Final Exam (Spring 2025)

PHYS 205B: UNIVERSITY PHYSICS

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

Date: 2025 May 6

(Name) (Signature)

Instructions

1. Seating direction: On even-numbered seats in alternate rows, B, D, F, ...
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. Academic misconduct will lead to a failing grade in the course.

1. (**5 points.**) A charge $q = 2.0\,\text{nC}$ is placed on the y-axis a distance $a = 3.0\,\text{cm}$ below the origin. Find the magnitude and direction of the electric field at the point marked $\times$ in Figure 1, on the x-axis a distance a to the right of the origin.

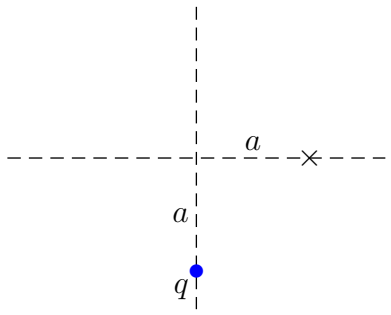

Figure 1: Problem 1

2. (**5 points.**) A 'zero-watt' bulb consumes about 12 watts of power. In early days this was too low power and it came to be known as zero-watt bulb. How much energy (in Joules) is consumed by a zero-watt bulb in one year if it is left on continuously.

3. (**5 points.**) Figure 2 shows a current carrying wire that is on the z axis. The directions of currents, either going into the page or coming out of the page, is shown in the figure. Draw the direction of the magnetic field at the point P.

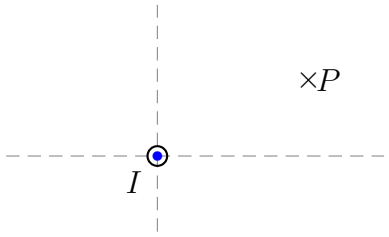

Figure 2: Problem 3

4. (**5 points.**) Figure 3 shows two rays originating from a point object o. Qualitatively, draw the trajectories of the two rays when they pass through two thin prisms placed as shown in Figure 3.

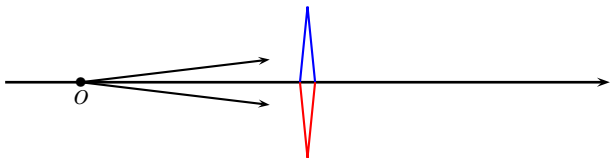

Figure 3: Convex thin prism.

5. (**10 points.**) Four charges $q_1 = +q$, $q_2 = -4q$, $q_3 = -3q$, and $q_4 = +q$, with $q > 0$, 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 4. Calculate the magnitude and direction of the total electric field at the center of the square.

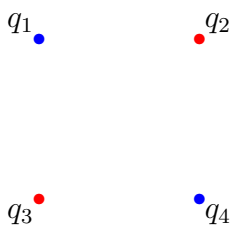

Figure 4: Problem 5

6. (**10 points.**) A 1.0 cm object is placed upright at a distance 20.0 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 15 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.