Midterm Exam No. 02 (Fall 2025)

PHYS 205B: UNIVERSITY PHYSICS

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

Date: 2025 Oct 9

(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 resistors $R_1 = 10.\,\Omega$ and $R_2 = 20.\,\Omega$ are connected in series. The electric potentials at the free ends of this combination is measured to be $V_a = 4.5\,\mathrm{V}$ and $V_b = -1.5\,\mathrm{V}$. Refer Figure 1. Determine the current passing through each of the the resistors.

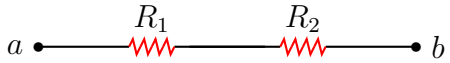

Figure 1: Problem 1

2. (**5 points.**) What is dimension of the ratio of capacitance of a capacitor and the permittivity of vacuum,

$$\frac{C}{\varepsilon_0}. \tag{1}$$

3. (**5 points.**) Charging the capacitor C in Figure 2, for the initial condition $Q(0) = 0$, is described by

$$Q(t) = CV\left[1 - e^{-\frac{t}{RC}}\right]. \tag{2}$$

At time $t = RC$ determine the amount of charge on the capacitor as a fraction of the maximum value of charge.

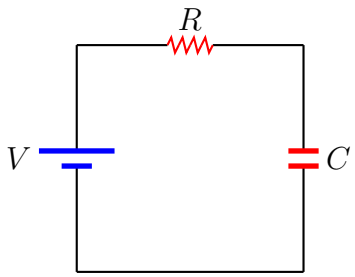

Figure 2: Problem 3

4. (**5 points.**) A proton at a moment in time has a velocity $2.0 \times 10^6\,\mathrm{m/s}$ in the same direction as the magnetic field of strength 0.30 T. What is the magnitude and direction of the magnetic force on the proton at this moment?

5. (**10 points.**) A potential difference $V = 10.\,\mathrm{V}$ is applied across a capacitor arrangement with two capacitors connected in parallel, $C_1 = 10.\,\mu\mathrm{F}$ and $C_2 = 20.\,\mu\mathrm{F}$. See Figure 3. Find the ratio U_1/U_2 of the potential energies stored inside the capacitors.

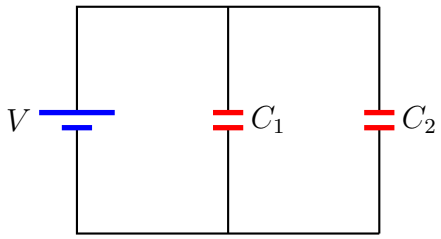

Figure 3: Problem 5

6. (**10 points.**) Determine the current in resistance R_1 in the circuit shown in Figure 4. Given $V = 5.0\,\mathrm{V}$ and $R_1 = R = 5.0\,\Omega$.

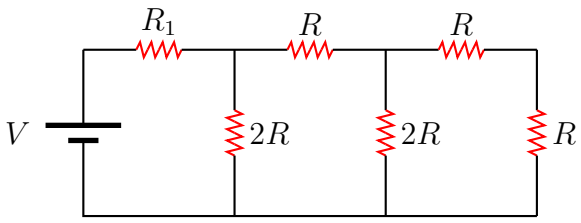

Figure 4: Problem 6

7. (**10 points.**) Consider the circuit in Figure 5. Determine the currents in each of the resistors. Given $R_1 = 10.\,\Omega$, $R_2 = 20.\,\Omega$, $V_1 = 10.\,\mathrm{V}$, and $V_2 = 20.\,\mathrm{V}$.

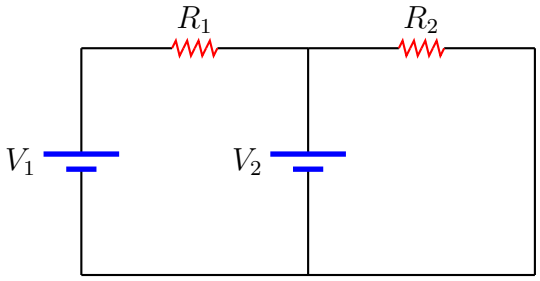

Figure 5: Problem 7