

HOME ASSIGNMENT [Moving Charges and Magnetism]

1) The radius of the circular path by the proton in the magnetic field change can be described.

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

where  $b$  is the magnetic field  
 $V$  is the potential difference.

Therefore

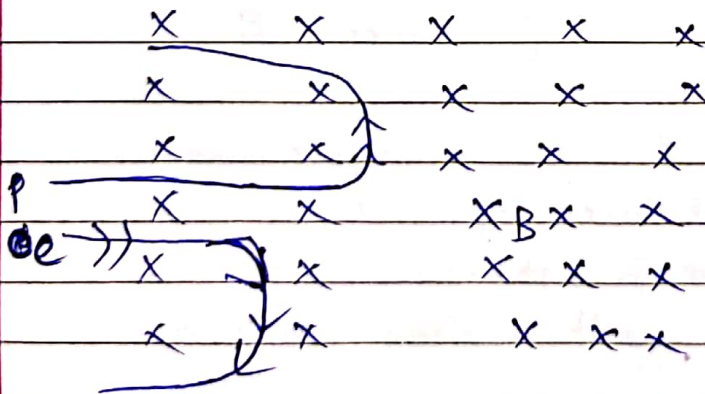
$$r \propto \sqrt{V}$$

Let  $r$  be the radius when the potential difference is  $V$  and  $r'$  be the radius when the potential difference is  $2V$ .

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

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

2) Trajectories are shown in figure



$$\text{As } r = \frac{mv}{qB} \rightarrow r \propto m$$

Ratio of radii of electron path and proton path

$$\frac{r_e}{r_p} = \frac{m_e}{m_p}$$

As mass of proton  $m_p = 1840 \times$  mass of electron

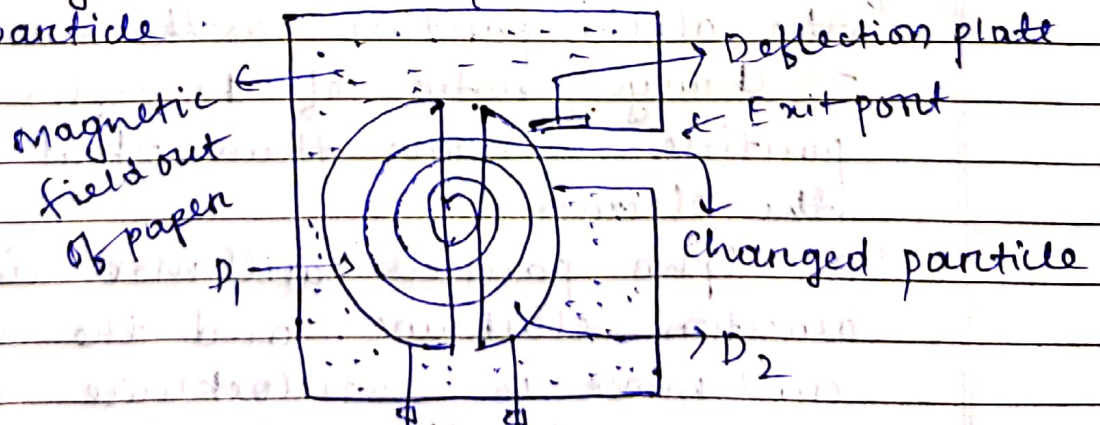
$$\therefore \frac{m_e}{m_p} \approx \frac{1}{1840}$$

$$\frac{r_e}{r_p} = \frac{1}{1840}$$

- 3) When a charged particle moves with certain velocity in a perpendicular magnetic field then a Lorentz magnetic force acted on it. The path followed by the charged particle is circular in shape.

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

The combination of electric and magnetic field helps to increase the energy of the charged particle. Due to the electric field, the polarity of  $D_1$  and  $D_2$  is changed which helps to accelerate the particle.



- 4) a) mass of proton =  $m$

charge of proton =  $q$

mass of  $\alpha$  particle =  $4m$

charge of alpha particle =  $2q$

Cyclotron frequency

$$v = \frac{Bq}{2\pi m} \Rightarrow v \propto \frac{q}{m}$$

For alpha particle : frequency  $\nu \propto \frac{q}{2m}$   
 The frequency of the ~~particle~~ ~~proton~~ is twice than the frequency of alpha particle

ii) Velocity  $v = \frac{Bqr}{m} \Rightarrow v \propto \frac{q}{m}$

For proton : velocity  $v_p \propto \frac{q}{m}$   
 For alpha particle velocity  $v_a \propto \frac{2q}{4m}$

The velocity of proton is twice than the velocity of alpha particle.

5) 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.

So alpha particle will move in the direction clockwise and the electron will move in anticlockwise direction according to the right hand thumb rule

