

# (Solutions to Midterm Exam 03, PHYS 203B, Fall 2015)

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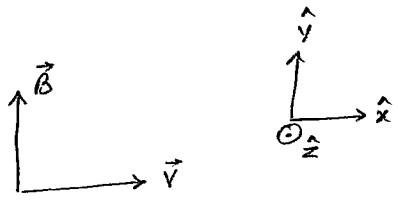
Prob. 1

$$F = qvB \sin \theta$$

$$= 1.6 \times 10^{-19} \times 4.0 \times 10^6 \times 0.20 \times \sin 90$$

$$= 1.28 \times 10^{-13} \text{ N}$$

direction:  $-\hat{z}$



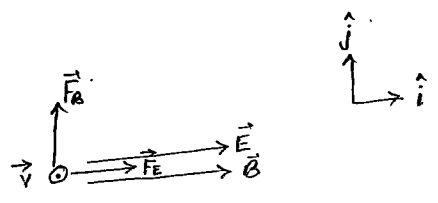
Prob. 2

$$\omega = \frac{q}{m} B \quad f = \frac{1}{2\pi} \frac{q}{m} B$$

$$= \frac{1.6 \times 10^{-19} \times 0.50}{2\pi \times 9.1 \times 10^{-31}} = 1.4 \times 10^{10} \frac{\text{times}}{\text{second}}$$

Prob. 3

Let  $\vec{E}$  and  $\vec{B}$  be along  $\hat{i}$ .  
Let  $\vec{v}$  be along  $\hat{k}$ .



$$\vec{F}_E = q \vec{E}$$

$$= 2.0 \times 10^{-6} \text{ C} \times 6.00 \times 10^3 \frac{\text{N}}{\text{C}} \hat{i} = 12 \text{ mN } \hat{i}$$

$$\vec{F}_B = qvB \hat{j}$$

$$= 2.0 \times 10^{-6} \text{ C} \times 3.00 \times 10^6 \frac{\text{m}}{\text{s}} \times 1.50 \times 10^{-3} \text{ T} = 9.0 \text{ mN } \hat{j}$$

$$\vec{F}_{\text{tot}} = \vec{F}_E + \vec{F}_B = (12 \hat{i} + 9.0 \hat{j}) \text{ mN}$$

$$|\vec{F}_{\text{tot}}| = \sqrt{12^2 + 9.0^2} \text{ mN} = 15 \text{ mN}$$

### Prob. 4

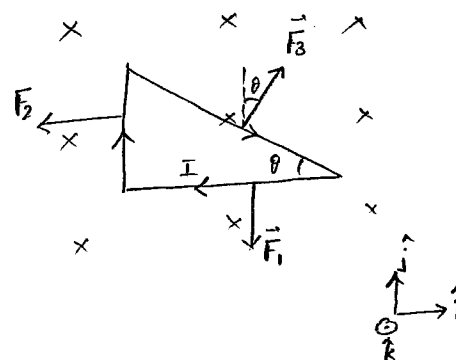
$$\begin{aligned} (a) \quad \vec{F}_1 &= -\hat{j} I x B \\ &= -\hat{j} 2.0 \text{ A} \times 3.0 \times 10^{-2} \text{ m} \times 2.0 \text{ T} \\ &= -0.12 \text{ N } \hat{j} \end{aligned}$$

$$\begin{aligned} (b) \quad \vec{F}_2 &= -\hat{i} I y B \\ &= -\hat{i} 2.0 \text{ A} \times 2.0 \times 10^{-2} \text{ m} \times 2.0 \text{ T} \\ &= -0.08 \text{ N } \hat{i} \end{aligned}$$

$$\begin{aligned} (c) \quad |\vec{F}_3| &= I \sqrt{x^2 + y^2} B \\ &= 2.0 \text{ A} \sqrt{3.0^2 + 2.0^2} \times 10^{-2} \text{ m} \times 2.0 \text{ T} \\ &= 0.144 \text{ N} \end{aligned}$$

$$\begin{aligned} \vec{F}_3 &= F_3 \sin \theta \hat{i} + F_3 \cos \theta \hat{j} \\ &= (0.08 \hat{i} + 0.12 \hat{j}) \text{ N} \end{aligned}$$

$$(d) \quad \vec{F}_{\text{tot}} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0$$

