Midterm Exam 03 (2015 Fall)

PHYS 203B: College Physics

Date: 2015 Nov 19

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 3.
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.**) An electron, traveling with a velocity of 4.0×10^6 m/s in the direction of $\hat{\mathbf{x}}$, passes through a region of magnetic field that has a magnitude of 0.20 T and direction along $\hat{\mathbf{y}}$. What is the magnitude and direction of the magnetic force acting on the electron?

2. (**10 points.**) An electron travels on a circular path that is perpendicular to a magnetic field whose magnitude is 0.50 T. How many times does the electron go around the circle in one second?

3. (**10 points.**) A magnetic field has a magnitude of 1.50 mT, and an electric field has a magnitude of 6.00 kN/C. Both fields point in the same direction. A positive 2.0 μC charge moves at a speed of 3.00×10^6 m/s in a direction that is perpendicular to both fields. Determine the magnitude of the net force that acts on the charge.

4. (**10 points.**) A loop in the shape of a right triangle, carrying a current $I = 2.0\,\text{A}$, is placed in a magnetic field $B = 2.0\,\text{T}$. (Choose $\hat{\mathbf{z}}$ to be out of the page, and $\hat{\mathbf{x}}$ to be along side 1 of the traingle.) Let $x = 3.0\,\text{cm}$, $y = 2.0\,\text{cm}$.

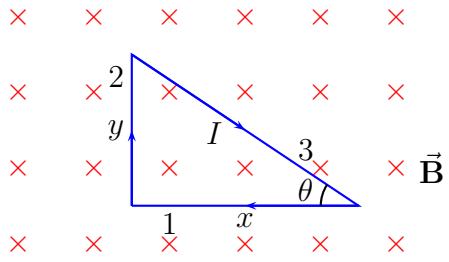

Figure 1: Problem 4.

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

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

(c) Determine the magnitude and direction of the magnetic force on side 3 of the traingle.

(d) Determine the magnitude and direction of the total magnetic force on the traingle.

5. (**10 points.**) The rectangular loop in the drawing consists of 50 turns and carries a current of $I = 4.0\,\text{A}$. A $2.0\,\text{T}$ magnetic field is directed along the $+y$ axis. The loop is free to rotate about the z axis. Given $\theta = 30°$.

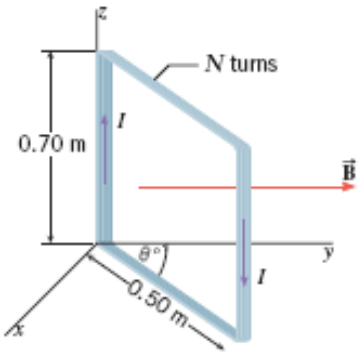

Figure 2: Problem 5.

(a) Determine the magnitude of the net torque exerted on the loop.

(b) Due to the torque will the angle θ increase or decrease?

6. (**10 points.**) A steady current I flows through a wire shown in Fig. 3. Determine the magnitude and direction of the magnetic field at point P for $I = 1.0\,\mathrm{A}$ and $a = 10.0\,\mathrm{cm}$.

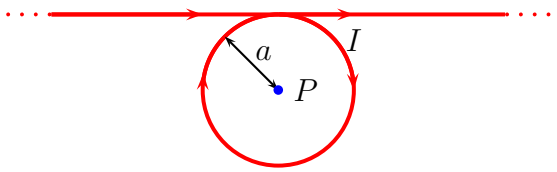

Figure 3: Problem 6.

7. (**10 points.**) Figure 4 shows two current carrying wires, separated by a distance D. The directions of currents, either going into the page or coming out of the page, are shown in the figure. Determine the point $\times$ where the magnetic field is exactly zero. Express your answer in terms of D, I_1, and I_2.

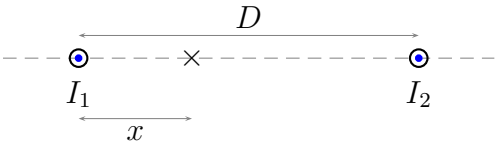

Figure 4: Problem 7.

8. (**10 points.**) Two infinitely long parallel wires, carrying currents $I_1 = 1.0\,\mathrm{A}$ and $I_2 = 2.0\,\mathrm{A}$ in the same direction, are separated by a distance $r = 10\,\mathrm{cm}$. Determine the magnitude and direction of the force per unit length exerted by one wire on the other wire.

9. (**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. Let $l = 10.0\,\text{cm}$, $v = 5.0\,\text{m/s}$, $B = 1.2\,\text{T}$, and $R = 0.40\,\Omega$.

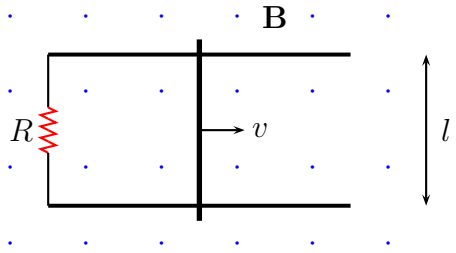

Figure 5: Problem 9.

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

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

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

10. (**10 points.**) A loop of wire having a resistance $R = 100.0\,\Omega$ is placed in a magnetic field whose magnitude is changing in time, as described in Figure 6. The direction of the magnetic field is normal to the plane of the loop. The loop of wire consists of 50 turns and has an area of $A = 25 \times 10^{-4}\,\mathrm{m}^2$.

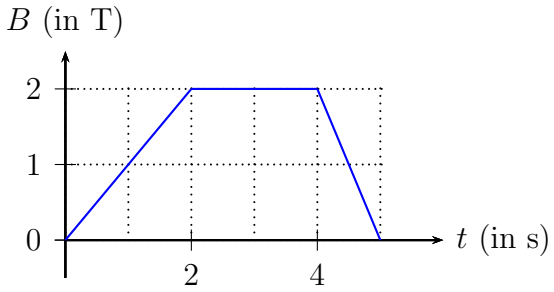

Figure 6: Problem 10.

(a) Determine the induced voltage and the induced current in the loop between 0 s to 2 s.

(b) Determine the induced voltage and the induced current in the loop between 4 s to 5 s.