Magnetism And Matter

NCERT EXERCISE

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5.3 $B = 0.25\,T$, $\tau = 4.5 \times 10^{-2}\,J$

$\tau = MB\sin\theta$

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

5.4 $M = 0.32\,JT^{-1}$

$B = 0.15\,T$

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

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

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

(b) $\theta = 180^\circ$

$\therefore$ Potential energy $= -MB\cos\theta$

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

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

5.5 No. of turns, $n = 800$

Area $= 2.5 \times 10^{-4}$

$I = 3.0\,A$

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

5.7 (a) $M = 1.5\,JT^{-1}$

$B = 0.22\,T$

(i) $\theta_1 = 0^\circ$ and $\theta_2 = 90^\circ$

$W = -MB(\cos\theta_2 - \cos\theta_1) = -1.5 \times 0.22(\cos 90^\circ - \cos 0^\circ)$

$= -0.33(0-1) = 0.33\,J$

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(ii) $\theta_1 = 0^\circ$ and $\theta_2 = 180^\circ$

$W = -MB(\cos\theta_2 - \cos\theta_1)$

$= -1.5 \times 0.22 (\cos 180^\circ - \cos 0^\circ)$

$= -0.33(-1-1)$

$= 0.66\ J$

(b) $\theta = \theta_2 = 90^\circ$

Torque $= MB\sin\theta = 1.5 \times 0.22 \sin 90^\circ = 0.33 J$

Case (ii) $\theta = \theta_2 = 180^\circ$

Torque, or $\tau = MB\sin\theta = MB\sin 180^\circ = 0 J$

5.8 No. of turns, $n = 2000$

$A = 1.6 \times 10^{-4}\ m^2$

$I = 4A$

(a) $M = nAI = 2000 \times 1.6 \times 10^{-4} \times 4 = 1.28\ Am^2$

(b) $B = 7.5 \times 10^{-2}\ T$

$\theta = 30^\circ$

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

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

5.9 No. of turns, $N = 16$

$r = 10\ cm = 0.1 m$

$A = \pi r^2 = \pi \times (0.1)^2\ m^2$.

$I = 0.75 A$

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

$\therefore$ Magnetic moment $(M) = NIA = nI\pi r^2 = 16 \times 0.75 \times \pi r^2$

$= 0.377\ JT^{-1}$

Frequency,

$$\nu = \frac{1}{2\pi}\sqrt{\frac{MB}{I}}$$

$$I = \frac{MB}{4\pi^2\nu^2} = \frac{0.377 \times 5 \times 10^{-2}}{4\pi^2 \times (2)^2} = 1.19 \times 10^{-4}\ kg\,m^2$$

$\therefore$ Moment of Inertia $= 1.19 \times 10^{-4}\ kg\,m^2$

5.11 $\theta = 12°$

$\delta = 60°$

$B_H = 0.16\ G$

Earth's magnetic field at the given location $= B$

$B_H = B\cos\delta$

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

5.13 $H = 0.36\ G$

$$B_1 = \frac{\mu_0\, 2M}{4\pi\, d^3} = H$$

μ_0 = Permeability of free space

M = Magnetic moment

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

$\therefore$ Total magnetic field, $B = B_1 + B_2$

$= H + H/2 = 0.36 + 0.18 = 0.54\ G$

5.18 $I = 2.5\,A$

$\delta = 0^\circ$

$H = 0.33\,G = 0.33 \times 10^{-4}\,T$

$H_H = H \cos \delta$

$= 0.33 \times 10^{-4} \times \cos 0^\circ = 0.33 \times 10^{-4}\,T$

$$H_H = \frac{\mu_0 I}{2\pi R}$$

$$R = \frac{\mu_0 I}{2\pi H_H} = \frac{4\pi \times 10^{-7} \times 2.5}{2\pi \times 0.33 \times 10^{-4}} = 15.15 \times 10^{-3}\,m = 1.51\,cm$$