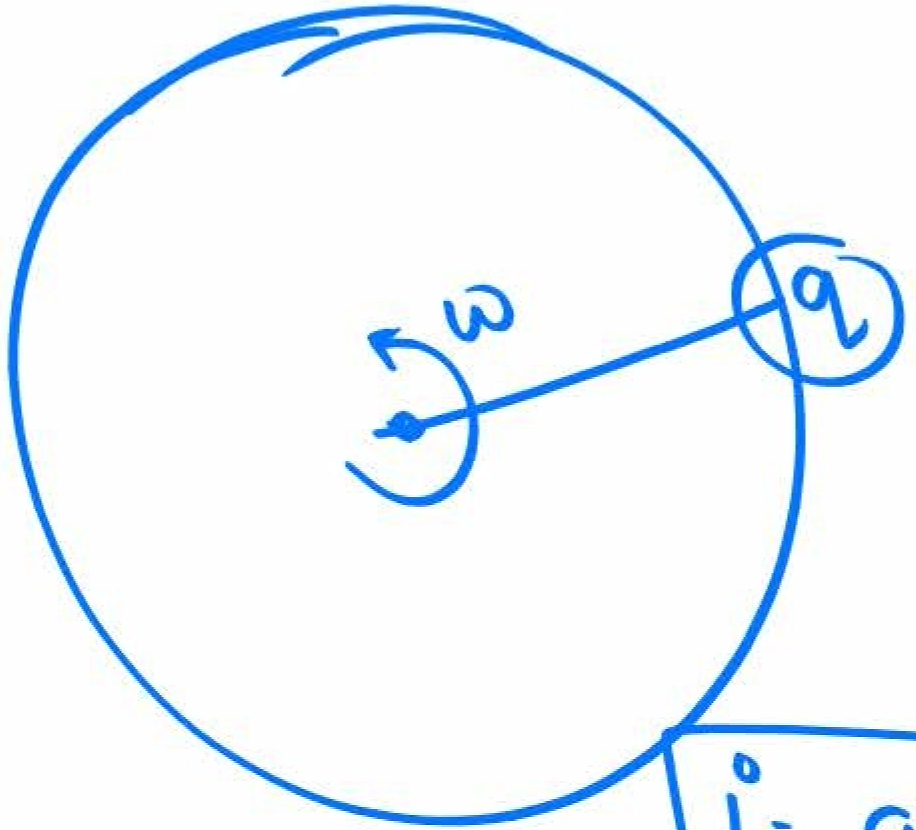
Q) Find Ratio of wavelength of e^- of 2nd orbit of He$^+$ and 4th orbit of Li^{++} as per bohr model

$$\lambda \Rightarrow \frac{h}{mv} \Rightarrow \frac{h}{m\left(\frac{Z}{n}\right)(2.18\times10^{6})}$$

$$\frac{\lambda_{He}}{\lambda_{Li}} \Rightarrow \frac{\cancel{2}/\cancel{2}}{\left(4/3\right)}$$

