Ch=5

Magnetism

3) $\theta = 30^\circ$

$B = 0.25T$

$\tau = 4.5 \times 10^{-2} J$

As $\tau = mB\sin\theta$

$$m = \frac{\tau}{B\sin\theta} = \frac{4.5\times10^{-2}}{0.25\times\sin 30} = 0.36 JT^{-1}$$

4) $m = 0.32 JT^{-1}$

$B = 0.15T$

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

$$U_{min} = -mB\cos 0^\circ = -0.32\times0.25\times1$$
$$= -4.8\times10^{-2} J$$

(ii) The bar will be is unstable equilibrium when its magnetic movement $\vec{m}$ is antiparallel to $\vec{B}$. Its potential ~~movement~~ energy is then maximum and is given by

$$U_{max} = -mB\cos 180^\circ = -0.32\times0.15\times(-1)$$
$$= +4.8\times10^{-2} J$$

5) $N = 800$

$A = 2.5\times10^{-4} m^2$

$I = 3 A$

$m = NIA = 800\times3\times2.5\times10^{-4}$

$= 0.60 JT^{-1}$

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.

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

(a) Magnetic movement of solenoid of turn N, area of cross section A and carrying current I is

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

The magnetic moment act 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 experted 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 tend to align the axis of the solenoid along the field $\vec{B}$.

9) $N = 16$
$r = 10 cm = 0.10 m$
$I = 0.75 A$
$B = 5.0 \times 10^{-2} T$
$v = 2.0 s^{-1}$

Magnetic movement of the coil is
$M = NIA = NI.\pi r^2$
Frequency of oscillation, $\nu = \frac{1}{2\pi}\sqrt{\frac{MB}{I}}$

Movement of inertia is

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

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

$$= 1.2 \times 10^{-4} \, Kgm^2$$

11) $B_H = 0.16 G$
$\delta = 60°$

$$B = \frac{B_H}{\cos\delta} = \frac{0.16}{\cos 60°} = \frac{0.16}{0.5} = 0.32 G$$

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° with the horizontal direction.

13) $B_{axis} = \frac{\mu_0}{4\pi} . \frac{2m}{r^3} = B_H$

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

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

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

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

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

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

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.