Midterm Exam No. 03 (2017 Spring)

PHYS 205B: University Physics

Date: 2017 Apr 13

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 4.
2. Total time = 75 minutes.
3. There are 8 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.**) An electron is accelerated from rest by a potential difference of 350 V. It then enters a uniform magnetic field of magnitude 200 mT with its velocity perpendicular to the field.

   (a) Calculate the speed of the electron.

   (b) Calculate the radius of its path in the magnetic field.

2. (**10 points.**) A magnetic field has a magnitude of 1.50 mT and points in the $-\hat{\mathbf{z}}$ direction, and an electric field has a magnitude of 6.00 kN/C pointing in the $\hat{\mathbf{x}}$ direction. A positive 1.0 μC charge moves at a speed of 2.00×10^6 m/s in the direction of $\hat{\mathbf{x}}$. Determine the magnitude of the net force that acts on the charge.

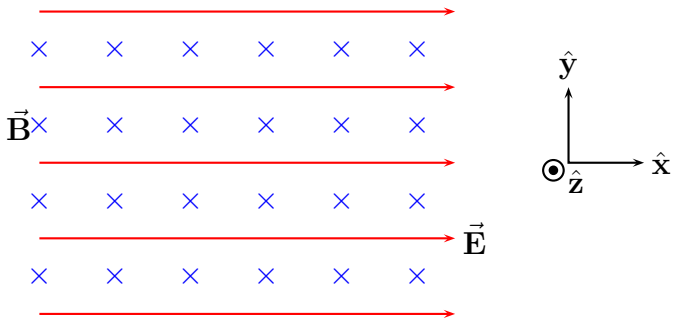

Figure 1: Problem 2.

3. (**10 points.**) A rod of mass m and radius R rests on two parallel rails (see Figure 2) that are a distance d apart have a length L. The rod carries a current I in the direction shown and slides along the rails without friction. A uniform magnetic field B is directed perpendicular to the rod and the rails. If it starts from rest, what is the speed of the rod as it leaves the rails?

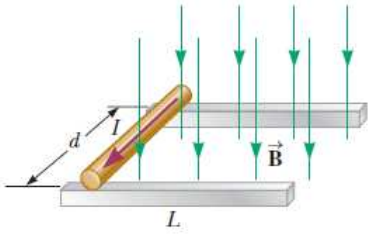

Figure 2: Problem 3.

4. (**10 points.**) What is the dimension of $\mu_0/4\pi$? Express it in terms of Length L, Mass M, Time T, and Charge C.

5. (**10 points.**) A steady current I flows through a wire in the shape of a square of side L, shown in Fig. 3. Show that the magnitude and direction of the magnetic field at the center of the square, P.

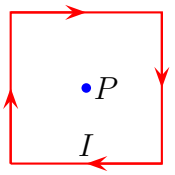

Figure 3: Problem 5

6. (**10 points.**) Figure 4 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 $I_1 = 1.0\,\mathrm{A}$, $I_2 = 2.0\,\mathrm{A}$, $x = 6.0\,\mathrm{cm}$, and $y = 4.0\,\mathrm{cm}$. Find the magnitude and direction of the total magnetic field at the origin.

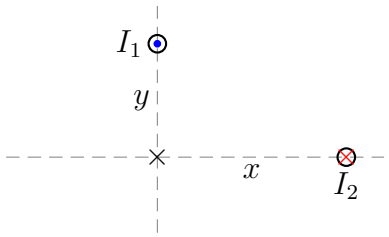

Figure 4: Problem 6.

7. (**10 points.**) Figure 5 shows a conducting rod being pulled along horizontal, frictionless, conducting rails at a constant speed v. A uniform magnetic field $\mathbf{B}$ fills the region in which the rod moves. Assume $L = 10\,\text{cm}$, $v = 5.0\,\text{m/s}$, $B = 1.2\,\text{T}$, and $R = 0.40\,\Omega$.

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

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

   (c) Determine the magnitude of the induced current in the loop.

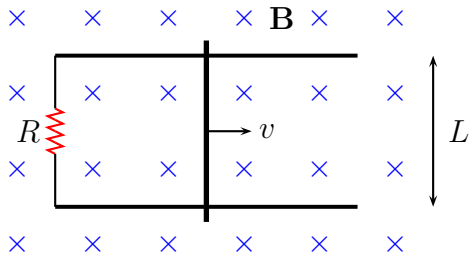

Figure 5: Problem 7

8. (**10 points.**) Figure 6 shows five snapshots of a rectangular coil being pushed across the dotted region where there is a uniform magnetic field directed into the page. Outside of this region the magnetic field is zero. Determine the direction of induced current in the loop at each of the five instances in the figure.

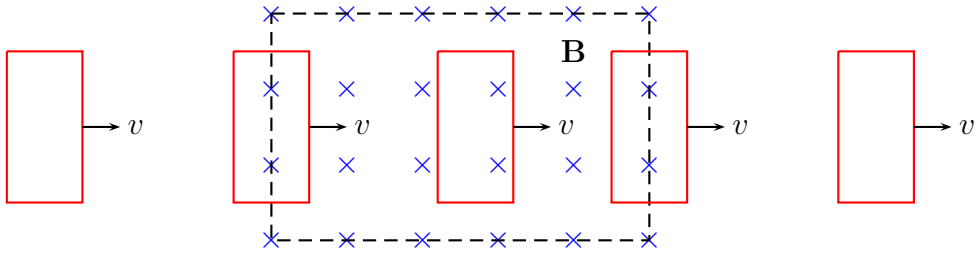

Figure 6: Problem 8.