Force on moving charge in uniform magnetic & electric field

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<u>Home Assignment</u>

(1) v along x-axis $\vec{v} = v\hat{i}$

B along y-axis $\vec{B} = B\hat{j}$

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

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

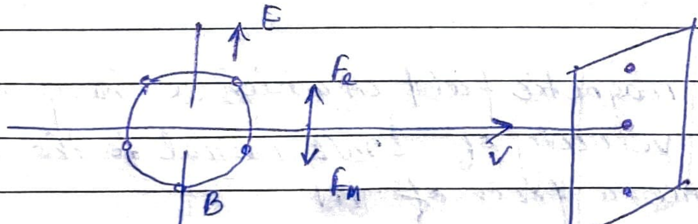
$\vec{F} = qvB\hat{k}$ is acting along z axis.

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

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

$\vec{F} = q(v\hat{k}) \times (B\hat{i}) = qvB\hat{j}$ acting along y-axis

(2) For a beam of charged particles to pass undeflected crossed electric and magnetic field, electric and magnetic forces must be equal & opposite.



$eE = evB$.

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

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

$v = \frac{50 \times 10^{3}}{50 \times 10^{-3}} = 1 \times 10^{6}\, m/s$.

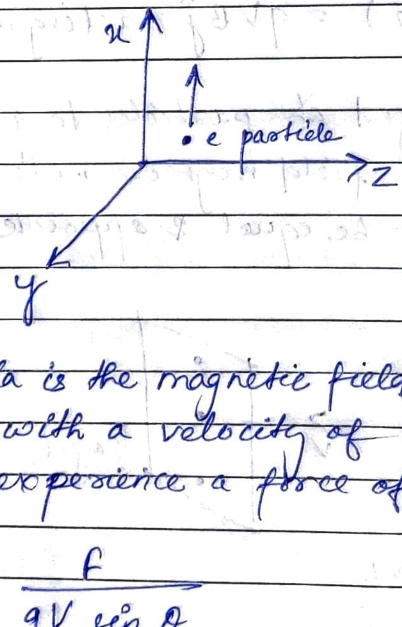
(iii) If beam strikes the target with a constant velocity, so force exerted on target is zero.

If proton beam comes to rest, it exerts a force on the target, equal to the rate of change of linear momentum of the beam.

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

$n \rightarrow$ no. of protons striking target per second.

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



(3) One tesla is the magnetic field in which a charge of 1C moving with a velocity of 1 m/s normal to the magnetic field, experience a force of 1N.

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

If $F = 1N$, $q = 1C$, $v = 1m/s$, $\theta = 90°$

then SI unit of $B = \frac{1N}{1C \cdot 1m/s \cdot \sin 90°}$

$= 1 N A^{-1} m^{-1} = 1$ tesla.

(4) Mass of electron is low as compared to proton. Hence when both enter into the uniform magnetic region, the electron will move in a circular path with higher frequency on the opposite direction to the current.

(5)