Final Exam (2022 Fall)

PHYS 205B: UNIVERSITY PHYSICS

School of Physics and Applied Physics, Southern Illinois University–Carbondale
Date: 2022 Dec 12

(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 conceptual questions and 3 problems 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 smart devices, including smart watches, are 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.**) What is the magnitude and direction of the electric field at distance $3.0\,\mathrm{cm}$ from the center of a uniformly positively charged sphere of radius $1.0\,\mathrm{cm}$ with total charge $1.0\,\mathrm{nC}$.

2. (**5 points.**) Briefly state Kirchhoff's junction rule and Kirchhoff's loop rule. Which one of these rules is associated to the law of conservation of energy?

3. (**5 points.**) An electron and a proton moving with the same speed enter a region of uniform magnetic field. Illustrate their trajectories using a diagram.

4. (**5 points.**) What is the dimension of

$$\frac{1}{4\pi R}\sqrt{\frac{\mu_0}{\varepsilon_0}}, \tag{1}$$

where ε_0 is the electric permittivity of vacuum, μ_0 is the magnetic permeability of vacuum, and R is the impedance of vacuum with demensions of electrical resistance.

5. (**10 points.**) Figure 1 shows two current carrying wires, in a plane. The directions of currents, either going into the page or coming out of the page, are shown in the figure. Determine the magnitude and direction of the magnetic field at the point $\times$, at the coordinate (x, y). Let $I_1 = 1.0\,\text{A}$, $I_2 = 2.0\,\text{A}$, $x = 12\,\text{cm}$, and $y = 8.0\,\text{cm}$.
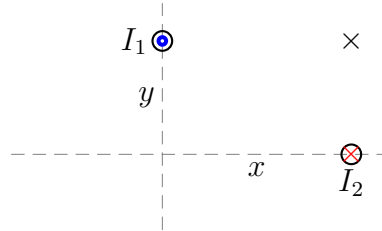

Figure 1: Problem 5

6. (**10 points.**) A 1.0 cm object is placed upright at a distance 15.0 cm away from a convex mirror. The mirror's focal length is 10.0 cm.

   (a) What is the mirror's radius of curvature? Is the mirror a converging mirror or a diverging mirror?

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

   (c) Calculate the magnification? Is the image upright or inverted? Determine the height of the image.

   (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.

7. (**10 points.**) A 1.0 cm object is placed upright at a distance 5.00 cm away from a convex lens. The lens' focal length is 10.0 cm.

    (a) Is the lens a converging lens or a diverging lens?

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

    (c) Calculate the magnification? Is the image upright or inverted? Determine the height of the image.

    (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.