10 July 2021

Home Assignment

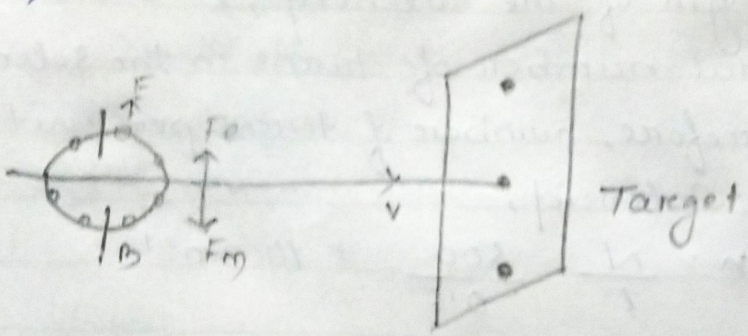
1) (a) $\vec{F} = q\vec{v} \times \vec{B}$

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

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

That is, force is acting along y-axis.

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



$eE = evB$

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

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

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

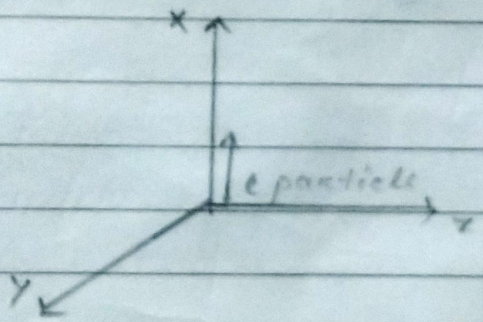
(b) The beam strikes the target with a constant velocity, so force exerted on the target is zero. However, if proton beam comes to rest, it exerts a force on the target, equal to rate of change of

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 number of protons striking the target per second.

2) By Fleming's left hand rule magnetic field must be along negative Z-axis.



3) When a charge of 1C, moving with velocity 1m/s, normal to the magnetic field, experiences a force 1N, the magnetic field is said to be one tesla.

4) Electron move in a circular path with a highere frequency.

$$\frac{mv^2}{r} = qvB, \quad r = \frac{mv}{qB}$$

$$\omega = \frac{v}{r} = \frac{qB}{m}$$

$$\omega = 2\pi f = \frac{qB}{m} = 2\pi f \Rightarrow f \propto \frac{1}{m}$$

Since $m_e < m_p$, therefore $f_e > f_p$

Thus, electron move in circular path with higher frequency.

e) - When an ~~electron~~ electron enterns normal to the field direction the trajectory is circular.

- When an electron enters 30° to the fixed direction the trajectory is helical.