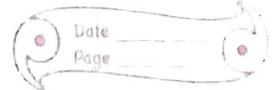


Chapter 5

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5.3) Here, $\theta = 30^\circ$, $B = 0.25 \text{ T}$, $T = 4.5 \times 10^{-2} \text{ J m}^{-2}$?

$$\text{As } T = mB \sin \theta,$$

$$\therefore m = \frac{T}{B \sin \theta} = \frac{4.5 \times 10^{-2}}{0.25 \times \sin 30^\circ} = 0.36 \text{ JT}^{-1}$$

5.4) Here $m = 0.32 \text{ JT}^{-1}$, $B = 0.15 \text{ T}$

(i) The bar will be in stable equilibrium when its magnetic moment \vec{m} is parallel to \vec{B} ($\theta = 0^\circ$). Its potential energy is then minimum and is given by

$$U_{\min} = -mB \cos 0^\circ = +0.32 \times 0.15 \times 1 \\ = +4.8 \times 10^{-2} \text{ J}$$

(ii) The bar will be in unstable equilibrium when its magnetic moment \vec{m} is antiparallel to \vec{B} ($\theta = 180^\circ$). Its potential energy is then maximum and is given by

$$U_{\max} = -mB \cos 180^\circ = -0.32 \times 0.15 \times 1 \\ = -4.8 \times 10^{-2} \text{ J.}$$

5.5) Here, $N = 800$, $A = 2.5 \times 10^{-4} \text{ m}^2$, $I = 3.0 \text{ A}$

$$m = NI A = 800 \times 3 \times 2.5 \times 10^{-4} = 0.60 \text{ JT}^{-1}$$

5.8) Here $N = 2000$, $A = 1.6 \times 10^{-4} \text{ m}^2$, $I = 4.0 \text{ A}$

(a) Magnetic moment of solenoid of turns N , area of cross-section A and carrying current I is

$$m = NI A = 2000 \times 4.0 \times 1.6 \times 10^{-4} \text{ Am}^2 \\ = 1.28 \text{ Am}^2$$

This magnetic moment acts along the axis of the solenoid in a direction related to the sense of current via the right

hand screw rule:

- (b) Net force experienced by the magnetic dipole in the uniform magnetic field $= 0$.

The magnitude of the torque τ exerted by the magnetic field B on the solenoid is given by

$$\tau = mB \sin \theta = 1.28 \times 7.5 \times 10^{-2} \text{ Nm}$$

$$= 0.048 \text{ Nm}$$

This torque tends to align the axis of the solenoid (i.e., its magnetic moment vector \vec{m}) along the field \vec{B} .

5.9) Here, $N = 16$, $r = 10 \text{ cm} = 0.10 \text{ m}$, $I = 0.75 \text{ A}$

$$B = 5.0 \times 10^{-2} \text{ T}, v = 2.0 \text{ s}^{-1}$$

Magnetic moment of the coil is $m = NI$

$$= NID \cdot \pi r^2$$

Frequency of oscillation, $v = \frac{1}{2\pi} \sqrt{\frac{mB}{I}}$

\therefore Moment of Inertia is

$$I = \frac{mB}{4\pi^2 v^2} = \frac{NID \cdot \pi r^2 \cdot B}{4\pi^2 v^2}$$

$$= \frac{16 \times 0.75 \times (0.1)^2 \times 5 \times 10^{-2}}{4 \times 3.14 \times 4}$$

$$= 1.2 \times 10^{-4} \text{ kg m}^2$$

5.11) Here, $B_H = 0.16 \text{ G}$, $\delta = 60^\circ$

$$\therefore B = \frac{B_H}{\cos \delta} = \frac{0.16}{\cos 60^\circ} = \frac{0.16}{0.5} = 0.32 \text{ G}$$

Thus, the earth's magnetic field has a magnitude of 0.32 G and lies in a vertical plane 12° west of the geographic meridian.

making an angle of 60° (upwards) with the horizontal (magnetic south to magnetic north) direction.

- 5.13) As the null points lie on the axis of the magnet, therefore

$$B_{\text{axial}} = \frac{\mu_0}{4\pi} \cdot \frac{2m}{r^3} = B_H$$

Magnetic field of the magnet on its normal bisector at the same distance will be

$$B_{\text{equa}} = \frac{\mu_0}{4\pi} \cdot \frac{m}{r^3} = \frac{B_H}{2} = \frac{0.36}{2} = 0.18 \text{ G}$$

\therefore Total magnetic field at the required point on the normal bisector is

$$B_{\text{equa}} + B_H = 0.18 + 0.36 = 0.54 \text{ G}$$

- 5.18) Suppose the neutral point lies at a distance r from the cable. Then at the neutral point,

$$\frac{\mu_0 I}{2\pi r} = B_H$$

$$\text{or } r = \frac{\mu_0 I}{2\pi B_H} = \frac{4\pi \times 10^{-7} \times 2.5}{2\pi \times 0.33 \times 10^{-4}} = 1.5 \times 10^{-2} \text{ m}$$

As the direction of the magnetic field of the cable is opposite to that of B_H at points above the cable, so the line of neutral points lies parallel to and above the cable at a distance of 1.5 cm from it.