Chapter - 4 (NCERT)

Q1) $n = 100$

$R = 8.0\,cm = 0.08\,m$

$I = 0.40\,A$

B at the centre = ?

$$B = \frac{\mu_0 n I}{2r}$$

$$= \frac{10^{-7} \times 4\pi \times 40}{2 \times 8 \times 10^{-2}}$$

$$= \frac{10^{-7} \times \pi \times 10}{10^{-2}}$$

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

$$\approx 3.1 \times 10^{-4}\,T$$

2) $I = 35\,A$

Magnitude of the field B at a point 20cm from the wire.

$$B = \frac{\mu_0 I}{2\pi r}$$

$$= \frac{4\pi \times 10^{-7} \times 35}{2\pi \times 20 \times 10^{-2}}$$

$$= 3.5 \times 10^{-5}\,T$$

6) l of wire = $3.0\,cm = 3 \times 10^{-2}\,m$

$I = 10\,A$

$B_{ext} = 0.15\,T$

$F = BIl \sin\theta$

$= 0.27 \times 10 \times 3\times10^{-2} \times \sin 90^\circ$

$= 8.1 \times 10^{-2} \times 1$

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

7) I_1 in wire A = 8.0 A

I_2 in wire B = 5.0 A

l = 10 cm = 0.1 m

Separation Distance (d) = 4 cm = 4×10^{-2} m

$$F = \frac{\mu_0 I_1 I_2 l}{2\pi r} \qquad r = d$$

$$= \frac{4\pi\times10^{-7} \times 8 \times 5 \times 0.1}{2\pi \times 4\times10^{-2}}$$

$= 20 \times 10^{-8} \times 10^{2}$

$= 2 \times 10^{-5}$ N

(Attractive force normal to A towards B)

8) 5 layers of windings of 400 turns each.

Total no of turns = 2000

I = 8.0 A

l = 0.8 m

Date
Page

$B = \mu_0 n I$

$= \frac{\mu_0 N I}{l}$

$= \frac{4\pi \times 10^{-7} \times 2000 \times 8}{0.1}$ ~~0.8~~

$= 8\pi \times 10^{-3}$

$= 2.512 \times 10^{-2}\ T$

11) $B = 6.5\ G$

$= 6.5 \times 10^{-4}\ T$

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

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

$v = 4.8 \times 10^{6}\ m/s$

$V_c = \frac{Bqr}{m}$

$r = \frac{m V_c}{Bq}$

$= \frac{9.1 \times 10^{-31} \times 4.8 \times 10^{6}}{6.5 \times 10^{-4} \times 1.6 \times 10^{-19}}$

$= \frac{21}{5} \times 10^{-2}\ m$

$r = 4.2\ cm$

Date
Page

The path of electron is a circle due to the magnetic field

4.12) frequency $= \frac{qB}{2\pi M}$

$= \frac{1.6 \times 10^{-19} \times 65 \times 10^{-4}}{2 \times 3.14 \times 91 \times 10^{-31}}$

$= \frac{4}{7 \times 3.14} \times 10^{+8}$

$= \frac{4}{7 \times \frac{22}{7}} \times 10^{8}$

$= \frac{2}{11} \times 10^{8}$

$= 0.18 \times 10^{8}$

$= 18 \times 10^{6}$ Hz

$= 18$ MHz

13) $N = 30$ turns

$r = 8 \times 10^{-2}$ M , $A = \pi \times (8 \times 10^{-2})^2$

$I = 6$ A

$B = 1$ Tesla

$\phi = 60°$

$\tau = NIAB \sin\phi$

$= 30 \times 6 \times \pi \times (8 \times 10^{-2})^2 \times 1 \times \frac{\sqrt{3}}{2}$

$= 3.133$ NM

Date
Page

b) The magnitude of the torque is not dependent on the shape of the coil. It depends on the area of the coil. So the answer would not change

14) B due to current X → $\frac{\mu_0 N I}{2r}$

$= \frac{4\pi \times 10^{-7} \times 20 \times 16}{2 \times 16 \times 10^{-2}}$

$= 40\pi \times 10^{-5}\,T$ (east)

B due to current X → $\frac{\mu_0 N I}{2r}$

$= \frac{4\pi \times 10^{-7} \times 25 \times 18}{2 \times 10 \times 10^{-2}}$

$= 90\pi \times 10^{-5}\,T$ (west)

$B_{net} = 50\pi \times 10^{-5}\,T$

$= 5\pi \times 10^{-4}\,T$ (west) (Ans)

H.15) $B = 100\,G$

$= 100 \times 10^{-4}$

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

$I = 15\,A$

$N = ?$

$L = 10\,cm$

$B = \mu_0 n I$

$nI = \frac{B}{\mu_0}$

$= \frac{100 \times 10^{-4}}{4\pi \times 10^{-7}}$

$\approx 8000\ A/m$

$n = ~~4880~~\ 800/m$

$I = 10A$

$l = 50\ cm$ & $A = 5 \times 10^{-3}\ m^2$ (5 times given value) to avoid edge effects

