Chapter-5 Magnetism NCERT Exercise

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

$\tau = mB\sin\theta$

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

4. $m = 0.32\ JT^{-1}$, $B = 0.15T$

i) The bar will be in stable equilibrium when its magnetic moments $\vec{m}$ is parallel to $\vec{B}$. 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 moments $\vec{m}$ is antiparallel to $\vec{B}$. 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. $N = 800$, $A = 2.5 \times 10^{-4} m^2$, $I = 3.0A$

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

The magnetic field of a solenoid has the same pattern as that of a bar magnet. It acts along the axis of the solenoid. Its direction is determined by the sense of flow of current.

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9 $N = 16$, $r = 10\ cm = 0.10 m$, $I = 0.75 A$

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

Magnetic moment of the coil in $m = NIA = NI.\pi r^2$

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

∴ Moment of inertia is

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

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

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

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

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 moments 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 $\vec{B}$ on the solenoid is given by

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

$= 0.048\ Nm$

This torque tends to align the axis of the solenoid along the field $\vec{B}$.

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11 $B_H = 0.16G$, $\delta = 60^\circ$

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

Thus the earth's magnetic field has a magnitude of 0.32G and lies in a vertical plane 12° west of the geographic meridian making an angle of 60° (up) with the horizontal direction.

13 As the null points lies on the axis of the magnets, 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

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

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

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

19 Suppose the neutral point lies at a distance r from the cable. Then at the neutral point,

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

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 $\vec{B}_H$ at point above the cable, so the line of neutral point lies parallel to and above the cable at a distance of 1.5 cm from it.