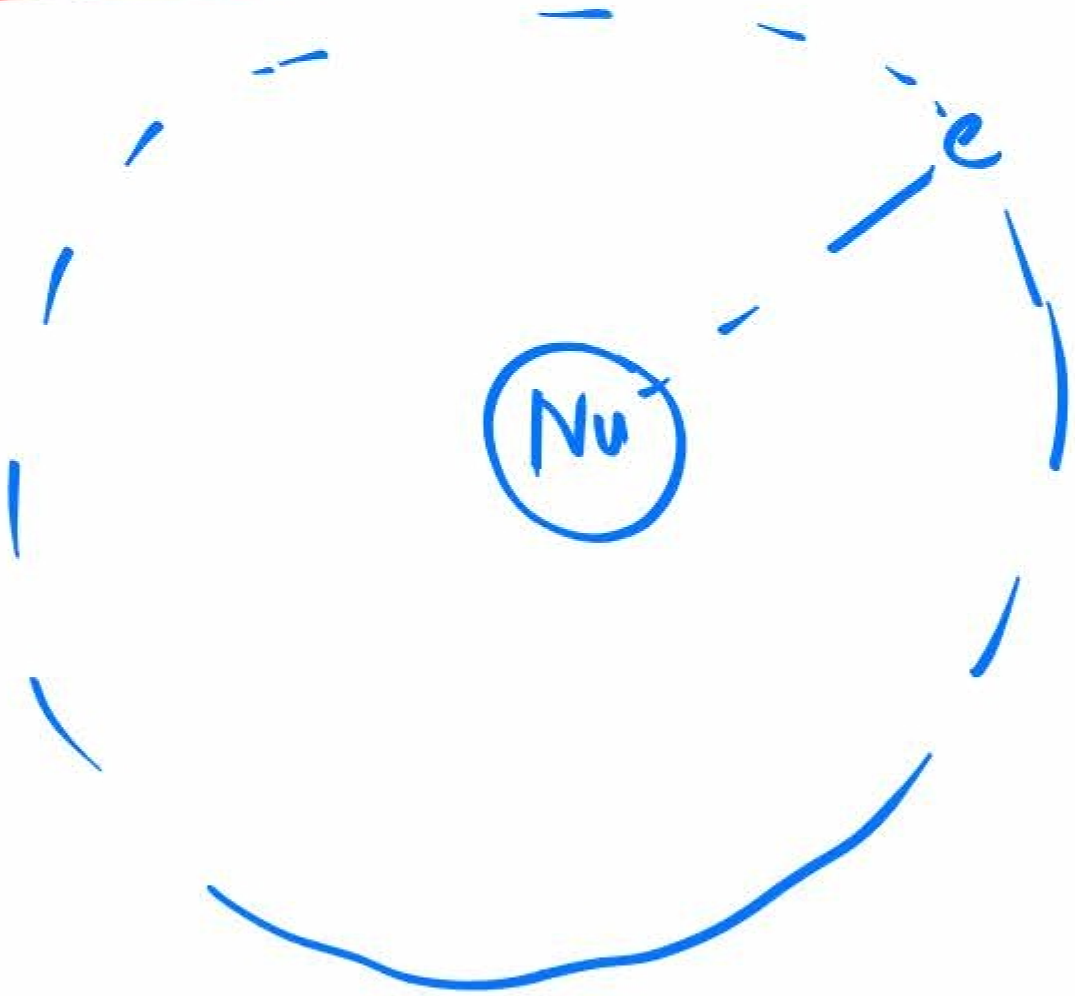
$$\boxed{\frac{\lambda_{He}}{\lambda_{Li}} = 3/4}$$ Ans//

