HOME ASSIGNMENT

MAGNETISM AND MATTER

Date: 3rd Sep
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1) No of turns in solenoid - (n) = 800
Area (A) = 2.5×10^{-4} m²
Current (I) = 30 A

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

∴ Hence, the magnetic moment is 0.6 JT^{-1}

2) Magnetic field (B) = 0.25 T
Torque (τ) = 4.5×10^{-2} J
Angle (θ) = 30°

We know,

∴ M = T / B × sin θ

=> $M = \dfrac{4.5 \times 10^{-2}}{0.25 \times \sin 30}$

= 0.36 JT^{-1}

∴ Hence, the magnetic moment of the magnet is 0.36 JT^{-1}.

3) Moment of the Bar Magnet (M) = $0.32 \, JT^{-1}$
External magnetic field (B) = 0.15 T
Angle (θ) = 0° (stable)

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

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

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

(b) Angle (unstable) = 180°

Potential Energy = $-M \cdot B \cdot \cos\theta$

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

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

4) a) magnetic moment (M) = $1.5 \, JT^{-1}$
Magnetic field (B) = 0.22T

i) Initial angle $\theta_1 = 0^\circ$
final angle $\theta_2 = 90^\circ$

The work required (W) = $-MB(\cos\theta_2 - \cos\theta_1)$

$= -1.5 \times 0.22 (\cos 90^\circ - \cos 0^\circ)$
$= -0.33 (0 - 1)$
$= 0.33$ J

(ii) Initial angle between the axis $\theta_1 = 0°$
final Angle $\theta_2 = 180°$

The work required $(W) = -MB(\cos\theta_2 - \cos\theta_1)$

$= -1.5 \times 0.22 (\cos 180° - \cos 0°)$
$= -0.33(-1-1)$
$= 0.66\ J$

(b) for case (i) :-

$\Rightarrow \theta = \theta_2 = 90°$
$\because \tau = MB\sin\theta$

$= MB\sin 90°$
$= 1.5 \times 0.22 \sin 90°$
$= 0.33\ J$

$\therefore$ The torque tends to align the magnitude moment vector along B.

for case (ii)

$\Rightarrow \theta = \theta_2 = 180°$
$\because \tau = MB\sin\theta$

$= 1.5 \times 0.22 \sin 180°$
$= 0\ J$

5) No. of turns (n) = 2000
Area of cross-section (A) = 1.6×10^{-4} m²
current (I) = 4.0 A

(a) Magnetic moment (M) = nAI
= $2000 \times 4 \times 1.6 \times 10^{-4}$
= 1.28 Am²

(b) Magnetic field (B) = 7.5×10^{-2} T
Angle (θ) = 30°
Torque (τ) = MBsinθ

= M·B·sinθ
= $1.28 \times 7.5 \times 10^{-2} \sin 30°$
= 0.048 J

∴ The force on solenoid is zero. The torque on the solenoid is 0.048 J.

6) No. of turns (n) = 16
Radius (r) = 0.1 m
Cross-section (A) = $\pi \times (0.1)^2$ m²
current (I) = 0.75 A
Magnetic field (B) = 5.0×10^{-2} T
frequency (ν) = 2.0 s⁻¹

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

frequency $(\nu) = \frac{1}{2\pi} \times \sqrt{\frac{MB}{I}}$

$\Rightarrow I = \frac{MB}{4\pi^2\nu^2}$

$= \frac{0.377 \times 5 \times 10^{-2}}{4\pi^2 \times (2)^2}$

$= 1.2 \times 10^{-4}$ Kgm² [moment of inertia]

7) Angle of declination (θ) = 12°
Angle of dip, (δ) = 60°
Earth's magnetic field (B_H) = 0.16 G
B and BH as :-

$\Rightarrow B_H = B\cos\delta$

$\because B = \frac{B_H}{B\cos\delta}$

$\Rightarrow \frac{0.16}{\cos 60°} = 0.32G$ [magnitude]

8) Earth's (B) at place (H) = 0.36 G

$\Rightarrow B_1 = \frac{\mu_0 2M}{4\pi d^3} = H \longrightarrow (1)$

Permitiability of free space = μ_0
Magnetic moment = M

$B_2 = \frac{\mu_0 M}{4\pi d^3} = \frac{H}{2} \rightarrow (2)$

$\because$ Total Magnetic field (B) $= B_1 + B_2$

$= H + H/2$

$= 0.36 + 0.18$

$= 0.54\ G$

9) Current in wire (I) = 2.5 A

B at a location $= 0.33 \times 10^{-4}\ T$

Angle of dip $\delta = 0$

Horizontal $B_H = R\cos\theta = 0.33 \times 10^{-4} \cos\theta = 0.33 \times 10^{-4}$

B current carrying Conductor $B_c = \frac{\mu_0}{2\pi} \times \frac{I}{r}$

$$B_c = \frac{4\pi \times 10^{-7}}{2\pi} \times \frac{2.5}{r}$$

$$= \frac{5 \times 10^{-7}}{r}$$

$\Rightarrow B_H = B_c$

$\Rightarrow 0.33 \times 10^{-4} = \frac{5 \times 10^{-7}}{r}$

$\Rightarrow r = \frac{5 \times 10^{-7}}{0.33 \times 10^{-4}}$

$= 0.015\ m$

$= 1.5\ cm$

$\therefore$ Hence, natural points lie on a straight line ∥ to the cable at ⊥ distance = 1.5 cm

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