17)

a) Magnetic field outside the toroid = 0

b) Inside the core of the toroid = $\frac{\mu_0 N I}{2\pi r}$

r = mean radius

$= \frac{25 + 26}{2} = 25.5\ cm$

$B = \frac{4\pi \times 10^{-7} \times 3500 \times 11}{2\pi \times 25.5}$

$= 3.019 \times 10^{-2}\ T$

c) Zero

18) a) Initial v is either parallel or antiparallel to B

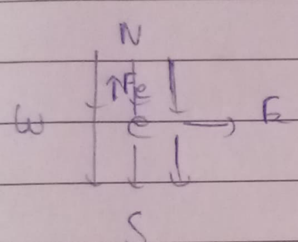
as $F = qvB\sin\theta$

If $\theta = 0°$ or $180°$

$F = 0$

(b) Yes, because magnetic force can change the direction but not the magnitude

18) c)



Using Fleming left hand rule, The direction of magnetic field is vertically downwards.

19) Circular trajectory ⊥ to B

$v = \frac{Bqr}{m}$

~~$v = \frac{E}{r}$~~

~~$v = Er$~~

$$r = \frac{1}{B}\sqrt{\frac{2mV}{q}}$$ V - Voltage

$$= \frac{1}{0.15}\sqrt{\frac{2 \times 9.1 \times 10^{-31} \times 2 \times 10^{3}\,V}{1.6 \times 10^{-19}}}$$

= 1 [illegible] $\times 10^{-3}$ m

(h) helical path

$v_1 = v \sin\theta$

$r = \frac{M v \sin\theta}{Be}$

$qV = \frac{1}{2} M v^2$

$v = \sqrt{\frac{2eV}{M}}$

$= \frac{M}{Be} \sqrt{\frac{2eV}{M}} \sin\theta$

$= \frac{9.1 \times 10^{-31}}{0.15 \times 1.6 \times 10^{-19}} \times \left[\frac{2 \times 1.6 \times 10^{-19} \times 2 \times 10^3}{9 \times 10^{-31}}\right]^{\frac{1}{2}} \times \sin 30^\circ$

$= 0.5 \times 10^{-3} M$

$= 0.5 MM$

Helical path of radius 0.5 mm

20) $B = 0.75 T$

$V = 15 kV = 15 \times 10^3 V$

$E = 9 \times 10^5 V m^{-1}$

Mass of the electron = M

Charge of the electron = e

Velocity of the electron = v

Kinetic energy = eV

$\Rightarrow \frac{1}{2} M v^2 = eV$

$\therefore \frac{e}{M} = \frac{v^2}{2V}$

Electric field is balancing the Magnetic field

$\therefore eE = evB$

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

$\frac{e}{m} = \frac{1}{2} \frac{(E/B)^2}{V} = \frac{E^2}{2VB^2}$

$= \frac{(9.0 \times 10^5)^2}{2 \times 15 \times 10^3 \times (0.75)^2} = 4.8 \times 10^7 \, C/kg$

This value of specific charge e/m is equal to the value of deuteron.

Q4.24 $B = 3000 G$
$= 3000 \times 10^{-4} T$

(a) Torque, $\vec{\tau} = I\vec{A} \times \vec{B}$

$\therefore \tau = -12 \times (50 \times 10^{-4})\hat{j} \times 0.3\hat{k}$
$= -1.8 \times 10^{-2} \hat{j} \, Nm$

(b) Similar to A

(c) $\tau = I\vec{A} \times \vec{B}$
$= -12 \times (50 \times 10^{-4})\hat{j} \times 0.3\hat{k}$
$= -1.8 \times 10^{-2} \hat{j} \, Nm$

(d) ~~As~~ Magnitude of torque

$|\tau| = IAB$

$= 12 \times 50 \times 10^{-4} \times 0.3$

$= 1.8 \times 10^{-2}$

(e) Torque

$\tau = I\vec{A} \times \vec{B}$

$= (50 \times 10^{-4} \times 12)\hat{k} \times 0.3\hat{k}$

$= 0$

(f) Torque

$\tau = I\vec{A} \times \vec{B}$

$= (50 \times 10^{-4} \times 12)\hat{k} \times 0.3\hat{k}$

$= 0$

27) $G = 12\,\Omega$

$I_e = 3\,mA$

$= 3 \times 10^{-3}\,A$

$\therefore$ Voltage $= 18\,V$

$R = \frac{V}{I_g} - G$

$= \frac{18}{3 \times 10^{-3}} - 12 = 6000 - 12$

$= 5988\,\Omega$

28) $G = 15\Omega$

$I_g = 4mA = 4 \times 10^{-3} A$

$I = 6A$

A shunt resistance (S) is connected in parallel with the galvanometer

$$S = \frac{I_g G}{I - I_g}$$

$$= \frac{4 \times 10^{-3} \times 15}{6 - 4 \times 10^{-3}}$$

$$S = \frac{6 \times 10^{-2}}{6 - 0.004} = \frac{0.06}{5.996}$$

$$\approx 0.01\Omega = 10m\Omega$$

Hence, a $10m\Omega$ shunt resistor is to be connected in parallel with the galvanometer