1st before the call : 1

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dq

Ch-4

NCERT - EXERSICE

(1.) $N = 100$

$r = 8cm = 0.08m$

$I = 0.4\ A$

$$B = \frac{\mu_0 N I}{2r} = \frac{4\pi \times 10^{-7} \times 100 \times 0.40}{2 \times 0.08}$$

$$= \pi \times 10^{-4} = \underline{3.1 \times 10^{-4}\ T}$$

(2.) $I = 35\ A$

$r = 20cm = 0.20m$

$\mu_0 = 4\pi \times 10^{-7}\ T m A^{-1}$

$$B = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7}}{2\pi \times 0.20} = \underline{3.5 \times 10^{-5}\ T}$$

(6) $l = 0.03m$ $\theta = 90°$

$I = 10A$ $B = 0.27\ T$

$F = BIl \sin\theta$

$= 10 \times 0.03 \times 0.27 \times \sin 90°$

$= \underline{8.1 \times 10^{-2}\ N}$

Direction given by Fleming left hand rule.

(7) $$f = \frac{\mu_0 I_1 I_2}{2\pi r} = \frac{4\pi \times 10^{-7} \times 8 \times 5}{2\pi \times 4 \times 10^{-2}} = \underline{2 \times 10^{-4}\ Nm^{-1}}$$

before the call : 1

called for now

force on 10 cm section of wire A is

$F = fl = 2\times10^{-4}\times\frac{10}{100} = 2\times10^{-5}\,N$

(8.) $n = \frac{\text{No. of turns per layer} \times \text{No. of layers}}{\text{length of solenoid}}$

$= \frac{400\times5}{0.80} = 2500\,m^{-1}$

Magnetic field inside the solenoid is

$B = \mu_0 n I = 4\pi\times10^{-7}\times2500\times8$

$= \cancel{8\pi\times10^{-3}}$

$= 2.5\times10^{-2}\,T$

(11) The perpendicular magnetic field exerts a force on the electron perpendicular to its path. This force continuously deflects the electron from its path and make it move along a circular path.

$\therefore$ Magnetic force on e^- = centripetal force

$evB\sin90^\circ = \frac{m_e v^2}{r}$

$\boxed{r = \frac{m_e v}{eB}}$

Now $B = 6.5\,G = 6.5\times10^{-4}\,T$

$v = 4.8\times10^{6}\,ms^{-1}$

$r = 9.1\times10^{-31}\times4.8\times10^{6} / 1.6\times10^{-19}\times6.5\times1$

$= 4$

(12) $f = \frac{eB}{2\pi m} = \frac{1.6\times10^{-19}\times6.5\times10^{-4}}{2\times3.14\times9.1\times10^{-31}}$

$= \underline{18.18\times10^{6}\ Hz}$

$= \underline{18\ MHz}$

(13) No frequency f does not depend upon the speed v of the e^-

13) (a) $N = 30$ $\quad I = 6A$

$r = 8\ cm = 0.08\ m$ $\quad B = 1T$ $\quad \theta = 60^\circ$

Magnitude of counter torque

$= NIBA\sin\theta$

$= 30\times6\times1\times(3.14\times0.08\times0.08)\sin60^\circ$

$= \underline{3.1\ Nm}$

(b) No, the ans would not change because the above formula for the torque is true for a planar loop of any shape.

(14) For coil X

$r_x = 0.16\ m$

$N_x = 20$

$I_x = 16\ A$

∴ Magnetic field at the centre of coil X

is $= B_x = \frac{\mu_0 I_x N_x}{2r_x} = \frac{4\pi\times10^{-7}}{2}\times\frac{16\times20}{0.16}$

$= \underline{4\pi\times10^{-4}\ T}$

As the current in the coil X is anticlockwise the field is directed towards east.

For coil Y:

$r_x = 10 cm = 0.10 m$

$N_x = 20$

$I_x = 16 A$

$$B_x = \frac{\mu_0 I_x N_x}{2 r_x} = \frac{4\pi \times 10^{-7}}{2} \times \frac{18 \times 25}{0.10} T$$

$$= 9\pi \times 10^{-4} T$$

As the current in the coil Y is clockwise The field B_y is directed towards west. Since $B_y > B_x$ therefore the net field is directed towards west and its magnitude is

$$B = B_y - B_y = 5\pi \times 10^{-4}$$

$$= 1.6 \times 10^{-3} T$$

15) $B = 100$

$4 = 10^{-2} T$

$I = 15 A$

$n = 1000$ turns m^{-1}

Magnetic field inside a solenoid

$$B = \mu_0 n I$$

$$nI = \frac{B}{\mu_0} = \frac{10^{-2}}{4\pi \times 10^{-7}} = 7955 \simeq 8000$$

We may take $I = 10\,A$ then $n = 800$

The solenoid may have length 50cm and the area of cross-section $5 \times 10^{-2} m^2$

(16) (a) Given

$$B = \frac{\mu_0 I R^2 N}{2(x^2+R^2)^{3/2}}$$

At the centre of the coil $x = 0$

so, $$B = \frac{\mu_0 I R^2 N}{2R^3} = \frac{\mu_0 I N}{2R}$$

This is the standard result for the field at the centre of the coil

(17) $I = 11\,A$ Mean radius of toroid

$n = 3500$ $$r = \frac{25+26}{2} = 25.5\,cm$$

$$= 25.5 \times 10^{-2}\,m$$

Total length of toroid :

$= 2\pi r$

$= 2\pi \times 25.5 \times 10^{-2} = 51 \cdot \times 10^{-2}\,\pi M$

$\therefore$ No of turns per unit length

$$n = \frac{3500}{51 \times 10^{-2}\,\pi}$$

(a) field outside toroid $= 0$

(b) field inside the core of toroid

$$B = \mu_0 n I = 4\pi \times 10^{-7} \times \frac{3500}{51 \times 10^{-2}\,\pi} \times 11$$

$$= 3.02 \times 10^{-2}\,T$$

(18) (a) The force on a charged particle mov in a magnetic field is given by

$$F = qvB\sin\theta$$

The force on a charged particle will be zero or the particle will remain undeflected if

$$\sin\theta = 0 \text{ or } \theta = 0^\circ, 180^\circ$$

i.e initially velocity $\vec{v}$ is either ∥ or anti-∥ to $\vec{B}$

(b) Yes, a magnetic field exerts a force on a charged particle in a direction perpendicular to its direction of motion and hence does no work on it, So the charged particle will have its final speed equal to initial.