Orbital current



$$\boxed{i = \frac{q\omega}{2\pi}}$$

Orbital Current due to e^-



$$(i_{e^-}) = \frac{e \cdot \omega}{2\pi}$$

$$\boxed{\omega = \frac{2\pi}{T} = 2\pi f}$$

$$\boxed{\omega \propto f \propto \frac{Z^2}{n^3}}$$

$$\boxed{i_e \propto \frac{Z^2}{n^3}}$$

Kotcha Remember

$$i_{orb} = \frac{q\omega}{2\pi}$$

M.F at center of circle

$$\Rightarrow B = \frac{\mu_0 i}{2R}$$

$$= \frac{\mu_0 \cdot q}{2R} \cdot \frac{\omega}{2\pi}$$

$$\boxed{B = \frac{\mu_0}{4\pi} \cdot \frac{q\omega}{R}}$$

Magnetic Moment

$$\overline{M} = i\,A$$

$$\boxed{\vec{M} = \left(q \cdot \frac{\omega}{2\pi}\right) \cdot \pi R^2}$$

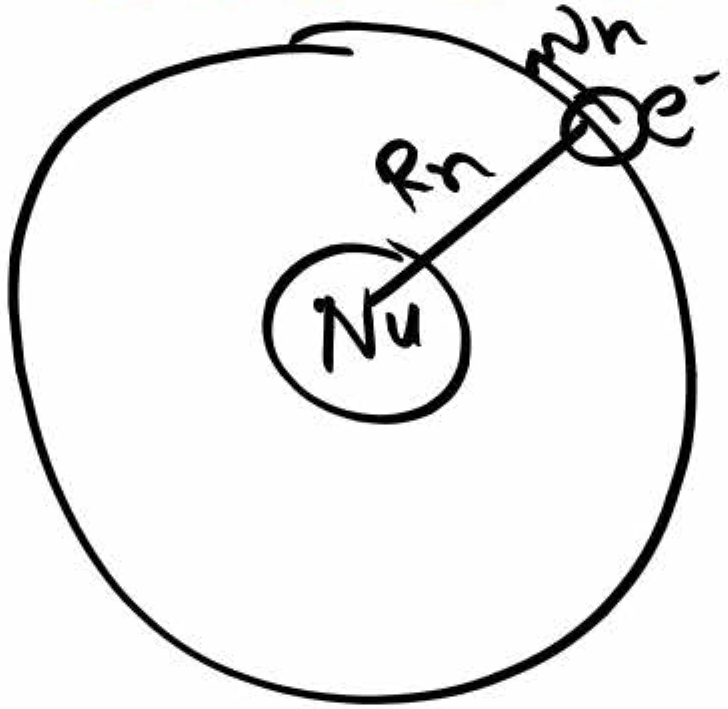
$$M = i \cdot A$$

$$= i \cdot \pi R^2$$

$$\propto \left(\frac{Z^2}{n^3}\right)\left(\frac{n^2}{Z}\right)^2$$

$$\boxed{M \propto n}$$

Application in Bohr model :-



$$\boxed{i_{orb} \propto \frac{Z^2}{n^3}}$$

$$B = \frac{\mu_0}{2}\left(\frac{I}{R}\right)$$

$$\Rightarrow \frac{\mu_0}{2}\left[\frac{\left(Z^2/n^3\right) \cdot C_0}{n^2/Z}\right]$$

$$\boxed{B \propto Z^3/n^5}$$

Gupt Gyan

Summary of Proportionality :-

$$\boxed{v_n \propto \frac{Z}{n} \left(2.18\times10^6\right)}$$

$$\boxed{R_n \propto \frac{n^2}{Z} \left(0.529\,\mathring{A}\right)}$$

$$\boxed{T \propto \frac{n^3}{Z^2}}$$

$$\boxed{f \propto \omega \propto \frac{1}{T} \propto \frac{Z^2}{n^3}}$$

$$\boxed{i_{orb} \propto \omega \propto \frac{Z^2}{n^3}}$$

Mag. field due to e⁻

$$\boxed{B \Rightarrow Z^3/n^5}$$

Magnetic Moment of e⁻

$$\boxed{M \propto n}$$

Independent of Z

$$\boxed{\text{Angular Moment} = \frac{nh}{2\pi}}$$

$$\boxed{L \propto n}$$

An electron, a doubly ionized helium ion (He++) and a proton are having the same kinetic energy. The relation between their respective de-Broglie wavelengths e, and P is: **[JEE Main-2020]**

(1) $\lambda_e < \lambda_P < \lambda_{He^{++}}$ (2) $\lambda_e < \lambda_{He^{++}} = \lambda_P$

(3) $\lambda_e < \lambda_{He^{++}} > \lambda_P$ (4) $\lambda_e > \lambda_P > \lambda_{He^{++}}$

$$\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2m(q(\Delta V))}}$$

$\boxed{K = K.E}$

$\boxed{\Delta V = \text{P.D across which } q \text{ in accelerat}}$

If $\boxed{K = \text{same}}$

$$\lambda = \frac{h}{\sqrt{2mK}} \qquad \boxed{\lambda \propto \frac{1}{\sqrt{m}}}$$

$m_\alpha \Rightarrow (2P + 2N) = 4m_p$

$m_p = P \quad = m_p$

$m_e = (m_e) \quad = \left(\frac{m_p}{1837}\right)$

$\boxed{HCV}$ - **Bohr model** : Pg. no 378

W. Ex :- 1, 2

O.1 . 1 - 5

O.2 :- 1 - 3

Ex :- 1 - 10

THANK -YOU

The de Broglie wavelength of a proton and α-particle are equal. The ratio of their velocities is :

[JEE Main-2021]

