CYCLOTRON

Home Assignment :-

01) The readius of the Circulare path by the proton in the magnetic field change :-

$$r = \frac{1}{B}\sqrt{\frac{2mV}{q}}$$

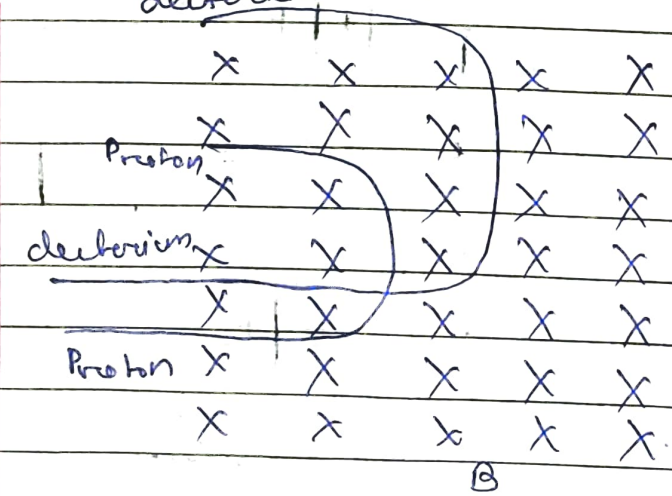
b → magnetic field
v → potential difference

$$r \propto \sqrt{V}$$

$$\frac{r'}{r} = \sqrt{\frac{2V}{V}} = \sqrt{2}$$

$$r' = \boxed{\sqrt{2}\, r}$$

02) Radive of charged particle in magnetic field.



$$r = \frac{mv}{qB}$$

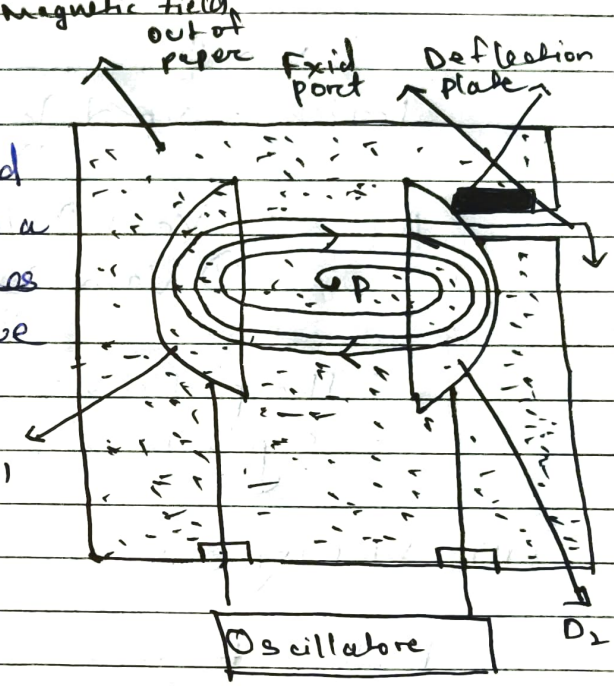
~~$\propto \frac{1}{q}$~~

$$\frac{r_{Proton}}{r_{electron}} = \frac{(m/q)_p}{(m/q)_d} = \frac{m_p/e}{4m_p/2e} = \boxed{\frac{1}{2}} = \boxed{1:2}$$

∴ The ratio of the radii of the circular path is 1:2.

Principle -

03) Working :- It works on the principle that a charged particle moving normal to a magnetic field experiences magnetic lorentz force due to which the particle moves in a circular path.



(Cyclotron)

$$\rightarrow \frac{mv^2}{r} = qvB \qquad r = \frac{mv}{qB}$$

$$\Rightarrow v = \frac{qBr}{m}$$

Period of revolution; $T = \frac{2\pi r}{v}$

$$\Rightarrow \frac{2\pi rm}{qBr} \quad \therefore T = \frac{2\pi(mv)}{vqB} = \boxed{\frac{2\pi m}{qB}}$$

$$\Rightarrow T = \frac{2\pi m}{qB} \Rightarrow f = \frac{1}{T} = \boxed{\frac{qB}{2\pi m}}$$

∴ This shows that frequency is independent of velocity of the charged particle.

04) (i) Mass of proton = m

Mass of alpha = 4m

Charge of proton = q

Charge of alpha = 2q

$v = \frac{Bq}{2\pi m}$

$\Rightarrow v \propto \frac{q}{m}$

Proton = $v_p \propto \frac{q}{m}$

Alpha = $v_\alpha \propto \frac{2q}{4m}$

$\Rightarrow v_\alpha \propto \frac{q}{2m}$

∴ The particles will not accelerate with same cyclotron frequency.

(ii) Velocity = $Bqr/m \Rightarrow v \propto q/m$

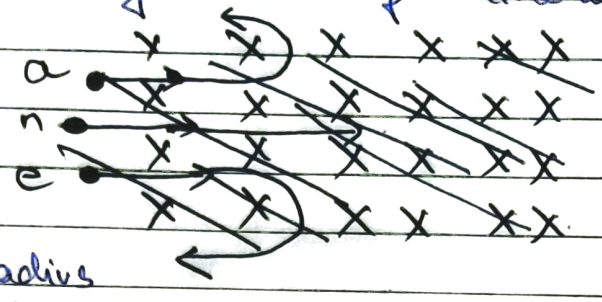
Proton :- velocity = $v_p \propto q/m$

Alpha :- $v_\alpha \propto \frac{2q}{4m}$

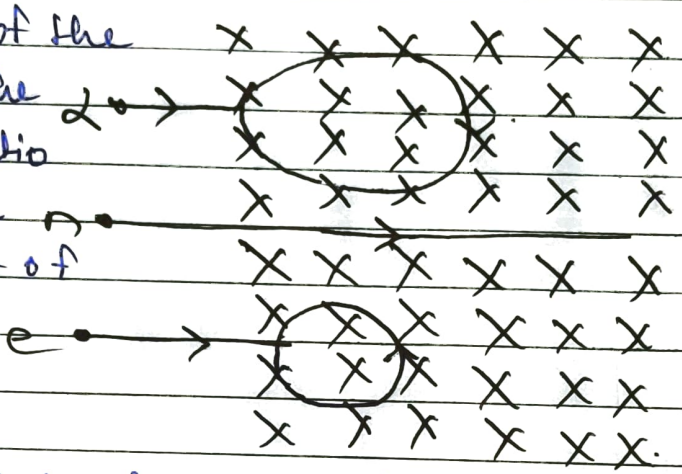
$\Rightarrow v_\alpha \propto \frac{q}{2m}$

∴ The velocity of proton will be higher at the exit slit of the dees.

05) → The neutron will move along the straight line as it has no charge.



→ The electron will inscribe a circle of radius smaller than that of the alpha particle as the mass to charge ratio of the alpha particle is more than that of the electron



→ The alpha particle will move in the clockwise direction and the electron will move in anticlockwise direction according to right hand rule.