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Magnetism and Matter:

3) $\theta = 30^\circ$

$B = 0.25\ T$

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

$\tau = MB\sin\theta$

$M = \dfrac{\tau}{B\sin\theta}$

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

$= 0.36\ JT^{-1}$

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

$B = 0.15\ T$

i) For stable equilibrium $\theta = 0^\circ$

$U = -MB\cos\theta$

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

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

ii) For unstable oquilibrium $\theta = 180^\circ$

$U = -MB\cos\theta$

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

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

5) $n = 800$

$A = 2.5 \times 10^{-4}\ m^2$

$I = 3\ A$

A current carrying solenoid acts as a bar magnet because a magnatic field develops along the axis.

$M = IAn$

$= 800 \times 3 \times 2.5 \times 10^{-4}$

$= 0.6\ JT^{-1}$

7) $m = 1.5\ JT^{-1}$

$B = 0.22\ T$

a) i) $\theta_1 = 0°$

$\theta_2 = 90°$

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

$= -1.5 \times 0.22\ (\cos 90° - \cos 0°)$

$= 0.33\ J$

ii) $\theta_1 = 0°$

$\theta_2 = 180°$

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

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

$= 0.66\ J$

b) case 1 : $\tau = MB\sin\theta$ $[\theta = 90°]$

$= 1.5 \times 0.22 \times \sin 90°$

$= 0.33\ J$

case 2 : $\tau = MB\sin\theta$ $[\theta = 180°]$

$= 1.5 \times 0.22 \times \sin 180°$

$= 0$

8) $n = 2000$

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

$I = 4A$

a) $M = nIA$

$= 2000 \times 4 \times 1.6 \times 10^{-4}$

$= 1.28\ Am^2$

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

$\theta = 30^\circ$

$\tau = MB\sin\theta$

$= 1.28 \times 7.5 \times 10^{-3} \sin 30^\circ$

$= 0.048\ J$

9) $N = 16$

$r = 10cm = 0.1m$

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

$I = 0.75A$

$B = 5.0 \times 10^{-2}\ T$

$\nu = 2.0\ s^{-1}$

$M = NIA = NI\pi r^2$

$= 16 \times 0.75 \times (0.1)^2 \pi$

$= 0.377\ JT^{-1}$

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

$$I = \frac{MB}{4\pi^2 \nu^2} = \frac{0.377 \times 5 \times 10^{-2}}{4\pi^2 \times 2^2} = 1.2 \times 10^{-4}\ kg\ m^2$$

11) $\theta = 12°$

Angle of dip $= 60°$ (I)

$B_H = 0.16\ G$

$B_H = B \cos I$

$\therefore B = \frac{B_H}{\cos I}$

$= \frac{0.16}{\cos 60°}$

$= 0.32\ G$

13) $H = 0.36\ G$

$B_{axis} = \frac{\mu_0}{4\pi} \frac{2m}{d^3} = H$ — (1)

$B_{equatorial} = \frac{\mu_0}{4\pi} \frac{m}{d^3} = \frac{H}{2}$

$B = B_{axis} + B_{equatorial}$

$= H + \frac{H}{2}$

$= 0.36 + 0.18$

$= 0.54\ G$

18) $I = 2.5A$

Earth's magnetic field at a location $R = 0.33\,G = 0.33 \times 10^{-4}\ T$

$I = 0$

$B_H = R \cos I$

$= 0.33 \times 10^{-4} \times \cos 0°$

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

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

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

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

$$B_H = B_c$$

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

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

$$\Rightarrow r = 0.015\,m$$

$$= 1.5\,cm$$