

# Midterm Exam No. 01 (Fall 2024)

## PHYS 205B: UNIVERSITY PHYSICS

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

Date: 2024 Sep 17

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(Name)

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### Instructions

1. Seating direction: On even-numbered seats in alternate rows A, C, E, . . . .
2. Total time = 75 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. 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.)** A conductor with no net charge on it is placed in a uniform electric field. Using a diagram describe the redistribution of the charges inside the conductor.

2. (5 points.) Draw the electric field lines for a configuration of two identical positive charges placed a fixed distance apart.

3. (**5 points.**) A spherical conductor of mass 1.0 gram with a charge  $+8.2\mu\text{C}$  on it is placed in a uniform electric field of magnitude  $1.0 \times 10^3 \text{ N/C}$ . Neglect gravity. Determine the acceleration of the conductor.

4. (5 points.) Consider a configuration consisting of two charged concentric spherical shells of radius  $a$  and  $b$  with charges  $Q_a$  and  $Q_b$ , respectively. Let us have  $a < b$ . Given  $a = 1.0$  cm,  $b = 2a$ ,  $Q_a = -3.5$  nC, and  $Q_b = -5.4$  nC. See Figure 1. Determine the total electric flux passing through a closed surface of concentric sphere of radius  $c = 3a$  enclosing the charges.

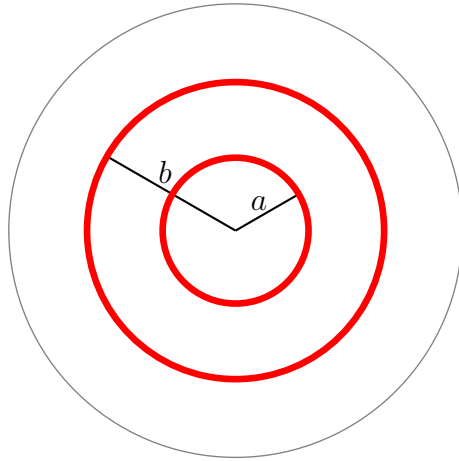


Figure 1: Problem 4

5. (10 points.) Three charges  $q_1 = +q$ ,  $q_2 = +2.0q$ , and  $q_3 = -q$ , with  $q = 1.0 \text{ nC}$ , are placed at three corners of a square of side  $L = 3.0 \text{ cm}$ , such that  $q_1$  and  $q_2$  are at diagonally opposite corners. Refer Figure 2. Calculate the magnitude and direction of the total electric force on charge  $q_3$ .

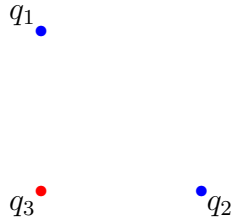


Figure 2: Problem 5

6. (10 points.) Two charges,  $q_1 = +1.00 \mu\text{C}$  and  $q_2 = -4.00 \mu\text{C}$  are a distance  $D$  apart. Refer Figure 3. As a multiple of distance  $D$ , at what coordinate  $x$  on the line connecting the two charges is the total electric field zero?

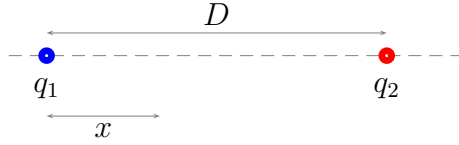


Figure 3: Problem 6

7. (10 points.) A charge  $q$  is placed at the origin. Point  $A$  is a distance  $s$  on the  $x$  axis from the charge and point  $B$  is a distance  $t$  on the  $y$  axis from the charge. Find the electric potential difference between points  $A$  and  $B$  in Figure 4. Given  $q = +1.0 \text{ nC}$ ,  $s = a$ ,  $t = 2a$ ,  $a = 3.0 \text{ cm}$ .

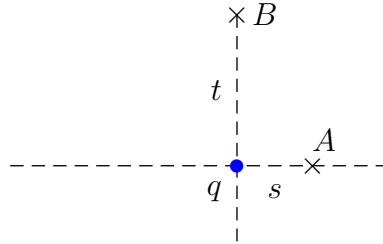


Figure 4: Problem 7