Final Exam (2016 Fall)

PHYS 203B: College Physics

Date: 2016 Dec 13

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 3.
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.**) The drawing shows three charges, $q_1 = +1.0\,\mu\text{C}$, $q_2 = -2.0\,\mu\text{C}$, $q_3 = +3.0\,\mu\text{C}$, that are placed on the x and y axes. They are all located at the same distance of $L = 20.0\,\text{cm}$ from the origin marked as $\times$. Determine the magnitude and direction of the net electric field at the origin.

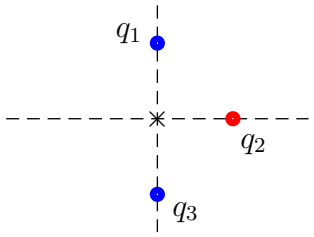

Figure 1: Problem 1

2. (**10 points.**) Charges of $-q$ and $+2q$ are fixed in place, with a distance of $a = 2.0\,\mathrm{m}$ between them. See Fig. 2. A dashed line is drawn through the negative charge, perpendicular to the line between the charges. On the dashed line, at a distance y from the negative charge, there is at least one spot where the total potential is zero. Find y.

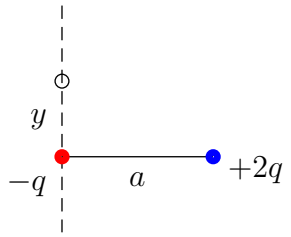

Figure 2: Problem 2.

3. (**10 points.**) A potential difference $V = 10.0\,\mathrm{V}$ is applied across a capacitor arrangement with two capacitors connected in parallel, $C_1 = 10.0\,\mathrm{nF}$ and $C_2 = 20.0\,\mathrm{nF}$. Find the ratio U_1/U_2 of the potential energies stored inside the capacitors.

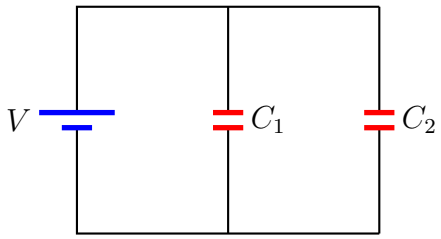

Figure 3: Problem 3

4. (**10 points.**) A proton, traveling with a velocity of $3.0 \times 10^6\,\mathrm{m/s}$ in the direction of $\hat{\mathbf{x}}$, passes through a region of magnetic field that has a magnitude of $0.100\,\mathrm{T}$ and direction along $\hat{\mathbf{y}}$. What is the magnitude and direction of the magnetic force acting on the proton?

5. (**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.

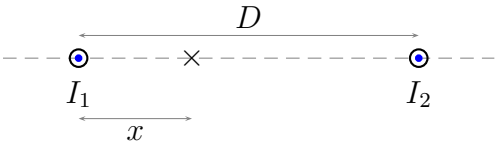

Figure 4: Problem 5.

6. (**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 $l = 10.0\,\text{cm}$, $v = 3.0\,\text{m/s}$, $B = 2.0\,\text{T}$, and $R = 0.40\,\Omega$.

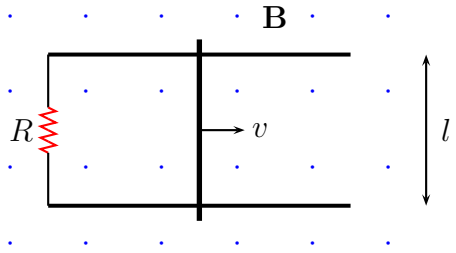

Figure 5: Problem 6.

(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.

7. (**10 points.**) The Crab nebula, which is about 6500 light-years (ly) distant, is thought to be the result of a supernova explosion recorded by Chinese astronomers in A.D. 1054. In approximately what year did the explosion actually occur?

8. (**10 points.**) The diagram in Figure 6 shows the passage of a ray of light from air into a substance X. Determine the index of refraction of substance X.

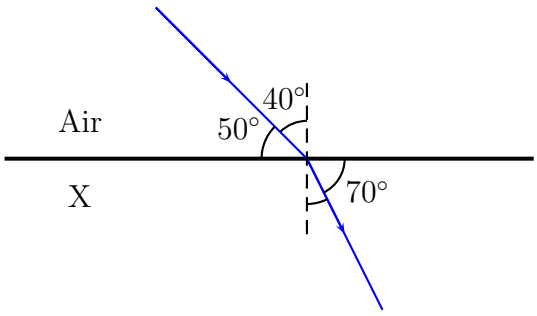

Figure 6: Problem 8.

9. (**10 points.**) A 1.00 cm high object is placed upright at a distance 40.0 cm from a concave 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.

10. (**10 points.**) A 1.00 cm high object is placed upright at a distance 40.0 cm from the center of a concave lens (diverging 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.