Final Exam (Fall 2025)

PHYS 203B-001: COLLEGE PHYSICS

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

Date: 2025 Dec 11

(Name) (Signature)

Instructions

1. Seating direction: In alternate rows, B, D, F, . . . , on even-numbered seats.
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. 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.**) Consider a region of uniform electric field $\vec{\mathbf{E}} = -E\,\hat{\mathbf{j}}$ of magnitude $E = 1.0 \times 10^3\,\mathrm{N/C}$ and direction vertically down. Refer Figure 1. What is the direction of the electric force on a charge particle $q = +2.0\,\mathrm{nC}$ moving with velocity $\mathbf{v} = \hat{\mathbf{i}}\,5.6 \times 10^4\,\mathrm{m/s}$.

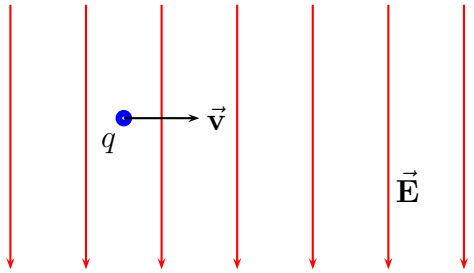

Figure 1: Problem 1

2. (**5 points.**) A charged particle initially moving with constant speed v enters a region of magnetic field **B** pointing into the page. It is deflected as shown in Fig. 2. What can you deduce about the sign of the charged particle? That is, is it a positive charge or a negative charge.

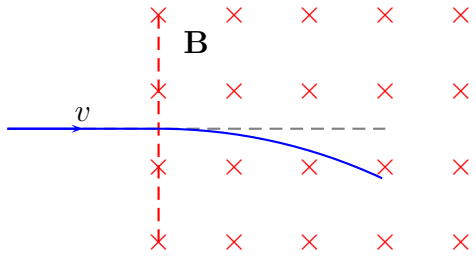

Figure 2: Problem 2

3. (**5 points.**) Figure 3 shows a snapshot of a rectangular coil being pushed through a uniform magnetic field directed into the page. Determine the magnitude and direction of induced current in the loop at the instance shown in the figure. Given $L = 10.0\,\text{cm}$, $v = 5.0\,\text{m/s}$, and $B = 1.2\,\text{T}$,

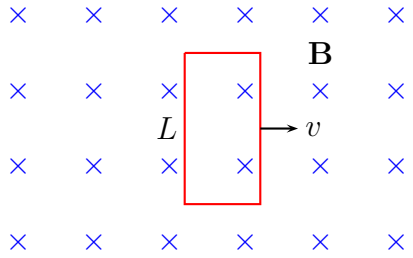

Figure 3: Problem 3.

4. (**5 points.**) The index of refraction of diamond is 2.4. Determine the critical angle for total internal reflection at a diamond-air interface.

5. (**10 points.**) Determine the equivalent capacitance between points A and B in the circuit in Figure 4. Given $C_1 = 10.\,\text{nF}$, $C_2 = 20.\,\text{nF}$, $C_3 = 30.\,\text{nF}$, $C_4 = 40.\,\text{nF}$, and $C_5 = 50.\,\text{nF}$.

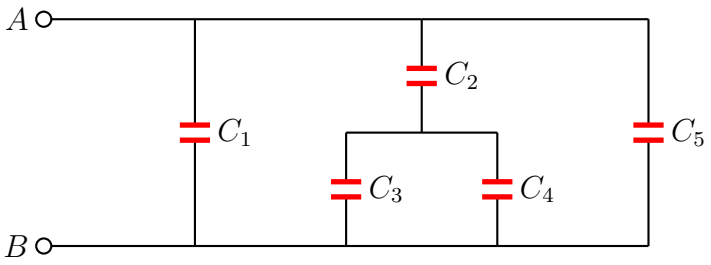

Figure 4: Problem 5

6. (**10 points.**) A 1.0 cm object is placed upright at a distance 30. cm away from a concave mirror. The mirror's focal length is 10. 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 and accuracy.

7. (**10 points.**) A 1.0 cm object is placed upright at a distance 20.0 cm away from a concave 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 and accuracy.