H.W

Ch-4

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

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

Hence,

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

$= 3.14 \times 10^{-4}\ T$

2.) $|\vec{B}| = \frac{\mu_0 2I}{4\pi r}$

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

By substituting the values in the eqn,
we get,

$|\vec{B}| = \frac{4\pi \times 10^{-7}}{4\pi} \times \frac{2 \times 35}{0.2} = 3.5 \times 10^{-5}\ T$

6.) length $(l) = 3cm$ or $0.03\ m$

Current flowing $= 10A$

The strength of the magnetic field (B) is $0.27T$

$\phi = 90^\circ$

$F = BIl\sin\theta$

$= 0.27 \times 10 \times 0.03 \times \sin 90^\circ$

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

7.) (I_A) is 8A

(I_B) is 5A

r = 4cm or 0.04 m

L = 10cm = 0.1 m

$$F = \frac{\mu_0 I_A I_B L}{2\pi r}$$

$\mu_0 = 4\pi \times 10^{-7}\ TmA^{-1}$

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

8.) (l) = 80 cm = 0.8 m

$N = 5 \times 400 = 2000$

D = 1.8 cm = 0.018 m

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

$\mu_0 = 4\pi \times 10^{-7}\ TmA^{-1}$

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

$= 2.5 \times 10^{-2}\ T$

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

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

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

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

magnetic field, $\phi = 90^\circ$

$F = evB\sin\phi$

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

$F_e = F$

$\Rightarrow \frac{mv^2}{r} = evB\sin\phi$

$\Rightarrow r = \frac{mv}{eB\sin\phi}$

So,

$r = \frac{9.1 \times 10^{-31} \times 4.8 \times 10^{6}}{6.5 \times 10^{-4} \times 1.6 \times 10^{-19} \times \sin 90^\circ}$

$= 4.2 \times 10^{-2}\,m$

$= 4.2\,cm$

12.) $(B) = 6.5 \times 10^{-4}\,T$

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

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

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

$r = 4.2\,cm = 0.042\,m$

$\because V = r\omega$

we can write,

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

$$\Rightarrow eB = \frac{mv}{r} = \frac{m(r\omega)}{r} = \frac{m(r \cdot 2\pi\nu)}{r}$$

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

$$\nu = \frac{6.5 \times 10^{-4} \times 1.6 \times 10^{-19}}{2 \times 3.14 \times 4.1 \times 10^{-31}} = 1.82 \times 10^{6}\ Hz \approx 18\ MHz$$

13) a) $n = 30$

$r = 0.08\ m$ or $8.0\ cm$

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

$I = 6.0\ A$

$B = 1\ T$

$\phi = 60^\circ$

$$\tau = nIBA \sin\phi$$
$$= 30 \times 6 \times 1 \times 0.0201 \times \sin 60^\circ$$
$$= 3.133\ Nm$$

b) $\tau = nIBA \sin\phi$

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14) $r_1 = 16\,cm = 0.16\,m$
$n_1 = 20$
$I_1 = 16\,A$
$r_2 = 10\,cm = 0.1\,m$
$n_2 = 25$
$I_2 = 18\,A$

$$B_1 = \frac{\mu_0 N_1 I_1}{2r_1}$$

μ_0 is the permeability of the free space $= 4\pi \times 10^{-7}\,Tm/A$

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

$$B_2 = \frac{\mu_0 N_2 I_2}{2r_2}$$
$$= \frac{4\pi \times 10^{-7} \times 25 \times 18}{2 \times 0.10}$$
$$= 9\pi \times 10^{-4}\,T$$

$$B = B_2 - B_1 = 9\pi \times 10^{-4}\,T - 4\pi \times 10^{-4}\,T$$
$$= 5\pi \times 10^{-4}\,T$$
$$= 5 \times 3.14 \times 10^{-4}$$
$$= 1.57 \times 10^{-3}\,T$$

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15) $B = 100\,G = 100 \times 10^{-4} T$

