Page

3. Magnetic field strength, $B = 0.25\ T$
Torque on the bar magnet, $T = 4.5 \times 10^{-2}\ J$
Angle between the bar magnet and the external magnetic field, $\theta = 30^\circ$
Torque is related to magnetic moment (M) as:

$$T = MB\sin\theta$$

$$\therefore M = \frac{T}{B\sin\theta}$$

$$= \frac{4.5 \times 10^{-2}}{0.25 \times \sin 30^\circ} = 0.36\ JT^{-1}$$

4. Moment of the bar magnet, $M = 0.32\ JT^{-1}$
External magnetic field, $B = 0.15\ T$

(a) The bar magnet is aligned along the magnetic field. This system is considered as being in stable equillibrium. Hence, the angle θ between the bar magnet and the magnetic field is 0°.

Potential energy of the system $= -MB\cos\theta$

$$= -0.32 \times 0.15 \cos 0^\circ$$

$$= -4.8 \times 10^{-2}\ J$$

(b) The bar magnet is oriented 180° to the magnetic field. Hence, it is unstable equillibrium. $\theta = 180^\circ$

Potential energy $= -MB\cos\theta$

$$= -0.32 \times 0.15 \cos 180^\circ$$

$$= 4.8 \times 10^{-2}\ J$$

5. No. of turns in the solenoid, $n = 800$
Area of cross-section, $A = 2.5 \times 10^{-4}\ m^2$

Current in the solenoid, $I = 3$ A

A current carrying solenoid behaves as a bar magnet because a magnetic field develops along its axis, i.e. along its length.

The magnetic moment associated with the given current-carrying solenoid is calculated as:

$$M = nIA$$
$$= 800 \times 3 \times 2.5 \times 10^{-4}$$
$$= 0.6 \ JT^{-1}$$

8. Number of turns on the solenoid, $n = 2000$

Area of cross-section of the solenoid,

$A = 1.6 \times 10^{-4} \ m^2$

Current in the solenoid, $I = 4A$

(a) The magnetic moment along the axis of the solenoid is calculated as:

$$M = nAI$$
$$= 2000 \times 1.6 \times 10^{-4} \times 4$$
$$= 1.28 \ Am^2$$

(b) Magnetic field, $B = 7.5 \times 10^{-2}$ T

Angle between the magnetic field and the axis of the solenoid, $\theta = 30^\circ$

$$\tau = MB\sin\theta$$
$$= 1.28 \times 7.5 \times 10^{-2} \sin 30^\circ$$
$$= 4.8 \times 10^{-2} \ Nm$$

$$\boxed{\tau = 4.8 \times 10^{-2} \ Nm}$$

Date ____
Page ____

9. Number of turns in the circular coil, $N = 16$
Radius of the coil, $r = 10\ cm = 0.1\ m$
Cross-section of the coil, $A = \pi r^2 = \pi \times (0.1)^2 m^2$
Current in the coil, $I = 0.75\ A$
Magnetic field strength, $B = 5 \times 10^{-2}\ T$
Frequency of oscillations of coil,
$\nu = 2 s^{-1}$

$\therefore$ Magnetic moment, $M = NIA = NI\pi r^2$
$= 16 \times 0.75 \times \pi \times (0.1)^2$
$= 0.377\ JT^{-1}$

Frequency is given by the relation:
$$\nu = \frac{1}{2\pi}\sqrt{\frac{MB}{I}},$$ where
I = moment of inertia of coil
$$\therefore I = \frac{MB}{4\pi^2 \nu^2}$$
$$= \frac{0.377 \times 5 \times 10^{-2}}{4\pi^2 \times (2)^2}$$
$$= 1.19 \times 10^{-4}\ kg\,m^2$$

11. Angle of declination, $\theta = 12^\circ$
Angle of dip, $\delta = 60^\circ$
Horizontal component of earth's magnetic field, $B_H = 0.16\ G$
Earth's magnetic field at the given location $= B$
We can relate B and B_H, as:
$$B_H = B \cos\delta$$
$$\therefore B = \frac{B_H}{\cos\delta} = \frac{0.16}{\cos 60^\circ} = 0.32\ G$$

13. Earth's magnetic field at the given place,
$H = 0.36\ G$

The magnetic field at a distance d, on the axis of the magnet is given as:

$$B_1 = \frac{\mu_0}{4\pi}\frac{2M}{d^2} = H \longrightarrow (1)$$

where, μ_0 = Permeability of free space
M = Magnetic moment

The magnetic field at the same distance d, on the equitorial line of the magnet is given as: using

$$B_2 = \frac{\mu_0 M}{4\pi d^2} = \frac{H}{2} \rightarrow (1)$$

Total magnetic field, $B = B_1 + B_2$

$$= H + \frac{H}{2}$$

$$= 0.36 + 0.18 = 0.54\ G$$

18. Current in the wire, $I = 2.5\ A$
Angle of dip at the given location on earth, $\delta = 0^\circ$
Earth's magnetic field, $H = 0.33\ G = 0.33 \times 10^{-4}\ T$

The horizontal component of earth's magnetic field is given as:

$$H_H = H \cos \delta$$
$$= 0.33 \times 10^{-4} \times \cos 0^\circ$$
$$= 0.33 \times 10^{-4}\ T$$

The magnetic field at the neutral point

at a distance R from the cable is given by the relation :

$$H_H = \frac{\mu_0 I}{2\pi R}$$

where, μ_0 = permeability of free space

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

$$\therefore R = \frac{\mu_0 I}{2\pi H_H}$$

$$= \frac{4\pi \times 10^{-7} \times 2 \cdot 5}{2\pi \times 0 \cdot 33 \times 10^{-4}} = 15 \cdot 15 \times 10^{-3} m$$

$= 1 \cdot 51$ cm