Chapter - 5

Name - Riki Roshan Jinda
Class - XII Sec - DB
School no - 10080

Magnetism & Matter

5·3) Here, $\theta = 30^\circ$, $B = 0.25\,T$, $\tau = 4.5 \times 10^{-2}\,J$, $m = ?$

As $\tau = mB \sin\theta$,

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

5·4) Here $m = 0.32\,JT^{-1}$, $B = 0.15\,T$

(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

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

(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

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

5·5) Here, $N = 800$, $A = 2.5 \times 10^{-4}\,m^2$, $I = 3.0\,A$

$$m = NIA = 800 \times 3 \times 2.5 \times 10^{-4} = 0.60\,JT^{-1}$$

5·8) Here $N = 2000$, $A = 1.6 \times 10^{-4}\,m^2$, $I = 4.0\,A$

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

$$m = NIA = 2000 \times 4.0 \times 1.6 \times 10^{-4}\,Am^2$$
$$= 1.28\,Am^2$$

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.

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

The magnitude of the torque τ exerted by the magnetic field $\vec{B}$ on the solenoid is given by

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

$= 0.048$ 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, $N = 16$, $r = 10$ cm $= 0.10$ m, $I = 0.75$ A

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

Magnetic moment of the coil is $m = NIA$

$= NI \cdot \pi r^2$

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

$\therefore$ Moment of Inertia is

$I = \frac{mB}{4\pi^2\nu^2} = \frac{NI\pi r^2 \cdot B}{4\pi^2\nu^2}$

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

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

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

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

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

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

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

∴ Total magnetic field at the required point on the normal bisector is

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

5·18) Suppose the neutral point lies at a distance r from the cable. Then at the neutral point,

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

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

$$= 1.5 cm$$

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.