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3) $B = 0.25 T$
$T = 4.5 \times 10^{-2} J$

Angle between the bar magnet and the external magnetic field 30°

Torque is related to (M) as

$T = MB \sin\theta$

$\therefore M = \frac{T}{B \sin\theta}$

$= \frac{4.5 \times 10^{-2}}{0.25 \times \sin 30^\circ} = 0.36 \, J T^{-1}$

4) $M = 0.36 J T^{-1}$
$B = 0.15 T$

a) The angle between bar magnet and magnetic field θ is 0. $\theta = 0°$

Potential energy $= -MB \cos\theta$
$= -0.32 \times 0.15 \cos 0°$
$= -4.8 \times 10^{-2} J$

b) $\theta = 180°$

Potential energy $= -MB \cos\theta$
$= -0.32 \times 0.15 \cos 180°$
$= 4.8 \times 10^{-2} J$

5) $n = 800$ (no. of turns)
$A = 2.5 \times 10 \, m^2$
$I = 3 A$

The magnetic moment associated with the given current carrying solenoid

$M = nIA$
$= 0.6 J T^{-1}$

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8) $n = 2000$
$A = 1.6 \times 10^{-4} m$
$I = 4A$

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

b) $\theta = 30^\circ$
Torque $\tau = MB \sin\theta$
$= 1.28 \times 7.5 \times 10^{-2} \sin 30^\circ$
$= 4.8 \times 10^{-2}$ Nm

Since the magnetic field is uniform, the force on the solenoid is zero. The torque on the solenoid is 4.8×10^{-2} Nm.

9) $N = 16$
$r = 10cm = 0.1m$
$A = \pi r^2 = \pi (0.1)^2 m^2$
$I = 0.75A$
$B = 5 \times 10^{2}$ T
$\nu = 2.0 s^{-1}$
$M = NIA = NI\pi r^2$
$= 16 \times 0.75 \times \pi \times (0.1)^2$
$= 0.377 \ JT^{-1}$

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

where

I = moment of the inertia of the coil

$$\therefore I = \frac{MB}{4\pi^2 \nu^2}$$

$$= \frac{0.377 \times 5 \times 10^{-2}}{4\pi^2 \times (2)^2}$$

$= 1.19 \times 10^{-1}$ Kg m^2

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11) $\theta = 12^\circ$ (Angle of declination)
Angle of dip = $\delta = 60^\circ$

$B_H = 0.16G$ (Horizontal component)
Earth's magnetic field = B
$B_H = B\cos\delta$
$\therefore B = \frac{B_H}{\cos\delta}$
$= \frac{0.16}{\cos 60^\circ} = 0.32\ G$

13) $H = 0.36G$
Distance of magnetic field = d
μ_0 = permeability of free space
M = Magnetic moment

$B_2 = \frac{\mu_0 M}{4\pi d^3} = \frac{H}{2}$ (using equation (1))
Total magnetic field $B = B_1 + B_2$
$H + \frac{H}{2}$

$= 0.36 + 0.18 = 0.54G$
Hence, the magnetic field is 0.54 G in the direction of earth's magnetic field.

18) $I = 2.5A$
$\delta = 0^\circ$
$H = 0.33G = 0.33 \times 10^{4}\ T$
$H_H = H\cos\delta$
$= 0.33 \times 10^{-4} \times \cos 0^\circ = 0.33 \times 10^{-4}$
The magnetic field at neutral point = R
$R = \frac{\mu_0 I}{2\pi H_H} = \frac{4\pi \times 10^{-7} \times 2.5}{2\pi \times 0.33 \times 10^{-4}} = 15.15 \times 10^{-3} = 1.51 cm$