Midterm Exam No. 01 (Fall 2025)

PHYS 205B: UNIVERSITY PHYSICS

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

Date: 2025 Sep 18

(Name) (Signature)

Instructions

1. Seating direction: In alternate rows, B, D, F, . . . , on even-numbered seats.
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. 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.**) Two identical conducting spheres A and B carrying equal charges are hung from a ceiling by insulating strings. The spheres repel each other. See Figure 1. What happens when a third grounded conducting sphere C is brought in between the spheres A anf B? Hint: Ground means a reservoir of charges.

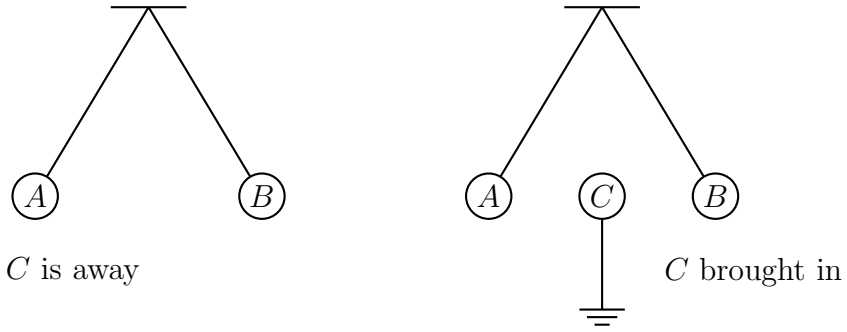

Figure 1: Problem 1

2. (**5 points.**) A positive charge is placed in the electric field described by the electric field lines in Figure 2. Where should it be placed so that it experiences the largest magnitude of force.

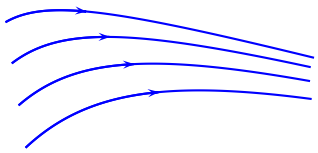

Figure 2: Problem 2

3. (**5 points.**) An electron and a proton are released from rest in a uniform electric field. [Recall that a proton is about 1800 times heavier than an electron.] In the same time interval Δt which of them picks up a higher speed?

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 $a = 1.0\,\text{cm}$, $b = 2a$, $Q_a = +8.85\,\text{nC}$, and $Q_b = -8.85\,\text{nC}$. See Figure 3. Determine the total electric flux passing through a surface of concentric sphere of radius $c = 3a$ enclosing the two shells.

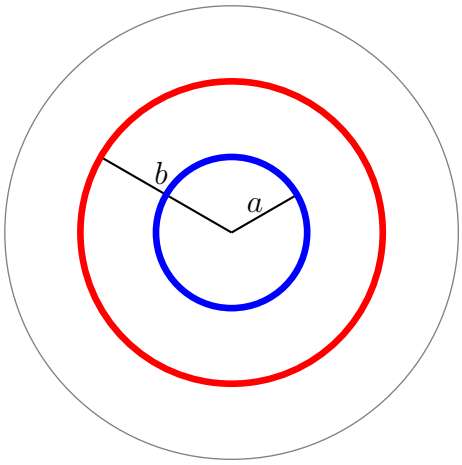

Figure 3: Problem 4

5. (**10 points.**) Three charges $q_1 = -q$, $q_2 = +q$, and $q_3 = +q$, with $q = 1.0\,\text{nC}$, are placed at the corners of an equilateral triangle of side $L = 3.0\,\text{cm}$. Refer Figure 4. Calculate the magnitude and direction of the total electric force on charge q_1.

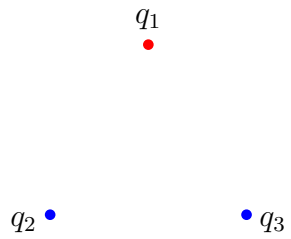

Figure 4: Problem 5

6. (**10 points.**) Two charges $q_1 = +q = +1.0\,\text{nC}$ and $q_2 = -q$ are placed at diagonally opposite corners of a square of side $L = 3.0\,\text{cm}$. Refer Figure 5. Calculate the magnitude and direction of the total electric field at the vertex of the square marked $\times$.

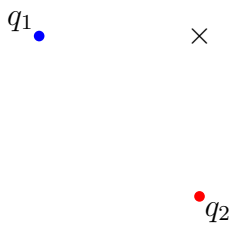

Figure 5: Problem 6

7. (**10 points.**) Two charges $q_1 = +q = +1.0\,\text{nC}$ and $q_2 = -2q$ are placed at diagonally opposite corners of a square of side $L = 3.0\,\text{cm}$. Refer Figure 6. Calculate the electric potential difference between the other two corners of the square marked $\times$.

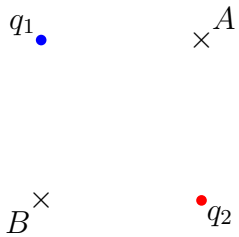

Figure 6: Problem 7