Midterm Exam No. 02 (Spring 2025)

PHYS 205B: UNIVERSITY PHYSICS

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

Date: 2025 Mar 6

(Name) (Signature)

Instructions

1. Seating direction: On even-numbered seats in alternate rows, B, D, F, ...
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. Academic misconduct will lead to a failing grade in the course.

1. (**5 points.**) A sphere of radius 1.0 cm with uniform charge distribution $-Q = -3.0\,\mu$C is fixed at the origin. Point A is a distance 5.0 cm away from origin and point B is a distance 10.0 cm away from origin. Refer Figure 1. Relative to Point A, is point B at a higher or lower electric potential?

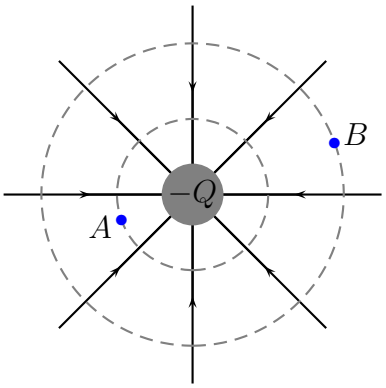

Figure 1: Problem 1

2. (**5 points.**) Determine the equivalent resistance between points a and d in the circuit shown in Figure 2. Given $R_1 = R_2 = R_3 = R$.

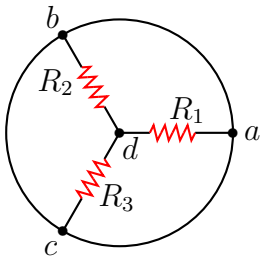

Figure 2: Problem 2

3. (**5 points.**) A 'zero-watt' bulb consumes about 12 watts of power. In early days this was too low power and it came to be known as zero-watt bulb. How much energy (in Joules) is consumed by a zero-watt bulb in one year if it is left on continuously.

4. (**5 points.**) Given R is resistance and C is capacitance, deduce the dimension of the quantity represented by the product

$$RC. \tag{1}$$

5. (**10 points.**) Four charges $q_1 = q = +1.0\,\text{nC}$, $q_2 = -2q$, $q_3 = -3q$, and $q_4 = +3q$, are placed at the corners of a square of side $L = 6.0\,\text{m}$, such that q_1 and q_4 are at diagonally opposite corners. Refer Figure 3. Points a, b, c, and d, are midpoints on the sides of the square, and point e is the center of the square. Calculate the electrical potential difference between points b and e. That is, calculate

$$(V_b - V_e). \tag{2}$$

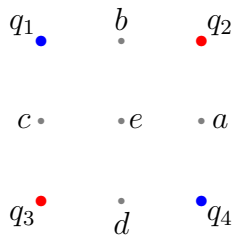

Figure 3: Problem 5

6. (**10 points.**) A potential difference $V = 10.0\,\mathrm{V}$ is applied across a capacitor arrangement with two capacitances connected in series, $C_1 = 1.0\,\mu\mathrm{F}$ and $C_2 = 2.0\,\mu\mathrm{F}$. Determine the electrical energies, U_1 and U_2, stored in the capacitors.

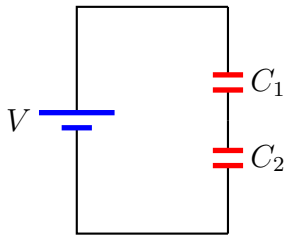

Figure 4: Problem 6

7. (**10 points.**) Consider the circuit in Figure 5 with $V_1 = 10.\,\mathrm{V}$, $R_1 = 10.\,\Omega$, $R_2 = 20.\,\Omega$, $R_3 = 30.\,\Omega$. Find the currents (with directions) through each of the resistors.

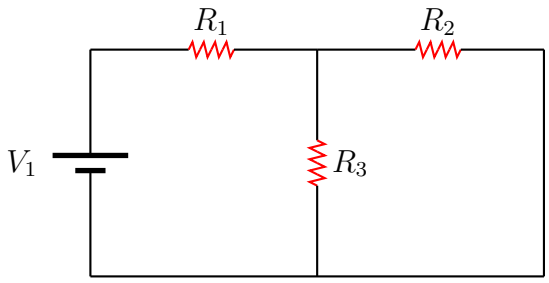

Figure 5: Problem 7