Date 08/07/21

Chapter-4

Moving Charges & Magnetism

Home Assignment-3

Q.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 is equal to current 0.8 mA.

Ans- Given:-

Charge of particle = q

Velocity of particle = V

Here,

Motion of charge is along X-axis.

So, $\vec{V} = V\hat{K}$

Magnetic field is along X-axis.

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

Now,

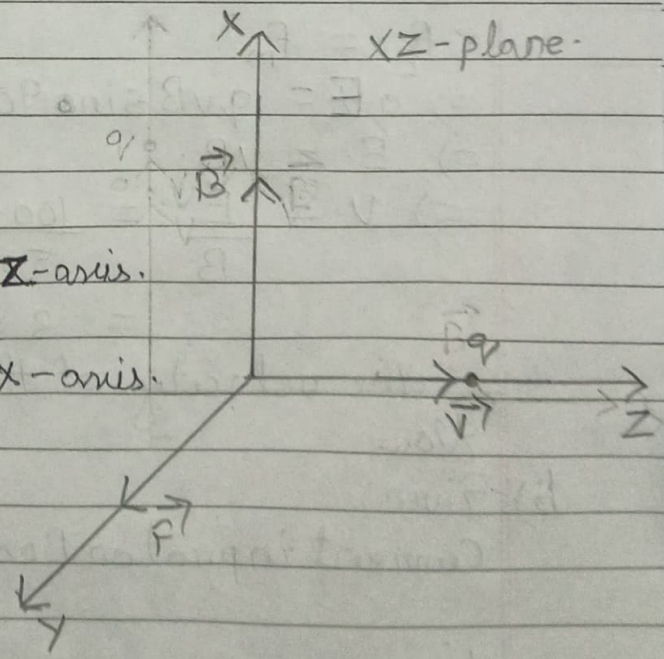
$\vec{F} = q(\vec{v} \times \vec{B})$

$= q(V\hat{K} \times B\hat{i})$

$= qVB(\hat{K} \times \hat{i})$

$= BVq(\hat{j})$

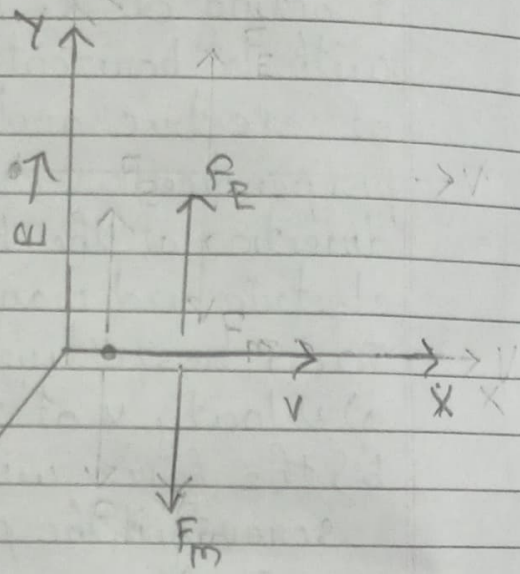
So, The direction of magnetic force is along Y-axis.



Now,

a) Given that

A beam of proton passes unelected horizontally with a velocity V through a region of the electric field and magnetic field mutually perpendicular to each other and normal to the direction of the beam.



So,

As the beam of proton passed unelected without having any effect of electric and magnetic field.

Then

The Force due to the magnetic field and the electric field have the same magnitude.

Hence,

$F_E = F_m$

$\Rightarrow qE = qvB \sin 90°$

$\Rightarrow E = vB.$

$\Rightarrow V = \frac{E}{B} = \frac{100 \times 10^3}{50 \times 10^{-3}}$

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

∴ The velocity of the beam of proton $= 2 \times 10^6$ m/s

Now,

b) Given;

Current in proton Beam $= 0.8 \text{ mA}$

$= 8 \times 10^{-4} \text{ A}$

Here,

The beam strikes the screen with a constant velocity because, the magnetic field and

electric field will have no effect on it. So, the force exerted on the screen due to the beam of protons is zero.

Q.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?

Ans- Given;
A beam of α-particles projected along +x axis experieces force.
So, The direction of motion of particle is along +x-axis
∴ The velocity of α-particle

$$\vec{v} = v(\hat{i})$$

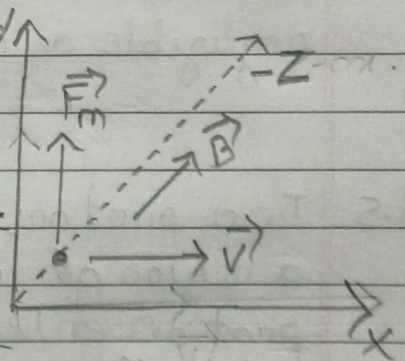
Magnetic force experienced by the α-particle is along +Y axis.
∴ The Magnetic force of α-particle

$$\vec{F_m} = F_m(\hat{j})$$

So, as we know,

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

i.e., the direction of magnetic force will be perpendicular to the direction of velocity of the particle and magnetic field.



Hence,
By Fleming's left hand rule, the magnetic field will be in the direction along negative z-axis.

Q.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.

Ans. One tesla is that magnetic field in which a charge of 1C moving with a velocity of $1 ms^{-1}$ at right angles to the field experiences a force of 1 N.

Q.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- The electron will move in a circular path with higher frequency on the opposite direction of the current because, the mass of electron is very negligible as compared to that of proton.

Q.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.

Ans- The trajectory for the first proton with motion normal to field is circular.
& the trajectory for the second proton making 30° with the field is helical.