MT03 Solution (PHYS 205B, 2015 Spring)

prob. 1, MT03

$$\vec{F} = \vec{F}_E + \vec{F}_B$$

$$\vec{F}_E = q\vec{E} = (3.20\times10^{-19})(4\hat{i} - \hat{j} - 2\hat{k}) \text{ N}$$

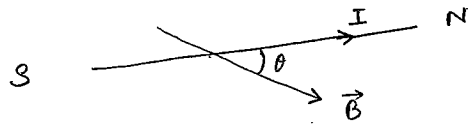
$$\vec{F}_B = q\,\vec{v}\times\vec{B} = (3.20\times10^{-19})\left[(3\times1 + 4\times1)\hat{i} - (2\times1 + 2\times1)\hat{j} + (2\times4 - 2\times3)\hat{k}\right] \text{ N}$$

$$= (3.20\times10^{-19})\left[7\hat{i} - 4\hat{j} + 2\hat{k}\right] \text{ N}$$

$$\vec{F} = \vec{F}_E + \vec{F}_B = (3.20\times10^{-19})\left[11\hat{i} - 5\hat{j} + 0\,\hat{k}\right] \text{ N}$$

$$= \left(35.2\times10^{-19}\,\hat{i} - 16.0\times10^{-19}\,\hat{j} + 0\,\hat{k}\right) \text{ N}$$

prob. 2, MT03



$\theta = 72°$

⊙ East

$$F = |I\vec{L}\times\vec{B}|$$

$$= I L B \sin\theta$$

$$= (6000\,A)(160\,m)(60.0\times10^{-6}\,T)\sin 72$$

$$= 54.78 \text{ N}$$

direction = West (into the page in figure)

prob. 3, MT03

(Ampere's law)

$$\oint \vec{B}\cdot d\vec{l} = \mu_0 I_{enclosed}$$

$$= \mu_0 (5A - 3A)$$

$$= 4\pi\times10^{-7}\times 2$$

$$= 8\pi\times10^{-7} \text{ Tm}$$

$$= 2.51\times10^{-6} \text{ Tm}$$

prob. 4, MT03

(a) positive

(b) circle.

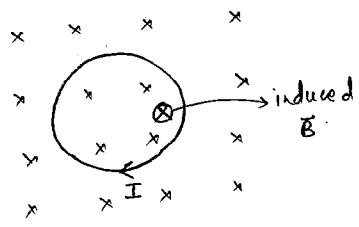
prob. 5, MT03

$$\vec{B} = -\frac{\mu_0 I}{4\pi R}\,\theta\,\hat{z} + \frac{\mu_0 I}{2\pi R}\,\frac{1}{2}\,\hat{z} + \frac{\mu_0 I}{2\pi R}\,\frac{1}{2}\,\hat{z}$$

$$= \frac{\mu_0 I}{4\pi R}\,(2-\theta)\,\hat{z}$$

$\vec{B} = 0 \Rightarrow \theta = 2$ radian $= 114.6$ deg.

prob. 6, MT03



(a) I is clockwise if the $\vec{B}$ is pointing into the page.

(b) $\Phi_B = BA = B\pi R^2$

$$V_{eff} = -\frac{d}{dt}\Phi_B = -\pi B \frac{d}{dt} R^2$$

$$= -\pi B\, 2R \frac{dR}{dt}$$

$$= -3.14 \times (0.600\,T)\; 2 \times (13\times10^{-2}\,m)\,(72\times10^{-2}\,\tfrac{m}{s})$$

$$= -0.353\,V$$

↳ sign not relevant in the problem.

prob. 7, MT03

(a) increasing

(b) anti clockwise

(c) $IR = -\frac{d}{dt}(BA)$

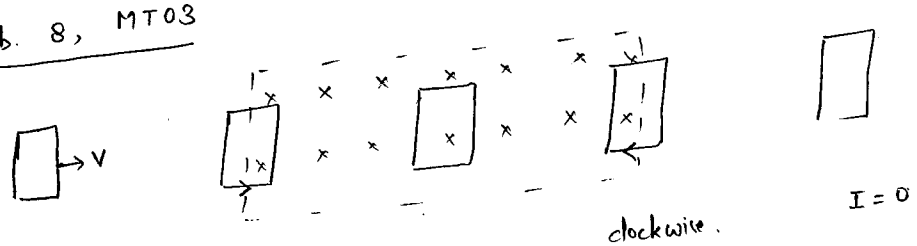
$= -BLV$

$I = \frac{BLV}{R}$

$= \frac{1.2\,T \times (10\times10^{-2}\,m) \times 5\,\frac{m}{s}}{0.40}$

$= 1.5\,A$

prob. 8, MT03



I=0 anticlockwise I=0 clockwise. I=0

prob. 9, MT03

$V_{eff} = BLv = 0.50\times10^{-4}\,T \times 1.7\,m \times \frac{75\times10^{3}}{60\times60}\,\frac{m}{s}$

$= 1.77\,mV$

prob. 10, MT03

$I(t) = I_0\left(1 - e^{-\frac{t}{\tau}}\right)$

$1 - e^{-\frac{t}{\tau}} = \frac{I(t)}{I_0}$

$e^{-\frac{t}{\tau}} = 1 - \frac{I}{I_0}$

$t = -\tau \ln\left(1 - \frac{I}{I_0}\right)$

$\tau = -\frac{t}{\ln\left(1-\frac{I}{I_0}\right)} = -\frac{3.30\,sec}{\ln\left(1-\frac{1}{3}\right)} = \frac{3.30\,sec}{\ln\left(\frac{3}{2}\right)} = 8.14\,sec.$