

**Final Exam (2021 Fall)**  
**PHYS 205B: University Physics**

Date: 2021 Dec 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 9 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. **(5 points.)** What is the magnitude of the electric field inside a perfectly conducting sphere?

2. **(5 points.)** The electric potentials at the two ends of a  $1.5\text{ k}\Omega$  resistor in a circuit is measured to be  $6.0\text{ V}$  and  $1.5\text{ V}$ . Determine the current passing through the resistor.

3. (5 points.) What is the difference between a virtual image and a real image. Give an example of a real image.

4. (5 points.) Can the refractive index of a material be less than unity? Explain.

5. (10 points.) Four charges  $q_1 = q$ ,  $q_2 = -q$ ,  $q_3 = -q$ , and  $q_4 = q$ , 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 1. Determine the total electric field at the center of the square.

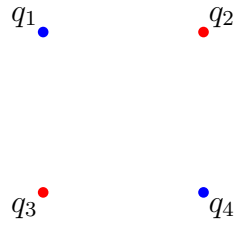


Figure 1: Problem 5

6. (10 points.) Four charges  $q_1 = q$ ,  $q_2 = -q$ ,  $q_3 = -q$ , and  $q_4 = q$ , 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 2. What is the total electric potential energy of the configuration.

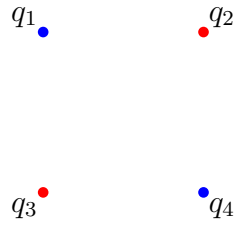


Figure 2: Problem 6

7. (10 points.) A loop in the shape of a right triangle of sides  $a = 3.0$  cm and  $b = 2.0$  cm, carrying a current  $I = 2.0$  A, is placed in a magnetic field 0.30 T as shown in Figure 3. Determine the magnitude and direction of the force on side 2 of the triangle.

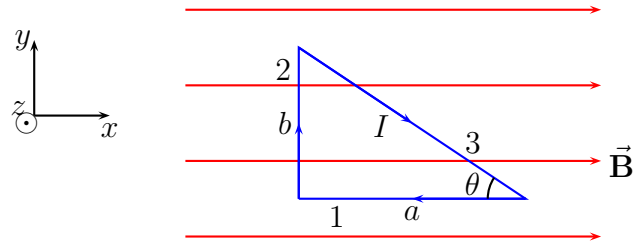


Figure 3: Problem 7



8. (10 points.) A 1.0 cm object is placed upright at a distance 15.0 cm away from a concave 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 and accuracy.

9. (10 points.) A 1.0 cm object is placed upright at a distance 10.0 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.