Midterm Exam No. 01 (2023 Fall)

PHYS 205B: UNIVERSITY PHYSICS

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

Date: 2023 Sep 19

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 4.
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 charged conducting sphere is brought close to another neutral spherical insulator. (The spheres are not allowed to touch.) Is the electric force between the spheres zero? If not, is the force attractive or repulsive?

2. (**5 points.**) A positive charge is placed in the electric field described by the electric field lines in Figure 1. Where should it be placed so that it experiences the largest magnitude of force.

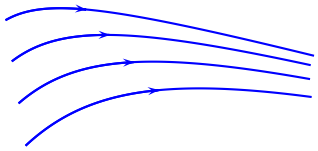

Figure 1: Problem 2

3. (**5 points.**) A spherical thin conducting shell of radius a has a negative charge $-16\,Q$ on it. Another concentric spherical thin conducting shell of radius $b > a$ has a positive charge $+17\,Q$ on it. Using Gauss's law determine the expression for the electric field outside the shell of radius b?

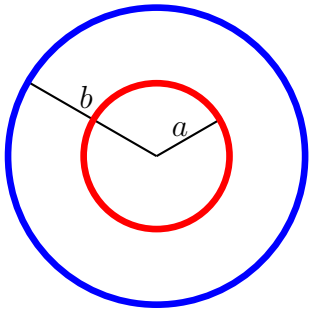

Figure 2: Problem 3

4. (**5 points.**) Draw equipotential surfaces associated with the electric field lines of a negatively charged sphere shown in Figure 3.

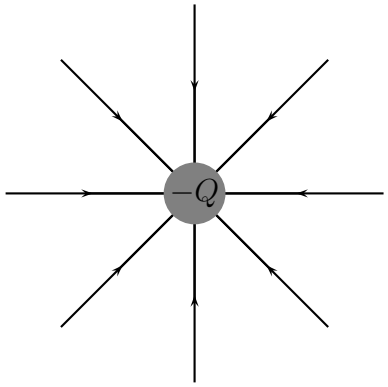

Figure 3: Problem 4

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 4. Calculate the magnitude and direction of the total electric field at the center of the square.

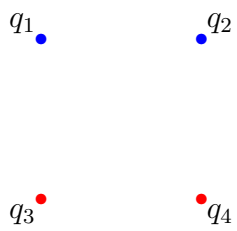

Figure 4: Problem 5

6. (**10 points.**) An electron and a proton are released from rest in a uniform electric field. The particles attain speeds v_e and v_p in a time Δt. Determine the ratio v_e/v_p.

7. (**10 points.**) Determine the total energy required to assemble one negative charge $q_1 = -Q$ and two positive charges $q_2 = +Q$, $q_3 = +Q$, at the corners of an equilateral triangle of sidelength L. Assume that the charges are brought from infinity.

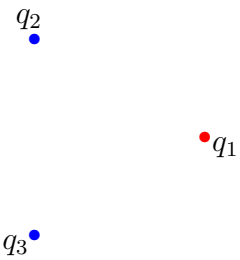

Figure 5: Problem 7