PHYS 223 University Physics III
Exam 4

March 25, 2020

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Proctor's signature _____

1. An electron moves in a circular path perpendicular to a uniform magnetic field with a magnitude of 3.00 mT. If the speed of the electron is 2.50×10^7 m/s, determine

   a. the radius of the circular path and

   b. the time interval required to complete one revolution.

$$F = qvB = \frac{mv^2}{R}$$

$$qB = \frac{mv}{R}$$

$$R = \frac{mv}{qB} = \frac{9.1\times10^{-31} \times 2.5\times10^{7}}{1.6\times10^{-19} * 3\times10^{-3}}$$

a) $R = 4.74\,cm$

b) $v = \frac{qBR}{m} = \frac{2\pi R}{T}$

$$T = \frac{2\pi m}{qB} = \frac{2\pi \times 9.1\times10^{-31}}{1.6\times10^{-19} \times 3\times10^{-3}}$$

$$T = 1.19\times10^{-8} = 11.9\,ns$$

2. In Figure 2, the current in the long straight wire is I_1 = 2.00 A and the wire lies in the plane of the rectangular loop, which carries a current I_2 = 6.00 A. The dimensions in the figure are c = 1.00 m, a = 1.50 m, and b = 2.00 m. Find the magnitude and direction of the net force exerted on loop by the magnetic field created by the wire.

a. Magnitude 2.88 μN

b. Direction $-\hat{x}$ to the Left

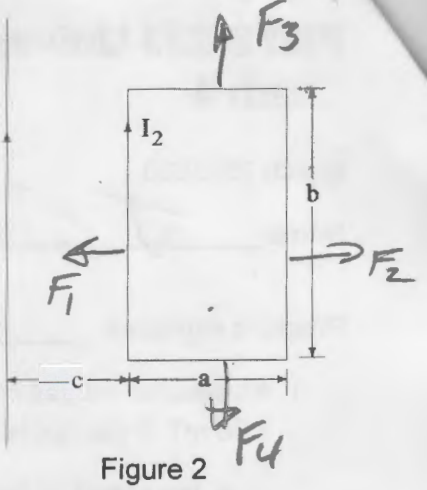

Figure 2
I_1 = 2.00 A
I_2 = 6.00 A
a = 1.5 m
b = 2.00 m
c = 1.00 m

$$B_1 = \frac{\mu_0}{2\pi r} I_1$$

$$F_3 = -F_4 \qquad F_3 + F_4 = 0$$

$$F_1 = I_2 b B_1 = \frac{\mu_0 b \cdot I_1 I_2}{2\pi c}$$

$$F_2 = \frac{\mu_0 b I_1 I_2}{2\pi (c+a)}$$

$$\vec{F} = \vec{F}_2 - \vec{F}_1 = \frac{\mu_0 b I_1 I_2}{2\pi}\left(\frac{1}{c+a} - \frac{1}{c}\right)\hat{x}$$

$$\frac{1}{c+a} - \frac{1}{c} = \frac{1}{2.5} - 1 = -0.6$$

$$\vec{F} = \frac{2}{4\pi \times 10^{-7}} \frac{12 \times 2}{\pi} (-0.6) = -48 \times 0.6 \times 10^{-7}\hat{x}$$

$$= -28.8 \times 10^{-7}$$

$$= -2.88\ \mu N\ \hat{x}$$

3. Given the uniform magnetic field,

$$\vec{B} = 2\hat{y} + 2\hat{z}$$

Find the magnetic flux passing through the rectangle lying in the x-y plane as shown in Figure 3.

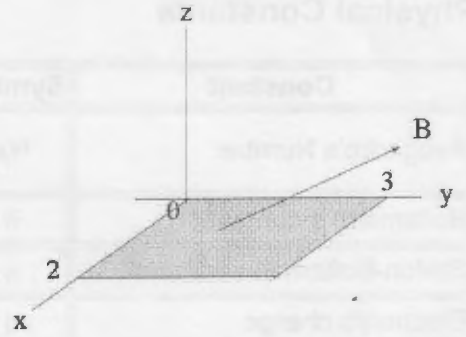

Figure 3

Φ_m _____

$\Phi_m = \vec{B} \cdot \vec{A}$

$\vec{B} = 2\hat{y} + 2\hat{z}$

$\vec{A} = 6\hat{z}$

$B \cdot A = 12$ webers

$B \cdot A = (2\hat{y} + 2\hat{z}) * 6\hat{z}$

$= 0 + 12$