HOME ASSIGNMENT

MOVING CHARGES AND MAGNETISM

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* Exercises :-

Q 4.1) $n = 100$

$r = 0.08\ m$

$I = 0.4\ A$

$$\Rightarrow |\bar{B}| = \frac{\mu_0 2\pi n I}{4\pi r} \times 2\pi \times 100 \times 0.4$$

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

$$\Rightarrow (\bar{B}) = \frac{4\pi \times 10^{-7}}{4\pi} \times \frac{2\pi \times 100 \times 0.4}{0.08}$$

$\therefore$ The magnitude of magnetic field $= 3.14 \times 10^{-4}$

Q4.2) $I = 35\ A$

$r = 0.2\ m$

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

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

$$\Rightarrow (\bar{B}) = \frac{4\pi\ 10^{-7}}{4\pi} \times \frac{2.35}{0.2}$$

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

Q 4.6) $l = 0.03 m$
$I = 10 A$
$B = 0.27 T$
$\theta = 90°$

$\Rightarrow F = BIl\sin\theta$

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

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

$\therefore$ Hence, force $= 8.1 \times 10^{-2}$ Newton and obeys flemings left-hand rule.

Q4.7) $I_A = 8 A$
$I_B = 5 A$
$r = 0.04 m$

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

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

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

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

$\therefore$ The magnitude of force $= 2 \times 10^{-5} N$

Q4.8) $l = 0.8 m$

$n = 5 \times 400$

$= 2000$

$D = 0.018 m$

$I = 8 A$

$\Rightarrow B = \frac{\mu_0 N I}{l}$, $\mu = 4\pi \times 10^{-7} TMA^{-1}$

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

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

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

Q4.8) $B = 6.5 \times 10^{-4} T$

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

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

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

$\theta = 90°$

$\Rightarrow f = evB \sin\theta$

$\Rightarrow F_c = \frac{mv^2}{r}$

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

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

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

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

$= 4.2 cm$

$\therefore$ Hence, the radius is 4.2 cm

Q(4.12) $B = 6.5 \times 10^{-4} T$
$e = 1.6 \times 10^{-19} C$
$m_e = 9.1 \times 10^{-31} kg$
$v = 4.8 \times 10^{6} m/s$
$r = 0.042$
$\omega = 2\pi\nu$

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

$\Rightarrow eB = \frac{mv}{r} = \frac{m(r\omega)}{r}$

$= \frac{m(r.2\pi\nu)}{r}$

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

$= \frac{6.5 \times 10^{-4} \times 1.6 \times 10^{-19}}{}$

∴ Hence, the frequency is 18 MHz.

Q 4.13) $n = 30$
(a) $r = 0.08\,m$

→ Area of coil $= \pi r^2$
$= \pi (0.08)^2$
$= 0.0201\,m^2$

$I = 6.0\,A$
$B = 1\,T$
$\theta = 60^\circ$

$\tau = nIBA\sin\theta$

$= 30 \times 6 \times 1 \times 0.0201 \times \sin 60^\circ$

$= 3.133\,Nm$

(b) $\tau = nIBA\sin\theta$

∴ The applied torque is not dependent on the shape of coil. It depends on the area of the coil. Hence, the answer would not change if the circular coil in the above case is replaced by a planner coil of some irregular shape that encloses the same area.

Q.4.14) $r_1 = 0.16m$
$n_1 = 20$
$I_1 = 16A$
$r_2 = 0.1m$
$n_2 = 25$
$I_2 = 18A$

$\Rightarrow B_1 = \frac{\mu_0 N_1 I_1}{2r_1}$ $\left(\mu_0 = 4\pi \times 10^{-7} \frac{Tm}{A}\right)$

$\Rightarrow B_1 = \frac{4\pi \times 10^{-7} \times 20 \times 16}{2 \times 0.16}$ [X]

$= 4\pi \times 10^{-4}$ T (towarde east)

