Ch-4 Moving charges & magnetism.

(Q.1) $n = 100$ $\qquad$ $r = 8 \times 10^{-2}$

$I = 4 \times 10^{-1}$

At centre of coil: $B = \frac{\mu_0 I \times n}{2r}$

$\Rightarrow B = \frac{\mu_0}{4\pi} \frac{2\pi n I}{r} = \frac{10^{-7} \times \cancel{6.28}^{3.14} \times 100 \times 4 \times 10^{-1}}{8 \times 10^{-2}}$

$= \cancel{25.12}^{3.14} \times 10^{-4} T = \cancel{2.512 \times 10^{-3}}$

(2.) $I = 35A$ $\qquad$ $r = 20cm = 0.2m$

$B = \frac{\mu_0}{4\pi} \frac{2I}{r} = \frac{10^{-7} \times 70}{2 \times 10^{-1}} = 35 \times 10^{-6}$

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

(3.) $l = 3cm = 0.03m$ $\qquad$ $I = 10A$

$B = 0.27T$ $\qquad$ $\theta = 90°$

$F = BIl\sin\theta = BIl$

$= 27 \times 10^{-2} \times 3 \times 10^{-2} \times 10$

$= 81 \times 10^{-3} = 8.1 \times 10^{-2} = \cancel{0.81}$

(7) $I_A = 8A$ $\qquad$ $I_B = 5A$

$r = 4cm = 0.04$ $\qquad$ $l = 10cm = 0.1m$

Date ______
Page ______

$B = \frac{\mu_0 2 I_A I_B l}{4\pi r} = \frac{10^{-7} \times 2 \times 8 \times 5 \times 0.1}{0.04} = 2 \times 10^{-5}$

This is an attractive force normal to A toward B as the direction of current in the wire is same

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

$N = 5 \times 400 = 2000$ $\quad D = 1.8cm = 0.018 m$

$I = 8A$

$B = \frac{\mu_0 N I}{l} = \frac{4\pi \times 10^{-7} \times 2000 \times 8}{0.8}$

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

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

$v = 4.8 \times 10^{6}$ $\quad e = 1.6 \times 10^{-19} C$

$m_e = 9.1 \times 10^{-31}$ $\quad \theta = 90°$

$\Rightarrow F_c = F_B$

$\Rightarrow \frac{mv^2}{r} = qvB\sin\theta = \frac{mv^{\cancel{2}}}{r} = qB\cancel{v}$

$\Rightarrow r = \frac{mv}{qB} = \frac{9.1 \times 10^{-31} \times 4.8 \times 10^{6}}{1.6 \times 10^{-19} \times 6.5 \times 10^{-4}} = 4.2 \times 10^{-2} m$

$\Rightarrow r = 4.2cm$

(12.) $B = 6.5 \times 10^{-4}$ $\quad e = 1.6 \times 10^{-19}$

$m_e = 9.1 \times 10^{-31}$ $\quad v = 4.8 \times 10^{6}$

$r = 0.042 m$

$f = v$ $\quad \omega = 2\pi v$

$v = r\omega \Rightarrow$

$\therefore q\cancel{v}B = \frac{mv^{\cancel{2}}}{r} \Rightarrow q\cancel{v}B = \frac{m}{r}(\omega r)$

$\Rightarrow qB = \frac{m}{\cancel{r}}(\cancel{r} \times 2\pi\nu)$

$\Rightarrow \nu = \frac{Bq}{2\pi m} = \frac{6.5 \times 10^{-4} \times 1.6 \times 10^{-19}}{2 \times 3.14 \times 9.1 \times 10^{-31}}$

$= 18.2 \times 10^{6}\ Hz$

$= 18\ MHz$

(13)

(a) $n = 30$ $\quad r = 8\ cm = 0.08\ m$

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

$I = 6A$; $B = 1T$

$\theta = 60^\circ$

$\Rightarrow \tau = nIBA \sin\theta$

$= 30 \times 6 \times 1 \times 0.0201 \times \sqrt{3}/2$

$= 3.133\ Nm$

(b) magnitude of applied torque depends on ~~shap~~ area of coil, not shape. Thus it will not effect the torque.

