# Final Exam (2016 Fall)

## PHYS 205B: University Physics

Date: 2016 Dec 15

(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.**) Four identical charges of equal magnitude $q$ are placed at the corners of a square of length $L$. Determine the magnitude and direction of the electric field at the center of the square.

2. (**10 points.**) An electron and a proton, starting from rest, are accelerated through an electric potential difference of the same magnitude. In the process, the electron acquires a speed $v_e$, while the proton acquires a speed $v_p$. Find the ratio of their kinetic energies.

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

4. (**10 points.**) A proton moving at $4.50 \times 10^6\,\text{m/s}$ through a magnetic field of magnitude $1.00\,\text{T}$ experiences a magnetic force of magnitude $3.60 \times 10^{-13}\,\text{N}$.

   (a) What is the angle between the proton's velocity and the direction of magnetic field?

   (b) Is the answer unique? If not, report all possible angles.

5. (**10 points.**) A loop in the shape of a right triangle, carrying a current $I$, is placed in a magnetic field $\vec{\mathbf{B}}$. (Choose $\hat{\mathbf{z}}$ to be out of the page.) Find the analytic expression for the magnetic force on side '1' of the loop in terms of $I$, $B$, $x$, $y$, and unit vectors $\vec{\mathbf{i}}$, $\vec{\mathbf{j}}$, $\vec{\mathbf{k}}$.

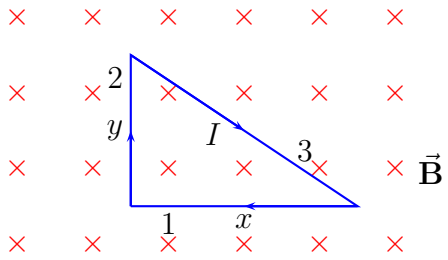


Figure 1: Problem 5.

6. (**10 points.**) Figure 2 shows five snapshots of a rectangular coil being pushed across the dotted region where there is a uniform magnetic field directed into the page. Outside of this region the magnetic field is zero. Determine the direction of induced current in the loop at each of the five instances in the figure.

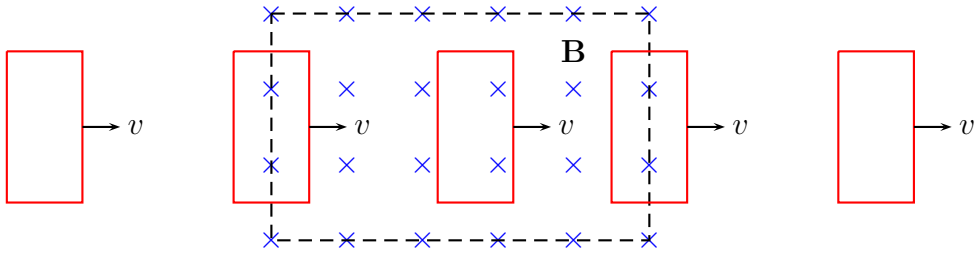


Figure 2: Problem 6.

7. (**10 points.**) The distance to the North Star, Polaris, is approximately $6.44 \times 10^{18}$ m. If Polaris were to burn out today, how many years from now would we on Earth see it disappear?

8. (**10 points.**) A glass optical fiber ($n = 1.50$) is submerged in water ($n = 1.33$). What is the critical angle for light to stay inside the fiber?

9. (**10 points.**) A 1.0 cm object is placed upright at a distance 40.0 cm away from a convex mirror. The mirror's focal length is 10.0 cm.

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

   (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.

10. (**10 points.**) A 1.0 cm object is placed upright at a distance 40.0 cm away from a convex 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.