(c) The electron travelling west to east experiences a force towards north due to ~~static force~~ electric field. It will remain unaffected if it experiences an equal force towards south due to magnetic field. Acc. to Fleming left hand rule, the magnetic field must act in vertically downward direction.

(19) $V = 2\,kV$

$B = 0.15\,T$

$e = 1.6 \times 10^{-19}\,C$

$m = 9.1 \times 10^{-31}\,kg$

ATQ

$$\frac{1}{2}mv^2 = eV$$

$$\text{or } v = \sqrt{\frac{2eV}{m}} = \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 2 \times 10^{3}}{9.1 \times 10^{-31}}}$$

$$= 2.65 \times 10^{7}\,ms^{-1}$$

(ii) when field $\vec{B}$ is transverse to the initial $\vec{v}$

$$evB \sin 90^\circ = \frac{mv^2}{r}$$

$$\therefore r = \frac{mv}{eB} = \frac{9.1\times10^{-31}\times2.65\times10^{7}}{1.6\times10^{-19}\times0.15} m$$

$$= \underline{10^{-3} m} = \underline{1 mm}$$

Thus the $\bar{e}$ travel a circular trajectory of radius 1mm normal to field $\vec{B}$.

(iii) when $\vec{B}$ makes an angle of 30° to initial velocity $\vec{v}$

$$V_\perp = v\sin 30^\circ = 2.65\times10^{7}\times\frac{1}{2} = 1.33\times10^{7} ms^{-1}$$

$$v_\parallel = v\cos 30^\circ = 2.65\times10^{7}\times0.866 = 2.3\times10^{7} ms^{-1}$$

The radius of the helical path is given by

$$r = \frac{mv_\perp}{eB} = \frac{mv\sin 30^\circ}{eB} = \frac{9.1\times10^{-31}\times1.33\times10^{7}}{1.6\times10^{-19}\times0.15}$$

$$= \underline{50.4\times10^{-5} m}$$

(20.)

$B = 0.75 T$

$E = 9\times10^{5} Vm^{-1}$

$V = 15 KV = 15\times10^{3} V$

for undeflected beam, velocity charged particle must be,

$$v = \frac{E}{B} = \frac{9.0\times10^{5}}{0.75} ms^{-1} = \underline{12\times10^{5} ms^{-1}}$$

called for ...

But the KE of the charged particle is given by

$$\frac{1}{2}mv^2 = qV$$

$$\frac{q}{m} = \frac{1}{2}\cdot\frac{v^2}{V} = \frac{1}{2}\frac{(12\times10^5)^2}{15\times10^3}\ C\ kg^{-1}$$

$$= \underline{4.8\times10^7\ C\,kg^{-1}}$$

Now for deutrons,

$$\frac{q}{m} = \frac{1.6\times10^{-19}}{2\times1.67\times10^{-27}} = \underline{4.8\times10^7\ C\,kg^{-1}}$$

which means the particle may be deutrons each of which contains one proton & one neutron. The one is not unique because we have determined only the ratio of charge to mass.

(Q4.) $B = 3000 G$

$q = 3000\times10^{-4} = \underline{0.3T}$

$A = 10\times5 = \underline{50cm^2} = 50\times10^{-4}\ m^2$

$I = 12A$

Magnetic moment,

$m = IA = 12\times50\times10^{-4} = \underline{0.06Am^2}$

We apply right hand thumb rule to various current loops to decide the direction of $\vec{m}$.

(a) $\vec{m} = 0.06\hat{i}\ Am^2$

$B = 0.3\hat{k}$

$\vec{\tau} = \vec{m}\times\vec{B}$

$= 0.06\times0.3 = \cancel{1.8}\ 1.8\times10^{-2}\hat{j}\ Nm$

Thus a torque of 1.8×10^{-2} Nm act along negative y axis.

(b) $\vec{m} = 0.06\hat{j}$ Am^2

$\vec{B} = 0.3\hat{k}$ T

Here $\vec{m}$ & $\vec{B}$ are same as in case (a)

(c) $\vec{m} = -0.06\hat{j}$ Am^2

$\vec{B} = 0.3\hat{k}$ T

$\vec{\tau} = \vec{m} \times \vec{B} = -0.06\hat{i} \times 0.3\hat{k} = -1.8 \times 10^{-2}\hat{i}$ Nm

$\tau = 1.8 \times 10^{-2}$ is acting along -ve x-axis.

(d) case similar to (c) But here the direction of torque is 60° anticlockwise with -ve X direction i.e. 240° with the x-direction.

e) $\vec{m} = 0.06\hat{k}$ Am^2

$B = 0.3\hat{k}$ T

$\vec{\tau} = \vec{m} \times \vec{B} = 0.06\hat{k} \times 0.3\hat{k} = 0$

f) also same as (e) but $\theta = 180°$

case (e) corresponding to stable equilibrium

Case (f) corresponding to unstable equilibrium.