$\Rightarrow B_2 = \frac{\mu_0 N_2 I_2}{2r_2}$

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

$= 9\pi \times 10^{-4}$ T (towards west)

$\because B = B_2 - B_1$

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

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

$\Rightarrow 5 \times 3.14 \times 10^{-4} = \underline{\underline{1.57 \times 10^{-3}}}$ T (west)

Q4.15) $B = 100 \times 10^{-4}\ T$
$n = 1000$ turns/m
$I = 15\ A$
$\mu = 4\pi \times 10^{-7}\ TmA^{-1}$

$\Rightarrow B = \frac{\mu_0 n I}{I}$

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

$= 7961$

$\because$ So, now $= \frac{(N \times 10)}{0.5} = 7961$

$\because N = 398$ turs ≈ 400 turns

Q4.17) $r_1 = 0.25\ m$
$r_2 = 0.26\ m$
$N = 3500$
$I = 11\ A$

a) The magnetic field outside the toroid $= 0$
b) the magnetic field induction of inside core toroid is $= \frac{B\ \mu_0 n I}{I}$

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

$= \pi(0.25 + 0.26)$

$= \pi \times 0.51$

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

$\Rightarrow \quad B = \frac{(4\pi \cdot 10^{-7}) \times 3500 \times 11}{\pi \times 0.51} = 3.02 \times 10^{-2}\,T$

(c) The m.f in the empty space surrounded by the toroid is zero.

Q4.18) (a) Initial velocity is either parallel or anti-parallel to the magnetic field. There is no magnetic force acting on the particle when it is parallel or anti-parallel and it moves undeflected.

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

(c) M.f should be vertically downwards direction.

Q4.19) $B = 0.15\,T$

$V = 2.0\,kV$

$E = \frac{1}{2} m v^2$

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∴ Hence, the frequency is 18 MHz.

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→ Area of coil $= \pi r^2$

$= \pi(0.08)^2$

$= 0.0201\,m^2$

$I = 6.0\,A$

$B = 1T$

$\theta = 60°$

$\tau = nIBA\sin\theta$

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

$= 3.133\,Nm$

(b) $\tau = nIBA\sin\theta$

∴ The applied torque is not dependent on
the shape of coil. It depends on the
area of the coil. It depends on the area
of the coil. Hence, the answer would not
change if the circular coil in the above
case is replaced by a planner coil in
the above case, is replaced by a planner
coil of some irregular shape that encloses
the same area.

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$\Rightarrow r = \dfrac{9.1 \times 10^{-31} \times 2.652 \times 10^{7} \times \sin 30^\circ}{0.15 \times 1.6 \times 10^{-19}}$

$= 50.25 \times 10^{-5} m$

$= 0.5 mm$

Q4.20) $B = 0.75 T$

$V = 15 \times 10^{3} V$

$\varepsilon = 9.0 \times 10^{-5} Vm^{-1}$

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

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

$\therefore (e/m) = \left(\frac{v^2}{2V}\right)$

$\Rightarrow \cancel{m} eE = evB$

$\Rightarrow v = \frac{\varepsilon}{B}$

$\therefore \left(\frac{1}{2}\right) m \left(\frac{\varepsilon}{B}\right)^2 = eV$

$= \dfrac{(9.0 \times 10^{5})^2}{2 \times 15000 \times (0.75)^2}$

$= 4 \times 8 \times 10^{7} C/kg$

$\Rightarrow \quad r = \dfrac{9.1 \times 10^{-31} \times 2.652 \times 10^{7} \times \sin 30^\circ}{0.15 \times 1.6 \times 10^{-19}}$

$= 50.25 \times 10^{-5}\, m$

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$\varepsilon = \frac{1}{2} m v^2$

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$= \dfrac{(9.0 \times 10^{5})^2}{2 \times 15000 \times (0.75)^2}$

$= 4 \times 8 \times 10^{7}\, C/kg$