Midterm Exam No. 02 (2022 Fall)

PHYS 205B: UNIVERSITY PHYSICS

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

Date: 2022 Oct 18

____________________ (Name) ____________________ (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 2.
2. Total time = 75 minutes.
3. There are 4 conceptual questions and 4 problems in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to show your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. (**5 points.**) Two resistors $R_1 = 1.0\,\mathrm{k\Omega}$ and $R_2 = 2.0\,\mathrm{k\Omega}$ 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.**) Determine the equivalent resistance in the two circuits shown in Figure 2. Which one of the two has a larger equivalent resistance?

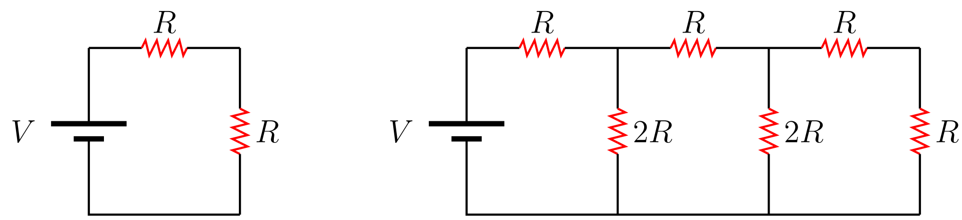

Figure 2: Problem 2

3. (**5 points.**) Draw an RC circuit. Give an application of RC circuit.

4. (**5 points.**) A charged particle initially moving with constant speed v enters a region of magnetic field $\mathbf{B}$ pointing into the page. It is deflected as shown in Fig. 3. What curve characterizes the path of the deflected particle? That is, what is the trajectory of the particle in the magnetic field.

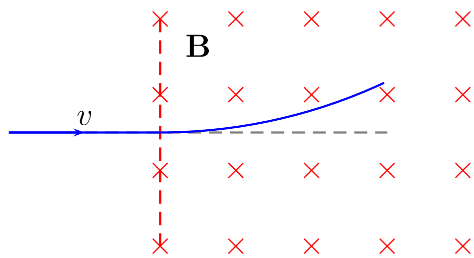

Figure 3: Problem 4

5. (**10 points.**) Four identical positive charges $q_1 = q_2 = q_3 = q_4 = q$, are placed at the corners of a square of side L. Refer Figure 4. What is the electric potential difference

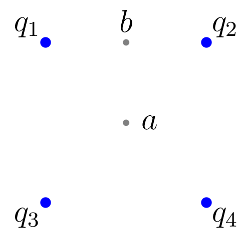

Figure 4: Problem 5

between points a and b? Given a is the center of the square and b is the midpoint of one of the sides.

6. (**10 points.**) In the circuit in Figure 5 determine the charge on capacitor C_2. Let $V = 10.0\,\mathrm{V}$, $C_1 = 10.0\,\mathrm{nF}$, $C_2 = 20.0\,\mathrm{nF}$, and $C_3 = 30.0\,\mathrm{nF}$.

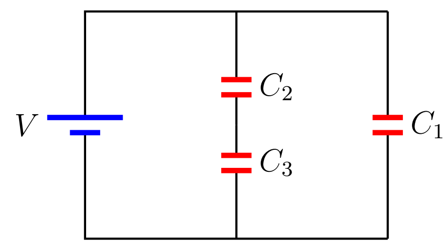

Figure 5: Problem 6.

7. (**10 points.**) Resistance is inversely proportional to the area of crosssection A and proportional to the length l, such that

$$R = \frac{\rho l}{A}, \tag{1}$$

where ρ is the resistivity of the material. A cylindrical copper rod has resistance R. It is reformed to twice its original length with no change of volume. What is its new resistance in terms of the original resistance R?

8. (**10 points.**) Consider the circuit in Figure 6. Determine the currents in each of the resistors. Let $R_1 = 100.\,\Omega$, $R_2 = 200.\,\Omega$, $V_1 = 10.0\,\text{V}$, and $V_2 = 20.0\,\text{V}$.

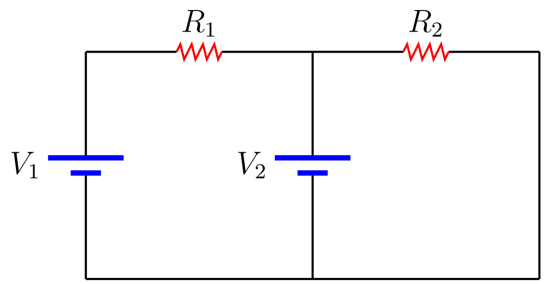

Figure 6: Problem 8