Midterm Exam 03 (2015 Summer)

PHYS 203B: College Physics

Date: 2015 Jul 24

(Name) (Signature)

Instructions

1. Total time = 60 minutes.
2. There are 8 questions in this exam.
3. Equation sheet is provided separately.
4. To obtain partial credit for your work you need to show your work in detail and organize it clearly.
5. A simple calculator (with trigonometric functions) is allowed.

1. (**10 points.**) Two parallel wires, 4.00 cm apart, carry currents of 2.00 A and 4.00 A respectively, in opposite directions. What is the force per unit length in N/m of one wire on the other?

2. (**10 points.**) Two long parallel wires carry currents $I_1 = 1.00\,\mathrm{A}$ and $I_2 = 4.00\,\mathrm{A}$ in opposite directions, one coming out of the page and the other going into the page. See Figure 1. The wires are separated by $d = 10.0\,\mathrm{cm}$. Where on the dashed line in the Figure is the magnetic field zero?

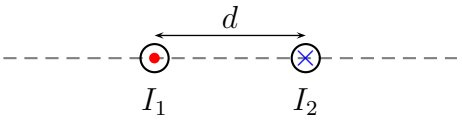

Figure 1: Problem 2

3. (**10 points.**) A steady current $I = 1.00\,\text{A}$ flows through a wire shown in Fig. 3. Given $a = 5.00\,\text{cm}$. Find the magnitude and direction of magnetic field at point P.

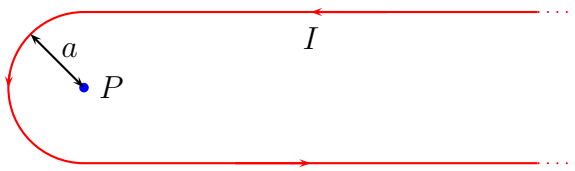

Figure 2: Problem 3

Hint: The magnitude of the magnetic field due to a wire of infinite length at distance ρ, and a circular loop of wire of radius R at the center of loop, is

$$B_{\infty\text{-wire}} = \frac{\mu_0 I}{2\pi\rho} \qquad B_{\text{loop}} = \frac{\mu_0 I}{2R}, \tag{1}$$

respectively.

4. (**10 points.**) Figure 3 shows a conducting a 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.

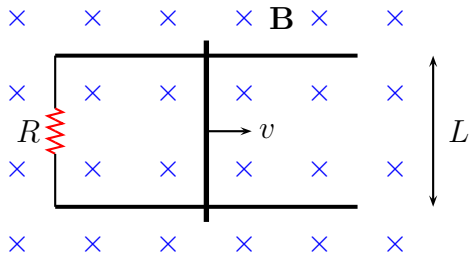

Figure 3: Problem 4

5. (**10 points.**) Figure 4 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.

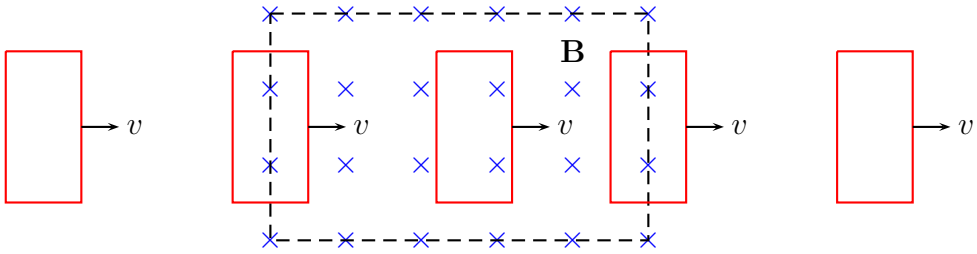

Figure 4: Problem 5

6. (**10 points.**) A generator has a square coil consisting of 560 turns. The coil rotates at 59 rad/s in a 0.17 T magnetic field. If length of one side of the coil is 12 cm, what is peak output of the generator?

7. (**10 points.**) A step-down transformer with turn ratio 1 : 20 is used with an electric toy train to reduce the voltage from the wall power supply of 120 V. What is the voltage across the electric toy train?

8. (**10 points.**) A series RCL circuit contains a $47.1\,\Omega$ resistor, a $2.50\,\mu$F capacitor, and a 4.25 mH inductor. When the frequency is 2575 Hz, what is the total impedance of the circuit?