Final Exam (2015 Fall)

PHYS 203B: College Physics

Date: 2015 Dec 15

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 3.
2. Total time = 2 hours.
3. There are 12 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.**) The drawing shows four charges, $q_1 = -1.0\,\mu\text{C}$, $q_2 = +2.0\,\mu\text{C}$, $q_3 = -1.0\,\mu\text{C}$, $q_4 = +2.0\,\mu\text{C}$, that are placed on the x and y axes. They are all located at the same distance of $L = 40.0\,\text{cm}$ from the origin marked as $\times$. Determine the magnitude and direction of the net electric field at the origin.

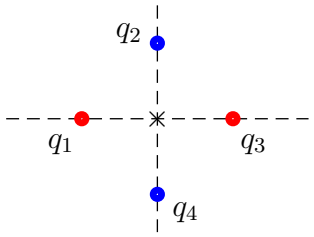

Figure 1: Problem 1

2. (**10 points.**) A proton is released from rest in a uniform electric field of $E = 4.0\times10^3\,\mathrm{N/C}$. Determine the distance travelled by the proton in one nanosecond.

3. (**10 points.**) Four positive charges of equal magnitude $Q = 1.0\,\mu\text{C}$ are placed at the corners of a square of side 5.0 cm. Determine the electric potential at the center of the square.

4. (**10 points.**) Figure 2 shows two resistors connected in parallel to a battery. The battery has a voltage of $V = 10.0\,\text{V}$, and the resistors have resistances $R_1 = 100.0\,\Omega$ and $R_2 = 200.0\,\Omega$.

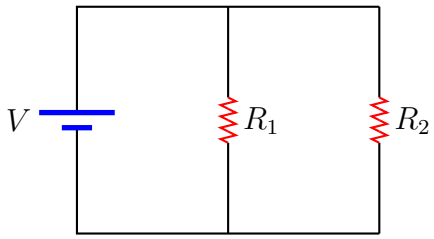

Figure 2: Problem 4

(a) Determine the equivalent resistance across the battery.

(b) Determine the voltage across each of the resistor.

(c) Determine the current passing through each resistor.

(d) Determine the power consumed by each resistor.

5. (**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 $x = 4.0\,\text{cm}$, $y = 3.0\,\text{cm}$.

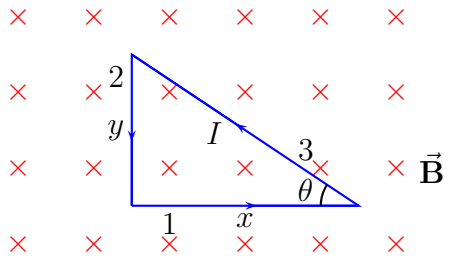

Figure 3: Problem 5.

(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.

6. (**10 points.**) A steady current I flows through a wire shown in Figure 4. Determine the magnitude and direction of the magnetic field at point P for $I = 1.0\,\text{A}$ and $a = 10.0\,\text{cm}$.

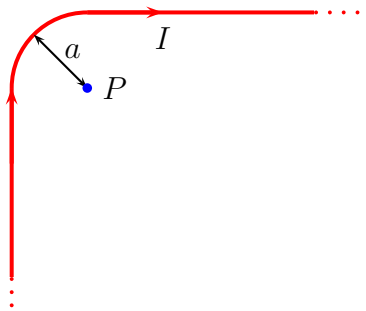

Figure 4: Problem 6.

7. (**10 points.**) Two infinitely long parallel wires, carrying currents $I_1 = 1.0\,\mathrm{A}$ and $I_2 = 2.0\,\mathrm{A}$ in opposite directions, are separated by a distance $r = 20.0\,\mathrm{cm}$. Determine the magnitude and direction of the force per unit length exerted by one wire on the other wire.

8. (**10 points.**) Figure 5 shows a conducting rod being pulled along horizontal, frictionless, conducting rails at a constant speed v. A uniform magnetic field $\vec{\mathbf{B}}$ fills the region in which the rod moves. Let $l = 5.0\,\text{cm}$, $v = 2.0\,\text{m/s}$, $B = 1.0\,\text{T}$, and $R = 0.50\,\Omega$.

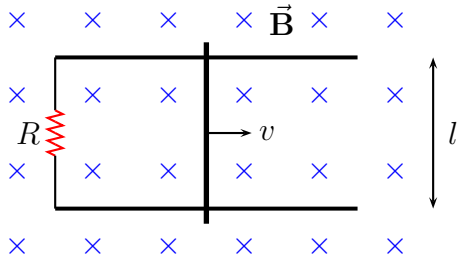

Figure 5: Problem 8.

(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.

9. (**10 points.**) Figure 6 shows three polarizers in series. The angles θ_A, θ_B, and θ_C, represent the angles the respective transmission axis of the polarizers A, B, and C, makes with the vertical. Consider a beam of unpolarized light of intensity I_0 incident on the polarizer A. (Express your answers in terms of I_0.)

   (a) What is the intensity of the transmitted beam after it passes the polarizer A and before it passes polarizer B?

   (b) What is the intensity of the transmitted beam after it passes the polarizer B and before it passes polarizer C?

   (c) What is the intensity of the transmitted beam after it passes the polarizer C?

   (d) In the absence of polarizer B, what is the intensity of the transmitted beam after it passes the polarizer C?

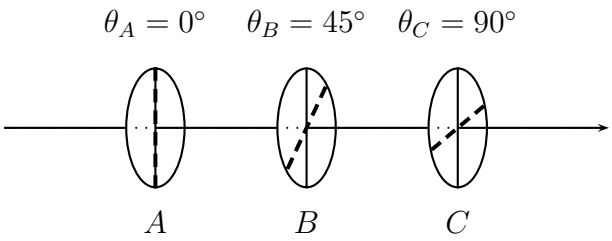

Figure 6: Problem 9

10. (**10 points.**) A ray of light is traveling in glass and strikes a glass-air interface. The index of refraction of glass is $n_g = 1.50$, and the index of refraction of air is $n_a = 1.00$. What is the criticial angle of incidence beyond which none of the light is transmitted into air and all of it is reflected back into the glass?

11. (**10 points.**) A 1.00 cm high object is placed upright at a distance 20.0 cm from a convex mirror. The mirror's focal length is 10.0 cm.

    (a) Calculate the image distance.

    (b) What is the magnification?

    (c) Is the image real or virtual?

    (d) Is the image inverted or upright?

    (e) What is height of the image?

    (f) Confirm your above results by drawing a ray diagram for the above case. Points will be awarded for precision.

12. (**10 points.**) A 1.00 cm high object is placed upright at a distance 15.0 cm from the center of a convex lens (converging lens). The lens' focal length is 10.0 cm.

    (a) Calculate the image distance.

    (b) What is the magnification?

    (c) Is the image real or virtual?

    (d) Is the image inverted or upright?

    (e) What is height of the image?

    (f) Confirm your above results by drawing a ray diagram for the above case. Points will be awarded for precision.