Midterm Exam No. 03 (2014 Fall)

PHYS 205B: University Physics

Date: 2014 Nov 6

(Name) (Signature)

Instructions

1. Total time = 75 minutes.
2. There are 10 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.

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. Calculate the radius of its path in the magnetic field.

2. (**10 points.**) A rod of mass m and radius R rests on two parallel rails (see Figure 1) that are a distance d apart have a length L. The rod carries a current I in the direction shown and rolls along the rails without slipping. 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?

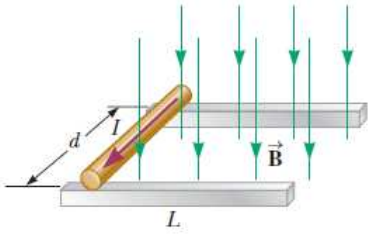

Figure 1: Problem 2.

3. (**10 points.**) A wire has a length of $4.80 \times 10^{-2}\,\mathrm{m}$ 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?

4. (**10 points.**) Calculate the magnitude of the magnetic field at a point 35.5 cm from a long, thin conductor carrying a current of 4.75 A.

5. (**10 points.**) A steady current I flows through a wire shown in Fig. 2. Find the magnitude and direction of magnetic field at point P.

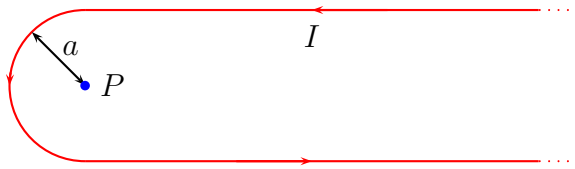

Figure 2: Problem 5.

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.

6. (**10 points.**) Fig. 3 shows a cross-sectional view of a coaxial cable. The center conductor is surrounded by a rubber layer, an outer conductor, and another rubber layer. In a particular application, the current in the inner conductor is $I_1 = 1.18\,\text{A}$ out of the page and the current in the outer conductor is $I_2 = 3.04\,\text{A}$ into the page. Assume distance $d = 1.00\,\text{mm}$. Determine the magnitude and direction of the magnetic field at point b.

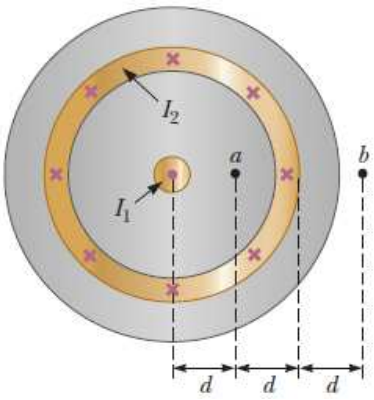

Figure 3: Problem 6.

7. (**10 points.**) Two long, parallel wires carry currents of $I_1 = 2.50\,\text{A}$ and $I_2 = 5.25\,\text{A}$ in the directions indicated in Fig. 4, where $d = 23.0\,\text{cm}$. (Take the positive x direction to be to the right.) Find the magnitude and direction of the magnetic field at a point midway

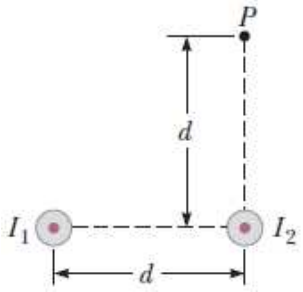

Figure 4: Problem 7.

between the wires.

8. (**10 points.**) In Figure 5, the long straight wire carries a current of 30 A and the rectangular loop carries a current of 20 A. Calculate the resultant force acting on the loop. Assume that $a = 1.0\,\text{cm}$, $b = 8.0\,\text{cm}$, and $L = 48\,\text{cm}$.

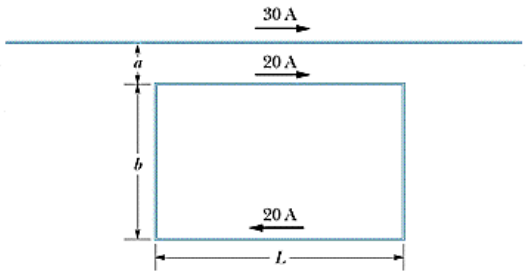

Figure 5: Problem 8.

9. (**10 points.**) A long solenoid has 145 turns/cm and carries current I. An electron moves within the solenoid in a circle of radius 3.20 cm perpendicular to the solenoid axis. The speed of the electron is $0.0452\,c$ ($c = 299\,792\,458$ m/s is the speed of light). Find the current I in the solenoid.

10. (**10 points.**) A square loop of wire consisting of a single turn is perpendicular to a uniform magnetic field. The square loop is then re-formed into a circular loop, which is also perpendicular to the same magnetic field. The magnetic flux that passes through the square loop is 3.9×10^{-3} Wb. What is the flux that passes through the circular loop?