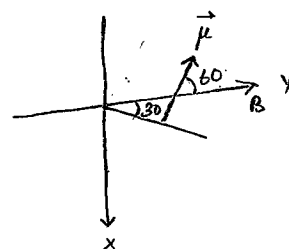


$$\begin{aligned} \theta &= \tan^{-1}\left(\frac{y}{x}\right) \\ &= \tan^{-1}\left(\frac{2}{3}\right) = 33.7^\circ \end{aligned}$$

### Prob. 5

$$\begin{aligned} (a) \quad \tau &= N I A B \sin \theta \\ &= 50 \times 4.0 \text{ A} \times (0.70 \text{ m} \times 0.50 \text{ m}) \times 2.0 \text{ T} \sin 60^\circ \\ &= 121 \text{ Nm} \end{aligned}$$

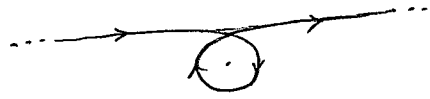
(b) Increase.



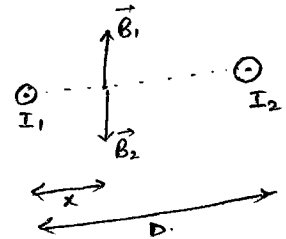
Prob. 6

$$\begin{aligned}
 B_{\text{tot}} &= B_1 + B_2 \\
 &= \frac{\mu_0 I}{2\pi a} + \frac{\mu_0 I}{2a} \\
 &= \frac{\mu_0 I}{2\pi a} (1 + \pi) \\
 &= \frac{2 \times 10^{-7} \times 1.0 \text{ A}}{2\pi \times 10.0 \times 10^{-2}} (1 + \pi) = 8.3 \mu\text{T}
 \end{aligned}$$

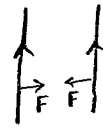
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Prob. 7

$$\begin{aligned}
 B_1 &= B_2 \\
 \frac{\mu_0 I_1}{2\pi x} &= \frac{\mu_0 I_2}{2\pi(D-x)} \\
 D-x &= \frac{I_2}{I_1} x \\
 x &= \frac{D}{(1 + \frac{I_2}{I_1})}
 \end{aligned}$$

Prob. 8

$$\begin{aligned}
 \frac{F}{L} &= \frac{\mu_0 I_1 I_2}{2\pi r} \\
 &= \frac{2 \times 10^{-7} \times 1.0 \text{ A} \times 2.0 \text{ A}}{2\pi \times 10 \times 10^{-2}} \\
 &= 4.0 \times 10^{-6} \frac{\text{N}}{\text{m}}
 \end{aligned}$$



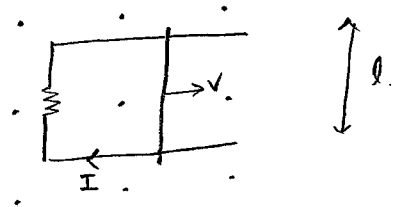
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Prob. 9

(a) Increasing

(b) Clockwise in the loop

$$\begin{aligned}
 (c) \quad I &= \frac{Blv}{R} = \frac{1.2 \text{ T} \times 10 \times 10^{-2} \text{ m} \times 5.0 \frac{\text{m}}{\text{s}}}{0.40 \Omega} \\
 &= 1.5 \text{ A}
 \end{aligned}$$



Prob 10

$$\begin{aligned} \text{(a)} \quad V_{\text{eff}} &= -50 \frac{\Delta(BA \cos \theta)}{\Delta t} \\ &= -50 \frac{\Delta B}{\Delta t} A \underbrace{\cos(0)}_{=1} \\ &= -50 \frac{2 \text{ T}}{2 \text{ sec}} 25 \times 10^{-4} \text{ m}^2 \\ &= -0.125 \text{ Volt} \end{aligned}$$

$$\begin{aligned} \text{(b)} \quad V_{\text{eff}} &= -50 \frac{\Delta B}{\Delta t} A \cos(0) \\ &= -50 \frac{(-2 \text{ T})}{1 \text{ s}} 25 \times 10^{-4} \text{ m}^2 \\ &= +0.250 \text{ Volt} \end{aligned}$$