H.W

CH - 5

Magnetism and Matter

Date 1.9.21

3) $B = 0.25\ T$

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

$\phi = 30^\circ$

$\tau = mB\sin\phi$

$m = \frac{\tau}{B\sin\phi} = \frac{4.5 \times 10^{-2}}{0.25 \times \sin 30^\circ} = 0.36\ J/T$

4) $M = 0.32\ J/T$

$B = 0.15\ T$

a) magnetic field is 0°

P.E of the system $= -mB\cos\phi$

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

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

b) $\phi = 180^\circ$

$P.E = -mB\cos\phi$

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

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

5) $n = 800$, $A = 2.5 \times 10^{-4}\ m^2$, $I = 3.0A$

$M = nIA$

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

$= 0.6\ J/T$

7) a) $M = 1.5\ J/T$, $B = 0.22\ T$

i) $\phi_1 = 0^\circ$

$\phi_2 = 90^\circ$

$W = -MB(\cos\phi_2 - \cos\phi_1)$

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

$= 0.33(0-1)$

$= 0.33\ J$

ii) $\phi_1 = 0^\circ$

$\phi_2 = 180^\circ$

$W = -MB(\cos\phi_2 - \cos\phi_1)$

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

$= -0.33(-1-1)$

$= +0.66\ J$

b) i) $\phi = \phi_2 = 90^\circ$

$T = MB\sin\phi = MB\sin 90^\circ$

$= 1.5 \times 0.22 \sin 90^\circ$

$= 0.33\ J$

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For Case(ii),

$\phi = \phi_2 = 180^\circ$

$\tau = MB\sin\phi = MB\sin 180^\circ$
$= 0$

8) $n = 2000,\ A = 1.6\times10^{-4}m^2,\ I = 4.0\,A$

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

b) $B = 7.5\times10^{-2}T,\ \phi = 30^\circ$

$\tau = MB\sin\phi$
$= 1.28 \times 7.5 \times 10^{-2}\sin 30^\circ$
$= 0.048\ J$

∴ Since the magnetic field is uniform, the force on the solenoid is zero. The torque on the solenoid is 0.048 J

9.) $N = 16,\ R = 10cm = 0.1m,\ A = \pi R^2 = \pi\times(0.1)^2 m^2$
$I = 0.75A,\ B = 5.0\times10^{-2}T,\ \nu = 2.0\ s^{-1}$

$M = NIA = NI\pi R^2 = 16\times0.75\times\pi\times(0.1)^2$
$= 0.377\ J/T$

$\nu = \frac{1}{2\pi}\sqrt{\frac{MB}{I}} \Rightarrow I = \frac{MB}{4\pi^2\nu^2} = \frac{0.377\times5\times10^{-2}}{4\pi^2\times(2)^2}$
$= 1.2\times10^{-4}\,kg\,m^2$

∴ Axis of rotation
$= 1.19\times10^{-4}\,kg\,m^2$

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11) $\phi = 12°$, $\delta = 60°$, $B_H = 0.16\,G$

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

Earth's magnetic field lies in the vertical plane, 12° west of the geographic meridian, making an angle of 60° (upwards) with the horizontal direction. Its magnitude is 0.32 G.

13) $H = 0.36\,G$

$$B_1 = \frac{\mu_0 2M}{4\pi d^3} = H \quad \text{— (i)}$$

μ_0 - Permeability of free space

M = magnetic moment

$$B_2 = \frac{\mu_0 M}{4\pi d^3} = \frac{H}{2} \quad [\text{using eq (i)}]$$

Total $\rightarrow B = B_1 + B_2 = H + \frac{H}{2}$

$= 0.36 + 0.18$

$= 0.54\,G$

18.) Current in the wire = 2.5 A
The earth's magnetic field at a location $R = 0.33\,G$
$= 0.33 \times 10^{-4} T$
Angle of dip is zero, $\delta = 0$

$B_H = R\cos\delta = 0.33 \times 10^{-4} \cos 0$
$= 0.33 \times 10^{-4} T$

$B_C = (\mu_0/2\pi) \times (I/r)$
$= (4\pi \times 10^{-7}/2\pi) \times (2.5/r)$
$= (5 \times 10^{-7}/r)$

$B_H = B_C$
$0.33 \times 10^{-4} = 5 \times 10^{-7}/r$

$r = \frac{5 \times 10^{-7}}{0.33} \times 10^{4}$
$= 0.015\,m$
$= 1.5\,cm$