CH-5

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

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

5.4) $M = 0.32\ J\,T^{-1}$
$B = 0.15\ T$

(a) Stable equilibrium i.e. $\theta = 0$
Potential energy $= -MB\cos\theta$
$= -(0.32 \times 0.15 \cos 0^\circ)$
$= -4.8 \times 10^{-2}\ J$

(b) Unstable equilibrium i.e. $\theta = 180^\circ$
Potential Energy $= -MB\cos\theta$
$= -(0.32 \times 0.15 \cos 180^\circ)$
$= -4.8 \times 10^{-2}\ J$

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

$M = nIA$
$= 800 \times 3 \times 2.5 \times 10^{-4} = 0.6\ A\,m^2$

5.7) $M = 1.5\ J\,T^{-1} \quad B = 0.22\ T$
initial angle $\Rightarrow \theta = 0^\circ$
(i) $\theta_1 = 90^\circ$
$W = -MB(\cos\theta_1 - \cos\theta)$
$= -1.5 \times 0.22\ (\cos 90^\circ - \cos 0^\circ)$
$= +0.33\ J$

(ii) $\theta_2 = 180^\circ$

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

$= -1.5 \times 0.22 (\cos 180 - \cos 0^\circ)$ $(-1, 1)$

$= 0.66\ J$

(b) (i) $\theta = 90^\circ$

$\gamma = MB\sin\theta$

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

$= 0.33\ J$

(ii) $\theta = 180^\circ$

$\gamma = MB\sin 180^\circ$

$= 0$

5.8) $n = 2000$ $A = 1.6 \times 10^{-4}\ m^2$ $I = 4A$

(a) $M = nIA$

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

$= 1.28\ Am^2$

(b) $B = 7.5 \times 10^{-2}\ T$ $\theta = 30^\circ$

$\gamma = MB\sin\theta$

$= 1.28 \times 7.5 \times 10^{-2} \times \sin 30^\circ$

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

5.9) $n = 16$ $r = 10\ cm = 0.1\ m$

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

$I = 0.75A$ $B = 5 \times 10^{-2}\ T$

$M = nIA$

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

$= 0.377\ JT^{-1}$

Frequency given by the relation:

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

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

$$= \frac{0.377 \times 3 \times 10^{-3}}{4\pi^2 \times 2^2}$$

$$= 1.19 \times 10^{-4}\ kg\,m^2$$

5.11) $I = 60^\circ \quad B_H = 0.16\ G \quad \theta = 12^\circ$

$$B_H = B_E \cos 60^\circ$$

$$B_E = \frac{0.16}{1/2} = 0.32\ G$$

5.13) $H = 0.36\ G$

$$B_1 = \frac{\mu_0}{4\pi}\frac{2M}{d^3} = H \quad \text{— (1)}$$

$$B_2 = \frac{\mu_0 M}{4\pi d^3} = \frac{H}{2}$$

total magnetic field (B) $= B_1 + B_2 + B_3$

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

$$= 0.36 + 0.18 = 0.54\ G$$

5.18) $I = 2.5\ A \quad H = 0.33\ G = 0.33 \times 10^{-4}\ T \quad \theta = 0^\circ$

$$B_H = H \cos I$$

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

B at neutral point

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

$$\Rightarrow R = \frac{4\pi \times 10^{-7} \times 2.5}{2\pi \times 0.33 \times 10^{-4}} = 1.51\ cm$$