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

$$B_1 = \frac{\mu_0 n_1 I_1}{2r_1} = \frac{4\pi \times 10^{-7} \times \cancel{20} \times \cancel{16}}{\cancel{2} \times \cancel{16} \times 10^{-2}} = 4\pi \times 10^{-4}\,T$$
(toward east)

$$B_2 = \frac{\mu_0 n_2 I_2}{2r_2} = \frac{4\pi \times 10^{-7} \times 25 \times \cancel{18}^{9}}{\cancel{2} \times 10^{-1}} = 9\pi \times 10^{-4}\,T$$
(toward west)

Net magnetic field :- $B = B_2 - B_1$
$= (9-4)\pi \times 10^{-4} = 5\pi \times 10^{-4}\,T$
$= 1.57 \times 10^{-3}\,T$ (toward west)

(15) $B = 100\,G = 100 \times 10^{-4}\,T$ $\quad$ $n = 1000$ turn/m
$I = 15A$

$B = \mu_0 nI$ ~~$= 4\pi \times 10^{-7} \times 100 \times 10^{-4}$~~
$$\Rightarrow nI = \frac{B}{\mu_0} = \frac{100 \times 10^{-4}}{4\pi \times 10^{-7}} = 7957.74 \approx 8000\,A/m$$

If $l = 50\,cm$, $r = 4\,cm$, $N = 400$, $I = 10A$, then these value are not unique for the given purpose there's always a possibility of some adjustment with limits.

(17)
(a) ~~Outside~~ Outside torroid, field is zero.

(b) Inside the core torroid ; $B = \frac{\mu_0 N I}{l}$

=

$l = 2\pi\left[\frac{r_1 + r_2}{2}\right] = 2\pi(0.25 + 0.26) = 0.51\pi$

$\therefore B = \frac{\mu_0 NI}{l} = \frac{4\pi \times 10^{-7} \times 3500 \times 11}{51 \times 10^{-2} \times \pi} \approx 3 \times 10^{-2} T$

(c) Magnetic field in the empty space surrounded by the toroid is zero.

(19)

(a) $K.E = eV \Rightarrow eV = \frac{1}{2}mv^2 \Rightarrow v = \left(\frac{2eV}{m}\right)^{1/2}$

$\therefore F_c = F_B$

$\Rightarrow \frac{mv^2}{r} = qvB \Rightarrow r = \frac{mv}{qB}$

$\Rightarrow r = \frac{m}{qB}\left[\frac{2eV}{m}\right]^{1/2}$

$= \frac{9.1 \times 10^{-31}}{0.15 \times 1.6 \times 10^{-19}} \times \left(\frac{2 \times 1.6 \times 10^{-19} \times 2 \times 10^{3}}{9.1 \times 10^{-31}}\right)^{1/2}$

$= 100.55 \times 10^{-5}$

$= 1.01 \times 10^{-3} \approx 1\ mm$

(b) when $\theta = 30^\circ \Rightarrow v_1 = v\sin\theta$

$\Rightarrow r_1 = \frac{mv_1}{Be} \Rightarrow r_1 = \frac{mv\sin 30^\circ}{Be}$

$r_1 = \frac{r}{2} \Rightarrow r_1 = \frac{1mm}{2} = 0.5mm$

(20)

(a) $\frac{1}{2}mv^2 = eV \Rightarrow \frac{e}{m} = \frac{v^2}{2V}$ — (i)

Date ______
Page ______

Since the particle remains undeflected by electric & magnetic field, then the electric field is balancing magnetic field.

$\Rightarrow qE = qBv \Rightarrow E = Bv \Rightarrow v = \frac{E}{B}$

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

$\Rightarrow \frac{e}{m} = \frac{1}{2}\times\frac{(9\times10^5)^2}{15000\times(.15)^2} = 4.8\times10^7$ C/kg

This value of specific charge e/m is equal to the value of deutron or deuterium ion. This is not a unique ans. Other possible are He^{++}, L^{++} etc.

(24) $B = 3000\,G = 3000\times10^{-4} = 0.3\,T$

$l = 10\,cm$ $\quad b = 5\,cm$

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

$I = 12\,A$

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

$= 12\times(50\times10^{-4})\hat{i}\times0.3\hat{k} = -1.8\times10^{-2}\hat{j}$ Nm

$F = 0$ as $\sin\theta = 0$

(b) Same case of (a)

(c) $\tau = -12\times(50\times10^{-4})\hat{j}\times0.3\hat{k}$

$= -1.8\times10^{-2}\hat{i}$ Nm

$F = 0$

(d) $\cancel{I}\ |\tau| = IAB$

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

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