MOVING CHARGES & MAGNETISM.

1. $N = 100$

$r = 8.0\ cm = 0.08\ cm$

$I = 0.4A$

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

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

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

2. $I = 35\ A$

$r = 20\ cm = 0.2\ m$

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

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

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

6. $l = 3\ cm = 0.03\ m$

$I = 10A$

$B = 0.27\ T$

$$F = BIl \sin\theta$$

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

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

7. $A, I_A = 8.0\ A$

$B, I_B = 5.0\ A$

$r = 4.0\ cm = 0.04\ m$

$A, l = 10\ cm = 0.1\ m$

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

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

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

8. $L = 80\ cm = 0.8 m$

$N = 5 \times 400 = 2000$

$D = 1.8 cm = 0.18 m$

$I = 8.0 A$

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

~~B =~~

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

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

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

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

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

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

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

$F_c = F$

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

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

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

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

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

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

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

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

$r = 4.2 cm = 0.042 m$

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

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

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

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

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

$$= 18 \, MHz$$

13.(a) $n = 30$

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

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

$I = 6.0 \, A$

$B = 1 \, T$

$\theta = 60^\circ$

$T = nIBA \sin\theta$

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

$= 3.133 \, N \, m$

(b) It can be inferred from relation (i) that the magnitude of the applied torque is not dependent on the shape 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 planar coil of some irregular shape that encloses the same area.

14. $X, r_1 = 16 \, cm = 0.16 \, m$

$Y, r_2 = 10 \, cm = 0.1 \, m$

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X, $n_1 = 20$
Y, $n_2 = 25$
X, $I_1 = 16\,A$
Y, $I_2 = 18\,A$

$B_1 = \frac{\mu_0 n_1 I_1}{2r_1}$

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

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

$= 4\pi \times 10^{-4}\ T$ (Towards East)

$B_2 = \frac{\mu_0 n_2 I_2}{2r_2}$

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

$= 9\pi \times 10^{-4}\ T$ (Towards West)

$B = B_2 - B_1$

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

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

$= 1.57 \times 10^{-3}\ T$ (Towards West)

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

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

$I = 15\,A$

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

$B = \mu_0 nI$

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

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

$\simeq 8000\ A/m$

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17. $r_1 = 25$ cm $= 0.25$ m
$r_2 = 26$ cm $= 0.26$ m
$N = 3500$
$I = 11$ A

(a) Magnetic field outside a toroid is zero. It is non-zero only inside the core of a toroid.

(b) $B = \frac{\mu_0 N I}{l}$

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

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

$= \pi(0.25 + 0.26)$

$= 0.51\pi$

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

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

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

18. (a) The initial velocity of the particle is either parallel or anti-parallel to the magnetic field. Hence, it travels along a straight path without suffering any deflection in the field.

(b) Yes, the ~~financial~~ 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.

(c) An electron travelling from West to East enters a chamber having a uniform electrostatic field in the North-South direction. This moving electron can remain undeflected in the electric force acting on it is equal and opposite of magnetic field. Magnetic force is directed towards the South. According to Fleming's left hand rule, magnetic field should be applied in a vertically downward direction.

19. $B = 0.15\ T$

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

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

$V = 2.0\ kV = 2 \times 10^3 V$

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

$v = \sqrt{\frac{2eV}{m}}$ ...... ①

(a) $Bev = \frac{mv^2}{r}$

$\therefore Bev = \frac{mv^2}{r}$

$r = \frac{mv}{Be}$ ...... ②

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

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

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

$= 1.01 \times 10^{-3} m$

$\approx 1\ mm$

(b) $v_1 = v\sin\theta$

$$r_1 = \frac{mv_1}{Be}$$

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

$$= \frac{9.1\times10^{-31}}{0.15\times1.6\times10^{-19}} \times \left[\frac{2\times1.6\times10^{-19}\times2\times10^{3}}{9\times10^{-31}}\right] \times \sin 30^\circ$$

$$= 0.5\times10^{-3}\,m$$

$$= 0.5\,mm$$

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