Ecu

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Ch-4 Moving Charges and Magnetism

1) $n = 100$

$r = 8.0 \text{ cm} = 0.08 \text{ m}$

$I = 0.4 \text{ A}$

Magnitude of the magnetic field at the center of the coil.

$$|B| = \frac{\mu_0}{4\pi} \frac{2\pi n I}{r}$$

$\Rightarrow 4\pi \times 10^{-7} \text{ T m A}^{-1}$

$$|B| = \frac{4\pi \times 10^{-7}}{4\pi} \times \frac{2\pi \times 100 \times 0.4}{0.08}$$

$\Rightarrow 3.14 \times 10^{-4} \text{ T}$

2) $I = 35 \text{ A}$

$r = 20 \text{ cm} = 0.2 \text{ m}$

$\Rightarrow B = \frac{\mu_0}{4\pi} \frac{2I}{r}$

$\Rightarrow B = \frac{4\pi \times 10^{-7} \times 2 \times 35}{4\pi \times 0.2}$

$\Rightarrow 3.5 \times 10^{-5} \text{ T}$

6) $l = 3 \text{ cm} = 0.03 \text{ m}$

$I = 10 \text{ A}$

$B = 0.27 \text{ T}$

$\theta = 90°$

$F = BIl \sin\theta$

$\Rightarrow 0.27 \times 10 \times 0.03 \sin 90° \Rightarrow 8.1 \times 10^{-2} \text{ N}$

7) $I_A = 8.0A$

$I_B = 5.0A$

$r = 4.0cm = 0.04m$

$l = 10cm = 0.1M$

$$B = \frac{\mu_0 2 I_A I_B l}{4\pi r}$$

$$\Rightarrow B = \frac{4\pi \times 10^{-7} \times 2 \times 8 \times 5 \times 0.1}{4\pi \times 0.04}$$

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

8) $l = 80cm = 0.8m$

$N = 5 \times 400 = 2000$

$D = 1.8 cm = 0.018 m$

$I = 8.0A$

$$B = \frac{\mu_0 N I}{L}$$

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

$\Rightarrow 8\pi \times 10^{-3} = 2.512 \times 10^{-2} T$

11) $B = 6.5G = 6.5 \times 10^{-4} T$

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

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

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

$\theta = 90°$

$F_c = F$ $\frac{mv^2}{r} = evB \sin\alpha$

$$r = \frac{mv}{Be\sin\theta}$$

$$\Rightarrow \frac{9.1\times10^{-31} \times 4.8\times10^{6}}{6.5\times10^{-4}\times1.6\times10^{-19}\times\sin 90^\circ}$$

$\Rightarrow 4.2\times10^{-2}$ m $= 4.2$ cm.

12) $B = 6.5\times10^{-4}$ T

$e = 1.6\times10^{-19}$ C

$m = 9.1\times10^{-31}$ kg

$v = 4.8\times10^{6}$ m/s

$r = 4.2$ cm $= 0.042$ m.

$\omega = 2\pi\nu$

$$evB = \frac{mv^2}{r}$$

$$eB = \frac{m}{r}(r\omega) = \frac{m}{r}(r2\pi\nu)$$

$$\nu = \frac{Be}{2\pi m}$$

$\Rightarrow$ On substituting the known values in this expression, we get the frequency as:

$$\nu = \frac{6.5\times10^{-4}\times1.6\times10^{-19}}{2\times3.14\times9.1\times10^{-31}}$$

$= 18.2\times10^{6}$ Hz

$\Rightarrow 18$ MHz

(3) $n = 30$

$r = 8.0\ cm = 0.08\ m$

$\pi r^2 = \pi(0.08)^2 = 0.0201\ m^2$

$I = 6.0\ A$

$B = 1\ T$

$\theta = 60°$

$\tau = nIBA \sin\theta$ ..... (i)

$\Rightarrow 30 \times 6 \times 1 \times 0.0201 \times \sin 60°$

$\Rightarrow 3.133\ Nm$

Hence, the answer would not change if the circular coil is replaced by planar coil.

(4) $r_1 = 0.16\ m$

$r_2 = 0.1\ m$

$n_1 = 20$

$n_2 = 25$

$I_1 = 16\ A$

$I_2 = 18\ A$

$\Rightarrow \therefore B = \frac{\mu_0 n_1 I_1}{2r_1}$

$\therefore B_1 = \frac{4\pi \times 10^{-7} \times 20 \times 16}{2 \times 0.16}$

$\Rightarrow 4\pi \times 10^{-4}\ T$

$\Rightarrow B_2 = \frac{4\pi \times 10^{-7} \times 25 \times 18}{2 \times 0.10}$

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

8.)

$\Rightarrow B = B_2 - B_1$

$\Rightarrow 9\pi \times 10^{-4} - 4\pi \times 10^{-4}$

$\Rightarrow 5\pi \times 10^{-4}$ T

$\Rightarrow 1.57 \times 10^{-3}$ T

(5) $B = 100 G = 100 \times 10^{-4}$ T

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

$I = 15$ A

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

$B = \mu_0 n I$

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

$= \frac{100 \times 10^{-4}}{4\pi \times 10^{-7}} = 7957.74$

$\simeq 8000$ A/m

(7) $r_1 = 25$ cm $= 0.25$ m

$r_2 = 0.26$ m

$N = 3500$

$I = 11$ A

μ_0 = Permeability of free space $= 4\pi \times 10^{-7}$ T m A^{-1}

l = length of toroid.

$= 2\pi \left[\frac{r_1 + r_2}{2} \right]$

$\Rightarrow \pi (0.25 + 0.26)$

$= 0.51\pi$

$\therefore B = \frac{4\pi \times 10^{-7} \times 3500 \times 11}{0.51\pi}$

$\simeq 3.0 \times 10^{-2}$ T

24

(8) i) The initial velocity of the particle is either ll or anti ll to the magnetic field. So it travels a straight path without suffering any deflection.

ii) Yes, the final speed of the charged particle will be equal to its initial speed. This is because magnetic force can change the direction of velocity, but not its magnitude.

iii) An electron travelling from west to east enters a chamber having a uniform electrostatic field in north-south direction.

20) $B = 0.75\,T$

$V = 15\,kV = 15\times10^{3}\,V$

$E = 9\times10^{5}\,V\,m^{-1}$

→ $\frac{1}{2}mv^2 = eV$

$\therefore \frac{e}{m} = \frac{v^2}{2V}$ ....(1)

$\therefore eE = evB$

$v = \frac{E}{B}$ --- (2)

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

$= \frac{(9.0\times10^5)^2}{2\times15000\times(0.75)^2} = 4.8\times10^{7}\,C/kg$

24) $B = 3000 G = 0.3 T$

$l = 10 cm$

$b = 5 cm$

A of loop $= A = l \times b = 10 \times 5 = 50 cm^2 = 50 \times 10^{-4} m^2$

$I = 12 A$

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

$\Rightarrow -1.8 \times 10^{-2} \hat{j}$ Nm

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

$\Rightarrow -1.8 \times 10^{-2} \hat{j}$ Nm

$|\tau| = IAB$

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

$\Rightarrow 1.8 \times 10^{-2}$ Nm

Torque $\tau = I \vec{a} \times \vec{B}$

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

$\Rightarrow 0$

Hence τ is zero

27) $G = 12 \Omega$

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

$\therefore V = 18 V$

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

$\Rightarrow \frac{18}{3 \times 10^{-3}} - 12 = 6000 - 12 = 5988 \Omega$

28)

$G = 15\,\Omega$

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

$\therefore$ current, $I = 6\,A$

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

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

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

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