Magnetism & Matter

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(3) $\theta = 30^\circ$ $B = 0.25T$ $\tau = 4.5 \times 10^{-2} J$ $m = ?$

$\tau = mB\sin\theta$

$m = \frac{B\sin\theta}{\tau} = \frac{0.25 \times \sin 30^\circ}{4.5 \times 10^{-2}} = \frac{25 \times 1}{450 \times 2 \times 10^{-2}}$ $= \frac{100}{18 \times 2}$

$m = \frac{\tau}{B\sin\theta} = \frac{4.5 \times 10^{-2}}{0.25 \times \sin 30^\circ}$

$= \frac{450 \times 10^{-2} \times 2}{25} = 0.36\ JT^{-1}$ Ans

(4) $m = 0.32\ JT^{-1}$ $B = 0.15T$

a) Stable equilibrium when $\vec{m}$ is paralle to $\vec{B}$ $\theta = 0^\circ$

$U_{min} = -mB\cos\theta = -0.32 \times 0.15 \times (1) = -4.8 \times 10^{-2} J$

b) Unstable equilibrium when $\vec{m}$ and $\vec{B}$ are antiparalle

$U_{max} = -mB\cos(180^\circ) = -0.32 \times 0.15 \times (-1) = +4.8 \times 10^{-2} J$

(5) $N = 800$ $A = 2.5 \times 10^{-4} m^2$ $I = 3A$

$m = NIA = 800 \times 3 \times \frac{25}{10} \times 10^{-4} = 0.60\ JT^{-1}$

The magnetic field of a solenoid has the same pattern as that of a bar magnet. It acts along the axis of the solenoid.

(7) $m = 1.5\ JT^{-1}$ $B = 0.22T$

a) i) normal to the field direction

$\theta_1 = 0^\circ$ $\theta_2 = 90^\circ$ $W = -mB(\cos\theta_2 - \cos\theta_1)$

$= -1.5 \times 0.22 \times (0 - 1)$

$= +0.33 J$ Ans

$\tau = mB\sin\theta = 1.5 \times 0.22 = 0.33 Nm$ Ans

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

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

$= -0.33 \times (-1-1) = 0.66 J$ Ans

$\tau = mB\sin 180^\circ = 1.5 \times 0.22 \times 0 = 0$ Ans

(9) $N = 16$ $\quad r = 10\text{ cm} = 0.1\text{ m}$ $\quad I = 0.75\text{ A}$ $\quad B = 5 \times 10^{-2}\text{ T}$ $\quad v = 2\text{ s}^{-1}$

$m = NIA = 16 \times \frac{75}{100} \times \pi r^2$ $\qquad \nu = \frac{1}{2\pi}\sqrt{\frac{mB}{I}}$

$I = \frac{mB}{4\pi^2 \nu^2} = \frac{NIAB}{4\pi^2\nu^2}$

$= \frac{NI\pi r^2 \cdot B}{4\pi^2 \nu^2}$

$= \frac{16 \times 0.75 \times (0.1)^2 \times 5\times10^{-2}}{4 \times 3.14 \times 4} = 1.2 \times 10^{-4}\text{ kg m}^2$ Ans

(13) $B = 0.36\text{ G}$ $\qquad B_{axial} = \frac{\mu_0}{4\pi}\frac{2m}{r^3} = B_H$

$B_{equ} = \frac{\mu_0}{4\pi}\frac{m}{r^3} = \frac{B_H}{2} = \frac{0.36}{2} = 0.18\text{ G}$

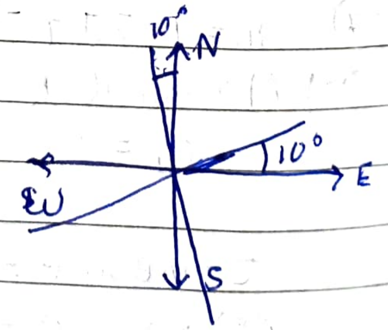
$B_{equ} + B_H = 0.18 + 0.36 = 0.54\text{ G}$ Ans

(11) $\delta = 60^\circ$ $\qquad B_H = 0.16\text{ G}$

$B = \frac{B_H}{\cos\delta} = \frac{0.16}{1} \times 2 = 0.32\text{ G}$ Ans

lies in a vertical plane 12° west of the geographic meridian making an angle of 60° with the horizontal.

(18) $I = 2.5\text{ A}$ $\qquad B = 0.33\text{ G}$



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

$r = \frac{\mu_0 I}{2\pi B_H} = \frac{4\pi \times 10^{-7} \times 2.5}{2\pi \times 0.33 \times 10^{-4}}$

$r = 1.5 \times 10^{-2}\text{ m} = 1.5\text{ cm}$ Ans

neutral point lie parallel to and above the cable at a distance of 1.5 cm from it.