1.8.21

L-4

Nrert Solution

4.1

$n = 100$
$r = 0.08m$

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

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

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

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

4.2

$I = 35A$
$r = 20 cm = 0.2 m$

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

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

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

16. $l = 3\,cm = 0.03\,m$

$I = 10\,A$

$B = 0.27\,T$

$F = BIl\sin\theta$

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

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

17. $I_A = 8.0\,A$

$I_B = 5.0\,A$

$r = 4.0\,cm = 0.04\,m$

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

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

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

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

This is an attractive force normal to A towards B because the direction of the currents in the wires is same.

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4.8 $l = 80\,cm = 0.8\,m$

$N = 5 \times 400 = 2000$

$D = 1.8\,cm = 0.018\,m$

$I = \cancel{0.8}\,A\ 8.0\,A$

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

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

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

4.11

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

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

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

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

$\theta = 90^\circ$

$F = evB \sin\theta$

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

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

$r = \frac{mv}{Be\sin\theta} = \frac{9.1\times10^{-31}\times4.8\times10^{6}}{6.5\times10^{-4}\times1.6\times10^{-19}\times\sin 90}$

$= 4.2\times10^{-2}\,m = 4.2\,m$

4 14 $B = 6.5\times10^{-4}\,T$

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

$m_e = 9.1\times10^{-31}$

$v = 4.8\times10^{6}$

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

Frequency $= \nu$

$\omega = 2\pi\nu$

$v = r\omega$

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

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

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

$\nu = \frac{6.5\times10^{-4}\times1.6\times10^{-19}}{2\times3.14\times9.1\times10^{-31}} = 18.2\times10^{6}\,Hz$

$\simeq 18\,MHz$

4.13

a) $n = 30$

$r = 8.0\ cm = 0.08 m$

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

$= 0.0201 m^2$

$I = 6.0 A$

$B = 1T$

$\theta = 60^0$

$T = n I B A \sin\theta$

$= 30 \times 6 \times 1 \times 0.0201 \times \sin 60^0$

$= 3.133 N m$

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 above case is replaced by a planar coil of some irregular shape that encloses same area.

4.14

$r_1 = 16\,cm = 0.16\,m$

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

$n_1 = 20$

$n_2 = 25$

$I_1 = 16\,A$

$I_2 = 18\,A$

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

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

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

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

$$= \frac{4\pi \times 10^{-7} \times 25 \times 18}{2 \times 0.1}$$

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

$$B = B_2 - B_1$$

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

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

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

4.15 $B = 100\ G \times = 100 \times 10^{-4}$ T

$n = 1000$ turns

$I = 15A$

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

$B = \mu_0 n I$

$$nI = \frac{B}{\mu_0} = \frac{100 \times 10^{-4}}{4\pi \times 10^{-7}} = 7957.74$$

$\simeq 8000\ A/m$

If the length of coil is taken as 50 cm, radius 4 cm number of turns 400 and current 10A these value are not unique for the given purpose. There is always a possibility of some adjustment with limits.

Magnetic field outside a [illegible] solenoid is zero. [illegible] within [illegible] uniform [illegible] of a solenoid

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

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

$= \pi(0.25 + 0.26)$

$= 0.51\pi$

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

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

Magnetic field in empty space surrounded by toroid is zero.

4 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 field

b) 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

4·20

$B = 0.75T$

$V = 15kV = 15 \times 10^3 V$

$E = 9 \times 10^5 V$

mass $= m$

Charge $= e$

Velocity $= v$

K.E $= eV$

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

$\frac{e}{m} = \frac{v^2}{2V}$

$eE = evB$

$v = \frac{E}{B}$

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

$= \frac{(9.0 \times 10^5)^2}{2 \times 15000 \times (0.75)^2} = 4.8 \times 10^7$

4.24 $B = 3000 \times 10^{-4} T = 0.3 T$

$L = 10 cm$

$b = 5 cm$

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

$I = 12 A$

a) Torque, $\tau = IA \times B$

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

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

b) This case is similar to case (a)

c) $\tau = IA \times B$
$\tau = 12 \times (50 \times 10^{-4}) \times 0.3$
$= -1.8 \times 10^{-2}$ Nm

d) $\tau = IAB$
$= 12 \times 50 \times 10^{-4} \times 0.3$
$= 1.8 \times 10^{-2}$ Nm

e) $\tau = 50 \times 10^{-4} \times 12 \times 0.3$
$= 0$

f) $\tau = IA \times B$
$= 0$

Case e equilibrium is stable

f equilibrium is unstable

4.27 $G = 12\,\Omega$

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

$V = 18\,V$

$$R = \frac{V}{I_B} - G = \frac{18}{3 \times 10^{-3}} - 12$$

$$= 6000 - 12 = 5988\,\Omega$$

Connected in series

4.28

$G = 15\,\Omega$

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

$I = 6A$

$$S = \frac{I_B G}{I - I_B} = \frac{4 \times 10^{-3} \times 15}{6 - 4 \times 10^{-3}}$$

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

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

shunt resistor is to be connected in parallel with Galvanometer