Magnetism And Matter

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

$\tau = MB\sin\theta \Rightarrow M = \frac{\tau}{B\sin\theta}$

$\Rightarrow M = \frac{4.5 \times 10^{-2}}{0.25 \times \sin 30} = 0.36\,JT^{-1}$

4) $M = 0.32\,JT^{-1}$ $\quad B = 0.15\,T$

a) For stable equilibrium, the angle betⁿ magnetic moment $\vec{m}$ & magnetic field $\vec{B}$, $\theta = 0^\circ$
Potential energy, $U = -MB\cos\theta$
$= -0.32 \times 0.15 \times 1 = -4.8 \times 10^{-2}\,J$

b) For the unstable equilibrium, the angle betⁿ $\vec{m}$ & $\vec{B}$, $\theta = 180^\circ$ & potential energy will be maximum,
i.e $U = -MB\cos 180 = -0.32 \times 0.15 \times (-1)$
$= 4.8 \times 10^{-2}\,J$

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

$M = NIA = 800 \times 3 \times 2.5 \times 10^{-4} = 0.6\,J/T$

By using maxwell's right hand ~~thumb~~ grip rule, the magnetic field is along the axis of solenoid.

8) $N = 2000$ $\quad A = 1.6 \times 10^{-4}\,m^2$ $\quad I = 4\,A$

a) Magnetic moment associated with Solenoid,
$M = NIA = 2000 \times 4 \times 1.6 \times 10^{-4}$
$= 1.28\,J/T$

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6) Net force on solenoid is 0.

$\tau = MB\sin\theta = 1.28 \times 1.5 \times 10^{-2} \times \sin 30$
$= 0.048\ N\ m$

This torque tends to allign the axis of the solenoid along the field $\vec{B}$.

9) $N = 16$ $r = 10cm = 0.1m$ $I = 0.75A$
$B = 5 \times 10^{-2} T$ $f = 2.0 s^{-1}$

Magnetic moment of coil, $M = nIA = 16 \times 0.75 \times \pi(0.1)^2$
$= 0.377\ J/T$

frequency of oscillation, $f = \frac{1}{2\pi}\sqrt{\frac{mB}{I}}$

Moment of Inertia, $I = \frac{mB}{4\pi^2 f^2} = \frac{0.377 \times 5 \times 10^{-2}}{4 \times 3.14 \times 3.14 \times 2 \times 2}$

$= 1.2 \times 10^{-4}\ kg\ m^2$

11) angle of declination, $\theta = 12°$ west

$\delta = 60°$ $B_H = 0.16G$

$\therefore B = \frac{B_H}{\cos\delta} = \frac{0.16}{\cos 60} = \frac{0.16 \times 2}{1} = 0.32\ G$

The earth's magnetic field lies in a vertical plane 12° west of geographical meridian at an angle 60° above the horizontal.

13) As the null points lies on the axis of the magnets, therefore

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$B_{axial} = \frac{\mu_0}{4\pi} \cdot \frac{2m}{r^3} = B_H$

Magnetic field of the magnet on its normal bisector at the same distance will be

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

Total magnetic field at the required point on the normal bisector is

$B_{equa} + B_H = 0.18 + 0.36 = 0.54\ G$

18) Suppose the neutral point lies at a distance r from the cable. Then at the neutral point,

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

or $r = \frac{\mu_0 I}{2\pi B_H} = \frac{4\pi \times 10^{-7} \times 2.5}{2\pi \times 0.33 \times 10^{-4}} = 1.5 \times 10^{-2} m = 1.5 cm$

As the direction of the magnetic field of the cable is opp to that of $\vec{B}_H$ at point above the cable, so the line of neutral point lies parallel to and above the cable at a distance of 1.5cm from it.