$N = 1000$ turns/m

Current carrying capacity of the coil = 15 A

$\mu_0 = 4\pi \times 10^{-7}\ TmA^{-1}$

$B = \mu_0 NI/l$

$\Rightarrow NI/l = B/\mu_0$

$= (100 \times 10^{-4})/(4\pi \times 10^{-7})$

$NI/l = 7961$

So, we get,

$(N \times 10)/0.5 = 7961$

$N = 398$ turns ≈ 400 turns

17) $r_1 = 25\,cm = 0.25\,m$

$r_2 = 26\,cm = 0.26\,m$

$N = 3500$ turns

$I = 11\,A$

a) The magnetic field outside the toroid is zero.

b) Inside the core of the toroid, the magnetic field induction is

$B = \mu_0 NI/l$

$l = 2\pi\left(\frac{r_1 + r_2}{2}\right)$

$= \pi(r_1 + r_2)$

$= \pi(0.25 + 0.26)$

$= \pi \times 0.51$

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So, $B = \mu_0 N I / l$

$$B = \frac{(4\pi \times 10^{-7}) \times 3500 \times 11}{\pi \times 0.5} = 3.02 \times 10^{-2}\ T$$

18) a) Initial velocity is either parallel or anti-parallel to the magnetic field.

b) Yes, because magnetic force can change the direction of velocity but not its magnitude.

c) magnetic field should be in a vertically downward direction.

19.) $B = 0.15\ T$

$V = 2.0\ kV$

$E = (1/2) m v^2$

$eV = (1/2) m v^2$

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

$$= 2.652 \times 10^{7}\ m/s$$

a) $F_1 = evB$

$F_2 = mv^2/r$

$F_1 = F_2$

$evB = mv^2/r$

$\Rightarrow r = mv/eB$

$$r = \frac{9.1 \times 10^{-31} \times 2.652 \times 10^{7}}{0.15 \times 1.6 \times 10^{-19}}$$

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

b) $R = mv\sin\phi / Be$

$$R = \frac{9.1\times10^{-31}\times2.652\times10^{7}\times\sin 30^\circ}{0.15\times1.6\times10^{-19}}$$

$= 50.25\times10^{-5}\,m$

$R = 0.5\,mm$

20.) $B = 0.75\,T$

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

$E = 9.0\times10^{-5}\,Vm^{-1}$

$E = (1/2)mv^2$

$(e/m) = (v^2/2V)$

$eE = evB$

$\Rightarrow v = E/B$

$\therefore (1/2)m(E/B)^2 = eV$

$e/m = E^2/2VB^2$

$$= \frac{(9.0\times10^{5})^2}{2\times15000\times(0.75)^2}$$

$= 4.8\times10^{7}\,C/kg$

24) $B = 3000\,G = 0.3\,T$

$A = 10 \times 5 = 50\,cm^2 = 50 \times 10^{-4}\,m^2$

$I = 12\,A$

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

$\vec{A} = 50 \times 10^{-4}\,\hat{i}$

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

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

$= -1.8 \times 10^{-2}\,\hat{j}$ N/m

b) This is as same as (a).
Therefore the torque is 1.8×10^{-2} N m along the negative y-direction. The net force is zero.

c) $\vec{A} = -50 \times 10^{-4}\,\hat{j}$

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

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

$= -18 \times 10^{-2}\,\hat{i}$ Nm

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

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

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

e) $\vec{A} = 50 \times 10^{-4} \hat{k}$

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

Accordingly,

$\vec{T} = 12 \times (-50 \times 10^{-4}) \hat{k} \times 0.3 \hat{k} = 0$

f) $\vec{A} = -50 \times 10^{-4} \hat{k}$

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

$\vec{T} = 12 \times (-50 \times 10^{-4}) \hat{k} \times 0.3 \hat{k}$
$= 0$

∴ Torque & force both are zero.

27) $G = 12 \Omega$
$i = 3 mA$
$R = (V/ig) - G = \frac{18}{3 \times 10^{-3}} - 12 = 6000 - 12$
$= 5988 \Omega$

28) $G = 15 \Omega$
$I_g = 4 mA = 4 \times 10^{-3} A$
Ammeter range = 0 to 6A

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

$S = S = \frac{4 \times 10^{-3} \times 15}{6 - 0.004} = 10 \times 10^{-3} A$
∴ $S = 10 mA$