(1) 4 : 3　　~~(2)~~ 4 : 1　　(3) 4 : 2　　(4) 1 : 4

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

$$\boxed{\alpha\text{-particle}}$$

$$2P \quad 2N \quad {}^{++}$$

$$\boxed{m_P \approx m_N}$$

$$\boxed{m_\alpha = 4m_p}$$

$$\frac{\lambda_\alpha = \dfrac{h}{m_\alpha \cdot v_\alpha}}{\lambda_p = \dfrac{h}{m_p \cdot v_p}}$$

$$1 = \frac{\lambda_\alpha}{\lambda_p} = \frac{m_p \cdot v_p}{m_\alpha \cdot v_\alpha} \Rightarrow \boxed{\frac{v_p}{v_\alpha} = \frac{m_\alpha}{m_p} = \frac{4}{1}}$$

The de Broglie wavelength of a proton and α-particle are equal. The ratio of their velocities is :

[JEE MAIN 2021 (FEB)]

(A) 4 : 3

(B) 4 : 1

(C) 4 : 2

(D) 1 : 4

A particle is travelling 4 times as fast as an electron. Assuming the ratio of de-Broglie wavelength of a particle to that of electron is 2 : 1, the mass of the particle is:-

[JEE MAIN 2021 (AUGUST)]

(A) 1/16 times the mass of e^-

(B) 8 times the mass of e^-

(C) 16 times the mass of e^-

(D) 1/8 times the mass of e^-

$$\boxed{V_p = 4V_e}$$

$$\frac{\lambda_{Pa} = \frac{h}{m_p \cdot V_p}}{\lambda_e = \frac{h}{m_e \cdot V_e}} \Rightarrow \frac{\lambda_{Pa}}{\lambda_e} = \frac{2}{1} = \frac{m_e V_e}{m_p \cdot V_p} = \frac{m_e \cdot \cancel{V_e}}{m_p \cdot 4\cancel{V_e}}$$

$$\frac{2}{1} = \left(\frac{m_e}{m_p}\right) \cdot \frac{1}{4} \Rightarrow \boxed{\frac{m_e}{8} = m_p}$$

The speed of electrons in a scanning electron microscope is $1 \times 10^7 \ ms^{-1}$. If the protons having the same speed are used instead of electrons, then the resolving power of scanning proton microscope will be changed by a factor of:

[JEE MAIN 2021 (MARCH)]

(A) 1837

(B) 1/1837

(C) $\sqrt{1837}$

(D) $\frac{1}{\sqrt{1837}}$

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

$$R.P = (c)\frac{1}{\lambda} = \frac{(c)\,mv}{h}$$

$$\boxed{R.P = (C_0) \cdot mv}$$

Resol. limit $\Rightarrow \frac{1.22\lambda}{d}$

$$\boxed{R.L \propto \lambda}$$

$$\boxed{R.P. = \frac{1}{R.L}}$$

$$\boxed{R.P \propto \frac{1}{\lambda}}$$

$$(R.P)_e \Rightarrow (C_0)\, m_e \cdot V$$

$$(R.P)_p = (C_0)\, m_p \cdot V$$

$$\frac{(R.P)_e}{(R.P)_p} = \frac{m_e}{(m_p)} = \frac{\cancel{m_e}}{1837\,\cancel{m_e}}$$

$$\boxed{(R.P)_p = (1837)(R.P)_e}$$

The de-Broglie wavelength associated with an electron and a proton were calculated by accelerating them through same potential of 100V. What should nearly be the ratio of their wavelengths? ($m_p = 1.00727$ u, $m_e = 0.00055$u)

[JEE MAIN 2021 (MARCH)]

(A) 1860 : 1

(B) $(1860)^2 : 1$

(C) 41.4 : 1

(D) 43 : 1

$$\lambda = \frac{h}{\sqrt{2m(q\cdot\Delta V)}}$$

$$\lambda_p = \frac{h}{\sqrt{2m_p\cdot(q\Delta V)}}$$

$$\lambda_e = \frac{h}{\sqrt{2(m_e)(q\cdot\Delta V)}}$$

$$\Rightarrow \frac{\lambda_p}{\lambda_e} = \frac{\sqrt{m_e}}{\sqrt{m_p}}$$