HOME ASSIGNMENT

Q1) 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.

ans)

$$\vec{v} = v\hat{k}$$

$$\vec{B} = B\hat{i}$$

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

$$= q(v\hat{k}) \times B\hat{i}$$

$$\vec{F} = qvB\hat{j}$$

$\therefore$ force is along y-axis

A beam of proton passes un-deflected 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 & 50 mT respectively, calculate.

(i) Velocity

$$F_{\text{electric field}} = F_{\text{magnetic field}}$$

$$qE = qvB\sin 90^\circ$$

$F = qvB \qquad [\sin 90° = 1]$

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

$= \frac{100 \times 10^{-3}}{50 \times 10^{-3}}$

$= 2 \times 10^{6}\ m/s$

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

Force exerted = Rate of change of momentum

$F_{exerted} = \frac{\Delta p}{\Delta t}$

$= mv_f - mv_i$

$= \frac{-mv_i}{q/t} \qquad v_f = 0$

$I = \frac{q}{t}$

$= \frac{-mv_i \times I}{q}$

$= \frac{-1.6 \times 10^{-27} \times 2 \times 10^{6} \times 0.8 \times 10^{-3}}{1.6 \times 10^{-19}}$

$F_{exerted} = -1.6 \times 10^{-5}\ N$

by target

Force exerted by proton $= 1.6 \times 10^{-5}\ N$

Q2 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.

ans $\vec{F} = q(\vec{v} \times \vec{B})$

$F \cdot \hat{j} = q(v \cdot \hat{i} \times B \hat{n})$

$\Rightarrow \hat{i} \cdot \hat{n} = \hat{j}$

Using right-hand thumb rule

$\hat{n} = -\hat{k}$

-ve z-axis.

Q3 Define one tesla using the expression the magnetic force acting on a particle charge q moving with velocity v in a magnetic field B.

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

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

$$\text{SI unit} = \frac{1N}{1C \cdot 1 ms^{-1} \cdot \sin 90^\circ}$$

$$= 1 N C^{-1} m s^{-1} = \underline{1 \text{ Tesla}}$$

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.

ans) Pr Electron will have higher frequency as its a very light particle more compared to proton.

5) The electron entering • normal to magnetic field - circular

The electron entering at an angle of 30° to the field - helical