Magnetism and Matter

CHAPTER 5

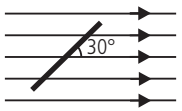
NCERT FOCUS

ANSWERS

Topic 1

1. Torque $\tau = MB \sin\theta$

$4.5 \times 10^{-2} = M\,(0.25 \sin 30°)$

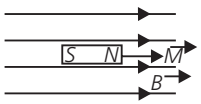


Magnetic dipole moment,

$M = 0.36\ \text{J T}^{-1}$.

2. (a) An equilibrium is stable, if on disturbing the magnet, it comes back to same initial state.

Bar magnet is in stable equilibrium at $\theta = 0°$



Potential energy

$U = -M \cdot B = -MB \cos 0°$

$= -0.32 \times 0.15 = -0.048$ J

(b) A bar magnet is in unstable equilibrium, if on disturbing from its position, it further gets disturb and do not come back to previous position of equilibrium.

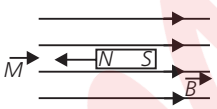
At $\theta = 180°$, the equilibrium is unstable.

Potential energy

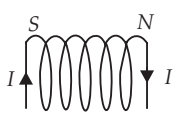
$U = -M.B$

$= -MB \cos 180°$

$= +MB = +0.048$ J



3.



A current carrying closely wound solenoid acts like bar magnet. Each of the turn provide a dipole moment and all turns together provides the dipole moment of the magnet.

Total magnetic moment, $M = NIA$

$= 800 \times 3 \times 2.5 \times 10^{-4} = 0.6\ \text{A m}^2$

4. The solenoid behaves as a bar magnet

so, torque, $\tau = MB \sin\theta$

$\tau = 0.6 \times 0.25 \times \sin 30° = 0.075$ N m.

5. (a) Work required to turn the dipole

$W = MB\,[\cos\theta_i - \cos\theta_f]$

(i) $\theta_i = 0°$ and $\theta_f = 90°$

$W = 1.5 \times 0.22\,[\cos 0° - \cos 90°] = 0.33$ J

(ii) $\theta_i = 0°$ and $\theta = 180°$

$W = 1.5 \times 0.22\,[\cos 0° - \cos 180°] = 0.66$ J

(b) Torque when $\theta = 90°$

$\tau_1 = MB \sin 90° = 0.33$ N m

Torque when $\theta = 180°$

$\tau_2 = MB \sin 180° = 0$

6. (a) Magnetic moment associated with solenoid

$M = NIA = 2000 \times 4 \times 1.6 \times 10^{-4} = 1.28\ \text{A m}^2$

(b) Force on the solenoid will be zero in uniform magnetic field.

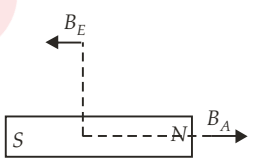
Torque $\tau = MB \sin\theta$

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

or $\tau = 4.8 \times 10^{-2}$ N m

The torque tends to align the solenoid in the direction of magnetic field.

7.



For short magnet

(i) $B_{\text{axial}} = \dfrac{\mu_0}{4\pi}\dfrac{2M}{r^3}$

$B_{\text{axial}} = \dfrac{10^{-7} \times 2 \times 0.48}{(0.1)^3} = 9.6 \times 10^{-5}$ T,

along S – N direction

(ii) B equatorial $= \dfrac{\mu_0}{4\pi}\dfrac{M}{r^3} = 4.8 \times 10^{-5}$ T,

along N – S direction

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