MT03 PHYS 205B Spring 2016

Solutions

Prob. 1

$$\vec{F} = q\,\vec{v}\times\vec{B}$$

$$= (-1.6\times10^{-19}\,C)\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2.1\times10^{6}\,\frac{m}{s} & 2.7\times10^{6}\,\frac{m}{s} & 0 \\ 0.03\,T & -0.15\,T & 0 \end{vmatrix}$$

$$= (-1.6\times10^{-19}\,C)\;\hat{k}\left[-2.1\times10^{6}\times0.15 - 0.03\times2.7\times10^{6}\right] T\,\frac{m}{s}$$

$$= \hat{k}\,(1.6\times10^{-19})\times10^{6}\left[2.1\times0.15 + 0.03\times2.7\right] N$$

$$= \hat{k}\;6.3\times10^{-14}\;N$$

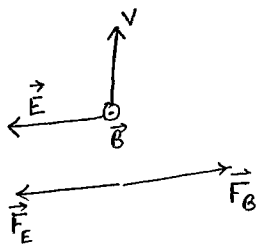
Prob. 2

$$F_E = F_B$$

$$\cancel{q}E = \cancel{q}vB$$

$$v = \frac{E}{B} = \frac{1.52\times10^{3}\,\frac{V}{m}}{0.375\,T}$$

$$= 4.05\times10^{3}\,\frac{m}{s}$$



Prob. 3

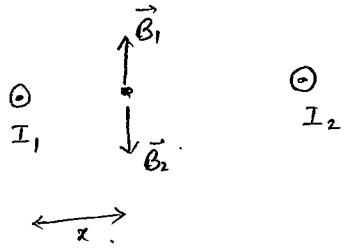
$$\vec{F} = I\,\vec{L}\times\vec{B}$$

$$= I\,y\,\hat{j}\times\hat{k}\;B\,(-1)$$

$$= -\hat{i}\;IBy\,.$$

$\hat{j}\times\hat{k}$

Prob. 4



$$|\vec{B}_1| = |\vec{B}_2|$$

$$\frac{\mu_0 I_1}{2\pi x} = \frac{\mu_0 I_2}{2\pi (D-x)}$$

$$D - x = x \frac{I_2}{I_1}$$

$$D = x\left(1 + \frac{I_2}{I_1}\right)$$

$$10.0\,\text{cm} = x\left(1 + \frac{6.0}{2.0}\right) \Rightarrow x = 2.50\,\text{cm}$$

Prob. 5

At the origin:

$$\vec{B}_1 = -\hat{i}\,\frac{\mu_0 I_1}{2\pi y} + 0\,\hat{j}$$

$$= -\hat{i}\,\frac{4\pi \times 10^{-7} \times 3.0}{2\pi \times 8.0 \times 10^{-2}} + 0\,\hat{j}$$

$$= -\hat{i}\; 7.5 \times 10^{-6}\,\text{T} + 0\,\hat{j}$$

$$\vec{B}_2 = 0\,\hat{i} + \frac{\mu_0 I_2}{2\pi x}\,\hat{j}$$

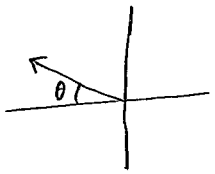
$$= 0\,\hat{i} + \frac{4\pi \times 10^{-7} \times 2.0}{2\pi \times 12 \times 10^{-2}}\,\hat{j}$$

$$= 0\,\hat{i} + 3.3 \times 10^{-6}\,\text{T}\,\hat{j}$$

$$\vec{B}_{tot} = \vec{B}_1 + \vec{B}_2$$

$$= -\hat{i}\; 7.5 \times 10^{-6}\,\text{T} + \hat{j}\; 3.3 \times 10^{-6}\,\text{T}$$

$$|\vec{B}_{tot}| = \sqrt{(7.5 \times 10^{-6})^2 + (3.3 \times 10^{-6})^2} = 8.2 \times 10^{-6}\,\text{T}$$



$$\theta = \tan^{-1}\left(\frac{3.3 \times 10^{-6}}{7.5 \times 10^{-6}}\right) = 23.8^\circ \quad \text{(clockwise w.r.t. } -\hat{i}\text{)}$$

Prob. 6

$$F = l \frac{\mu_0 I_1 I_2}{2\pi a}$$

$$= \frac{\cancel{10.0\ cm}^{2}}{\cancel{2\pi}} \frac{\cancel{4\pi} \times 10^{-7} (2.0)(1.0)}{\cancel{5.0\ cm}} = 8.0 \times 10^{-7}\ N$$

direction
- towards I_2
- attractive.

Prob. 7

$$\Phi_{square} = B A_{square}$$

$$\Phi_{circle} = B A_{circle}.$$

Since the loop is deformed we have

$$4L = 2\pi R$$

$$\frac{L}{R} = \frac{\pi}{2}$$

$$\frac{\Phi_{square}}{\Phi_{circle}} = \frac{\cancel{B} L^2}{\cancel{B} \pi R^2}$$

$$= \frac{1}{\pi} \left(\frac{L}{R}\right)^2$$

$$= \frac{1}{\pi} \left(\frac{\pi}{2}\right)^2 = \frac{\pi}{4}.$$

Prob. 8

(a) Increasing

(b) anti clockwise

(c) $I = \frac{BLv}{R} = \frac{1.2 \times (10.0 \times 10^{-2})(5.0)}{0.40}$

$$= 1.5\ A.$$

Prob. 9

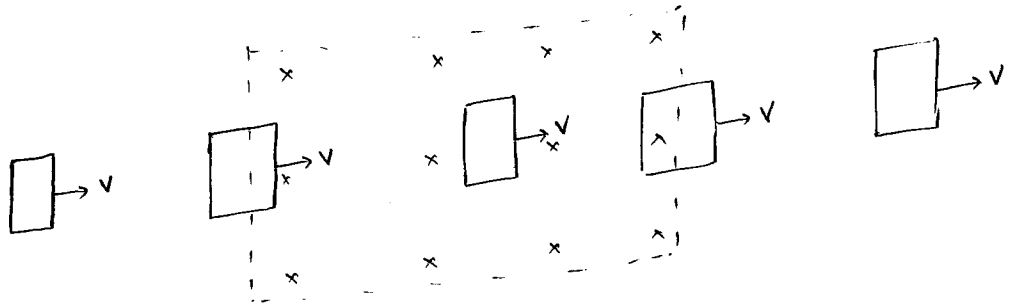
$$V = -\frac{d}{dt} B A \cos\omega t \qquad A = \frac{\pi a^2}{2}.$$

$$= B A \omega \sin\omega t$$

$$V_{max} = B A \omega = B \frac{\pi a^2}{2} \omega = (0.1)\ \frac{\pi \left(10.0\times10^{-2}\right)^2}{2}\ 600\ \frac{\text{rev.}}{\text{min}}\ \frac{2\pi\ \text{rad.}}{1\ \text{rev}}\ \frac{1\ \text{min}}{60\ \text{s.}}$$

$$= (0.1)\ \pi\ 3\ \frac{2\pi}{60} = 9.8\times10^{-2}\ \text{V}$$

Prob. 10



I = 0 anti clockwise I = 0 clockwise I = 0