Final Exam (2024 Spring)

PHYS 205B: UNIVERSITY PHYSICS

School of Physics and Applied Physics, Southern Illinois University–Carbondale

Date: 2024 May 7

(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 4 short questions and 3 homework-style problems in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to present your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of smart devices, including smart watches, is strictly prohibited. They should stay out of reach during the exam.
8. Restroom breaks are allowed. Under questionable circumstances this might lead up to a Makeup Exam.
9. Academic misconduct will lead to a failing grade in the course.

1. (**5 points.**) Two charges, $q_1 = +1.00\,\mu\text{C}$ and $q_2 = -9.00\,\mu\text{C}$ are a distance D apart. Refer Figure 1. As a multiple of distance D, at what coordinate x on the line connecting the two charges is the total electric field zero?
   Caution: The point need not be in the region between the charges.

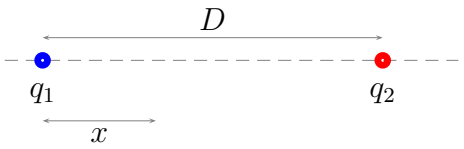

Figure 1: Problem 1

2. (**5 points.**) Determine the equivalent resistance in the circuit shown in Figure 2. Given $V = 5.0\,\mathrm{V}$ and $R = 5.0\,\mathrm{k\Omega}$.

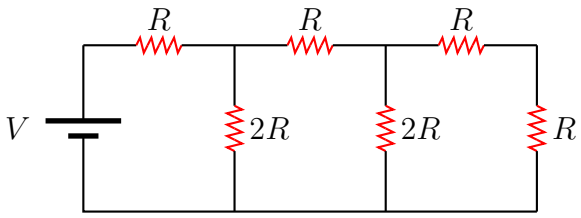

Figure 2: Problem 2

3. (**5 points.**) Can an electromagnetic wave impart momentum to an object? That is, can you move an object by shining light on it in empty space.

4. (**5 points.**) Refractive index n of a material is described by the speed of light in the medium v relative to the speed of light in vacuum c,

$$n = \frac{c}{v}. \tag{1}$$

Is the refractive index of a medium frequency (color) dependent?

5. (**10 points.**) Four charges $q_1 = +1.0\,q$, $q_2 = +2.0\,q$, $q_3 = -3.0\,q$, and $q_4 = -4.0\,q$, are placed at the corners of a square of side L, such that q_1 and q_4 are at diagonally opposite corners. Refer Figure 3. Calculate the total electric potential at the center of the square. Assume the electric potential to be zero at infinity, for reference.

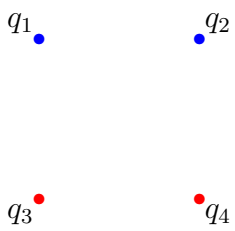

Figure 3: Problem 5

6. (**10 points.**) A 1.0 cm object is placed upright at a distance 15 cm away from a concave mirror. The mirror's focal length is 10.0 cm.

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

   (b) Calculate the image distance. Is the image real or virtual?

   (c) What is the magnification? Determine the height of the image.

   (d) Is the image upright or inverted?

   (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 and accuracy.

7. (**10 points.**) A 1.0 cm object is placed upright at a distance 20.0 cm away from a convex lens. The focal length of the lens is 10.0 cm.

   (a) Calculate the image distance. Is the image real or virtual?

   (b) What is the magnification? Determine the height of the image.

   (c) Is the image upright or inverted?

   (d) 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 and accuracy.