Midterm Exam No. 03 (2015 Fall)

PHYS 205B: University Physics

Date: 2015 Nov 19

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(Name) (Signature)

Instructions

1. Seating direction: Please be seated on odd-numbered seats.
2. Total time = 75 minutes.
3. There are 10 questions in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to show your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. (**10 points.**) A laboratory electromagnet produces a magnetic field of magnitude 1.54 T flowing in the direction of $\hat{\mathbf{x}}$. A proton and an electron moves through this field with the speed of 6.28×10^6 m/s, along the y-axis.

   (a) Find the magnitude and direction of the magnetic force that could be exerted on the proton.

   (b) Find the magnitude and direction of the magnetic force that could be exerted on the electron.

   (c) What is the magnitude and direction of the acceleration of the proton?

   (d) What is the magnitude and direction of the acceleration of the electron?

2. (**10 points.**) A proton and an electron are moving in circles around a magnetic field of $B = 5.0 \times 10^{-6}\,\mathrm{T}$. If both the particles are moving with uniform speed $v = 2.0 \times 10^{6}\,\mathrm{m/s}$, determine the radiuses of the circles describing their path.

3. (**10 points.**) A loop in the shape of a semi circle of radius $R = 5.0\,\mathrm{cm}$, carrying a current $I = 1.0\,\mathrm{A}$, is placed in a magnetic field $B = 0.10\,\mathrm{T}$. (Choose $\hat{\mathbf{z}}$ to be out of the page.)

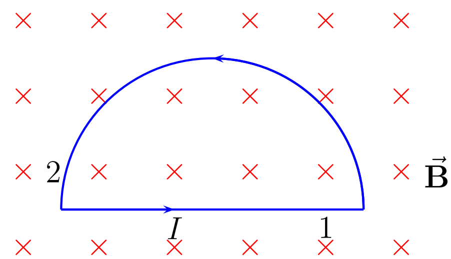

Figure 1: Problem 3.

(a) Determine the magnitude and direction of the force on side 1 of the loop.

(b) Determine the magnitude and direction of the force on side 2 of the loop.

(c) Determine the magnitude and direction of the total force on the loop.

4. (**10 points.**) Uniform electric field of magnitude $2.00 \times 10^3\,\mathrm{N/C}$ and uniform magnetic field of magnitude $3.00\,\mathrm{mT}$ are both pointing the $\hat{\mathbf{x}}$ direction. Determine the magnitude and direction of the total force on a positive charge $q = 2.0\,\mu\mathrm{C}$ that is moving with speed $3.0 \times 10^6\,\mathrm{m/s}$ in the $\hat{\mathbf{z}}$ direction.

5. (**10 points.**) A wire has a length of $5.00 \times 10^{-2}\,\mathrm{m}$ and is used to make a circular coil of one turn. There is a current of $4.40\,\mathrm{A}$ in the wire. In the presence of a $1.50\,\mathrm{T}$ magnetic field, what is the maximum torque that this coil can experience?

6. (**10 points.**) A conducting loop in the shape of a square of edge length $L = 1.00\,\mathrm{cm}$ carries a current $I = 2.00\,\mathrm{A}$ as shown in the figure. Calculate the magnitude and direction of the magnetic field at the center, P, of the square.

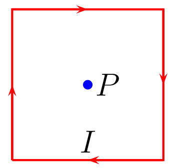

Figure 2: Problem 6.

7. (**10 points.**) Figure 3 shows two, infinitely long, current carrying wires, passing through a plane. The directions of the currents, either going into the page or coming out of the page, are shown in the figure. Determine the magnitude and direction of the magnetic field at the point $\times$, the origin. Let $I_1 = 1.0\,\mathrm{A}$, $I_2 = 2.0\,\mathrm{A}$, $x = 12\,\mathrm{cm}$, and $y = 8.0\,\mathrm{cm}$. Find the magnitude and direction of the total magnetic field at the origin.

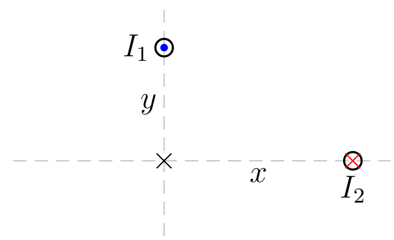

Figure 3: Problem 7.

8. (**10 points.**) Two long, parallel conductors, separated by 14.0 cm, carry currents in the same direction. The first wire carries a current $I_1 = 5.00\,\mathrm{A}$, and the second carries $I_2 = 8.00\,\mathrm{A}$. What is the force per length exerted by I_2 on I_1? Do the conductors attract or repel?

9. (**10 points.**) A conducting bar of length l moves to the right on two frictionless rails as shown in the figure below. A uniform magnetic field directed into the page has a magnitude of $0.300\,\mathrm{T}$. Assume $R = 8.0\,\Omega$ and $l = 10.0\,\mathrm{cm}$.

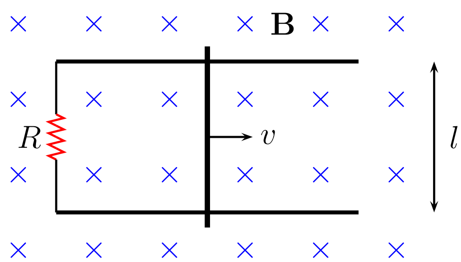

Figure 4: Problem 9.

(a) Is the magnetic flux in the loop increasing or decreasing?

(b) What is the direction of the induced current in the loop?

(c) At what constant speed should the bar move to produce a $9.0\,\mathrm{mA}$ current in the resistor?

10. (**10 points.**) Consider the diagram shown in Figure 5 in which the free conducting rod is pulled with velocity v. Let $R_1 = 100.0\,\Omega$, $R_2 = 200.0\,\Omega$, $B = 0.20\,\mathrm{T}$, $l = 10.0\,\mathrm{cm}$, and $v = 10.0\,\mathrm{m/s}$. Determine the currents in the two resistances.

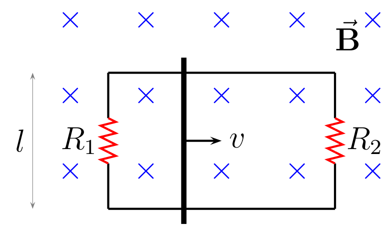

Figure 5: Problem 10.