HOME ASSIGNMENT

1. If a particle of charge q is moving with velocity v along the z-axis and the magnetic field B is acting along the x-axis, use the expression $\vec{F} = q(\vec{v} \times \vec{B})$ to find the direction of the force F acting on it. A beam of proton passes unelected with a horizontal velocity v, through a region of electric and magnetic fields, mutually perpendicular to each other and normal to the direction of the beam. If the magnitudes of the electric and magnetic fields are 100 kV/m and 50 mT respectively, calculate

(a) velocity v of the beam.

(b) the force with which it strikes a target on a screen if the proton beam cutting is equal to 0.80 mA.

2. A beam of α-particles projected along +X-axis, experiences a force due to a magnetic field along the + Y-axis. What is the direction of the magnetic field?

3. Define one tesla using the expression the magnetic force acting on a particle charge q moving with velocity v in a magnetic field B.

4. A proton and an electron travelling along parallel paths enter a region of uniform magnetic field, acting perpendicular to their paths. Which of them will move in a circular path with higher frequency?

5. Two protons of equal kinetic energies enter a region of uniform magnetic field. The first proton enters normal to the field direction while the second enters at 30° to the field direction. Name the trajectories followed by them.

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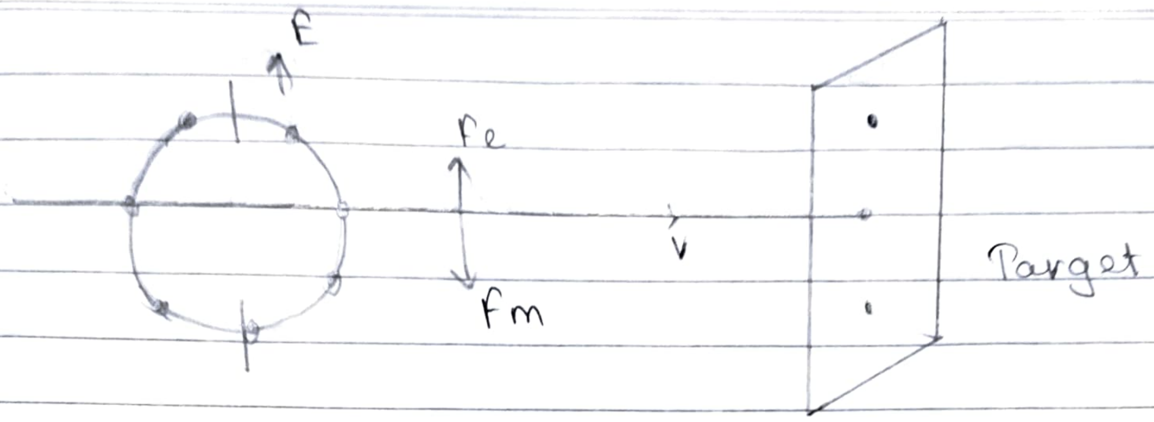
1 $\vec{F} = q\vec{v} \times \vec{B}$

given, $\vec{v} = v\hat{k}$, $\vec{B} = B\hat{i}$

$\vec{F} = q(v\hat{k}) \times (B\hat{i}) = qvB\hat{j}$

This is Force is acting along y-axis.

i) For a beam of charged particles to pass undeflected crossed electric and magnetic field, the condition is that electric and magnetic forces on the beam must be equal and opposite



$eE = evB$

$v = \frac{E}{B}$

Given, $E = 50kV/m = 50 \times 10^{3}\ V/m$, $B = 50mT = 50 \times 10^{-3}\ T$

$\therefore \quad v = \frac{50 \times 10^{3}}{50 \times 10^{-3}} = 1 \times 10^{6}\ ms^{-1}$

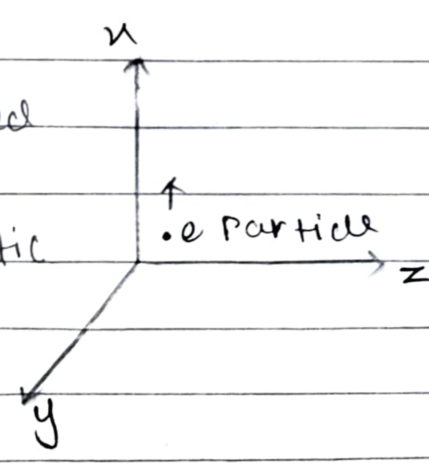
ii) The beam strikes the target with a constant velocity, so force exerted on the target is zero. However, if proton beam comes to rest, it exerts a force on the target, equal to rate of change of linear momentum of the beam i.e.,

$$F = \frac{\Delta P}{\Delta t} = \frac{mv}{\Delta t} = \frac{mv}{q/i} = \frac{mvi}{q} = \frac{mvi}{ne}$$

where n is the no. of proton striking the targets per second.

2 From the graph it can be concluded that

By Fleming's left hand rule magnetic field must be along negitive z-axis.



3 One tesla is the magnetic field in which a charge of 1 C moving with a velocity of $1 ms^{-1}$ normal to the magnetic field, experience a force of 1N

$$B = \frac{F}{qv \sin\theta}$$

If $F = 1N$, $q = 1C$, $v = 1 ms^{-1}$, $\theta = 90°$

then SI units of $B = \frac{1N}{1C \cdot 1ms^{-1} \cdot \sin 90°}$

$= 1 NA^{-1} m^{-1} = 1$ tesla

9 When a charge particle entres a region of uniform magnetic field, perpendicular to their paths, they move in a circular path.

And the time period of their motion is given by.

$$T = \frac{2\pi m}{qB}$$

But, $f = \frac{1}{T}$

$$f = \frac{qB}{2\pi m}$$

Since B & q is same for electron & proton.
So, $f \propto \frac{1}{m}$

Since mass of electron is smaller than that of proton, hence it will have higher frequency.

5→ When an electron enters normal to the field direction the trajectory is circular.

→ When an electron entre 30° to the field direction the trajectory is helical.