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Homework

Force on moving charge in uniform magnetic and electric field.

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(i) Ans

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

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 and opposite,

$$eE = evB$$

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

Given:-

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

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

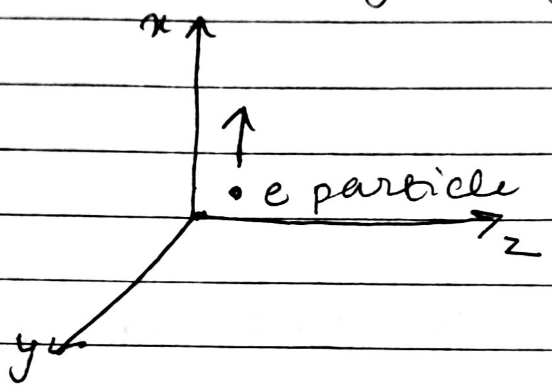
(ii) The beam strikes the target with a constant velocity, so force exerted on the target is zero. However, if proton beam comes to rest, it exerts a force on the target, equal to rate of change of linear momentum of the beam

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

where n is the number of protons striking the target per ~~sec~~ second.

Ans 2

From the graph it can be concluded that By Fleming's left hand rule magnetic field must be along negative z-axis



Ans 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, experiences a force of 1 N

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

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

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

$= 1\ NA^{-1}m^{-1}$ = ~~1 tesa~~ 1 tesla

Ans 4

When a charge particle enters 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 and q is same for electron and proton so $f \propto \frac{1}{m}$.

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

Ans 5

We know that when a charged particle enters a uniform magnetic field the force ~~entered~~ exerted on it,

$$f = q(v \times B) = qvb \sin\theta$$

Case 1: when the particle enters perpendicular $\theta = 90°$

In this case since $\sin\theta = 1$ is the maximum value and the direction of the force is perpendicular to the direction of motion of particle, hence the particle starts moving in a circular path with radius

$r = mv/bq$

Case II : the particle enters at an angle of 30°.

In this case the force acting on it has two components, one parallel to the motion which will cause a linear motion, the other component will act perpendicular to motion which will cause circular motion.

Hence, due to the resultant of these two component the particle will move along a Helical path.