Final Exam (2016 Spring)

PHYS 205B: University Physics

Date: 2016 May 10

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 4.
2. Total time = 120 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.**) Three identical charges of equal magnitude q are placed at the corners of a triangle of length L. Determine the magnitude of the Coulomb force on one of the charges.

2. (**10 points.**) See Figure 1. Two charges $q_1 = -4.0\,\mu\text{C}$ and $q_2 = +16.0\,\mu\text{C}$ are fixed to a line separated by a distance $d = 10.0\,\text{cm}$. At what point on the line is the electric field zero?

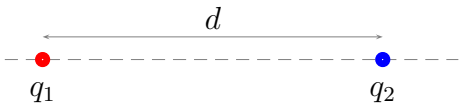

Figure 1: Problem 2.

3. (**10 points.**) Determine the total electrostatic energy required to assemble three identical positive charges q (moving them from infinity) at the corners of an equilateral triangle of side L.

4. (**10 points.**) A sphere with mass $m_2 = 10.0\,\text{g}$ and charge $q_2 = 1.0\,\mu\text{C}$ is fired directly toward another sphere of charge $q_1 = 10.0\,\mu\text{C}$ (which is pinned down to avoid its motion). If the initial velocity of charge q_2 is $v_i = 10.0\,\text{m/s}$ when it is $r_i = 30.0\,\text{cm}$ away from charge q_1, at what distance away from the charge q_1 does it come to rest?

5. (**10 points.**) A potential difference $V = 10.0\,\mathrm{V}$ is applied across a resistor arrangement with two resistances connected in series, $R_1 = 100.0\,\Omega$ and $R_2 = 200.0\,\Omega$.

   (a) Find the equivalent resistance.

   (b) Find the currents I_1 and I_2 flowing through the resistors.

   (c) Find the voltages V_1 and V_2 across each of the resistors.

   (d) Find the power P_1 and P_2 dissipated in each of the resistors.

6. (**10 points.**) A loop in the shape of a semi circle of radius $R = 5.0\,\text{cm}$, carrying a current $I = 1.0\,\text{A}$, is placed in a magnetic field $B = 0.10\,\text{T}$.

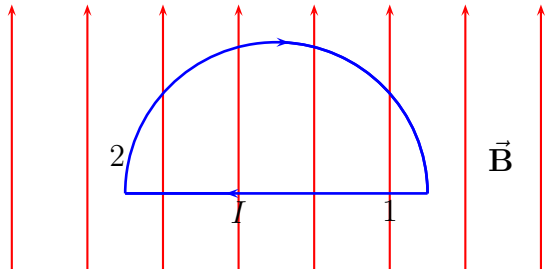

Figure 2: Problem 6.

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

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

(c) Determine the magnitude and direction of the total force on the loop.

7. (**10 points.**) Figure 3 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 $L = 10.0\,\text{cm}$, $v = 5.0\,\text{m/s}$, $B = 1.2\,\text{T}$, 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.

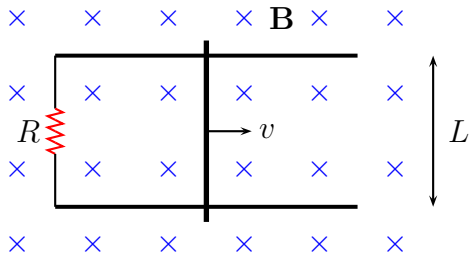

Figure 3: Problem 7

8. (**10 points.**) The index of refraction of benzene is 1.80. Determine the critical angle for total internal reflection at a benzene-air interface.

9. (**10 points.**) A 1.0 cm object is placed upright at a distance 5.0 cm away from a concave mirror. The mirror's focal length is 10.0 cm.

   (a) What is the mirror's radius of curvature?

   (b) Calculate the image distance.

   (c) What is the magnification?

   (d) Is the image real or virtual?

   (e) Is the image inverted or upright?

   (f) Determine the height of the image.

   (g) Confirm your results by drawing a ray diagram for the above case. Choose the scale for the two relevant directions appropriately so that the relevant features are illustrated well. Points will be awarded for clarity.

10. (**10 points.**) A 1.0 cm object is placed upright at a distance 15.0 cm away from a convex 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) Confirm your results by drawing a ray diagram for the above case. Choose the scale for the two relevant directions appropriately so that the relevant features are illustrated well. Points will be awarded for clarity.