Name: _____

# PHYS 1220-02 Quiz 5

You may use an 8.5"×11" note sheet written on both sides, a calculator of any type, and a slice of bread. Please write your answers in the boxes provided. Show your work outside the boxes. If you wish to change an answer written in a box, thoroughly erase the unwanted answer and write the desired answer in its place. If a numerical answer is a physical quantity rather than a pure number, include the units with your answer.

"Multiple choice" questions, in which only one answer is correct, have circular bubbles (○): select exactly one choice. "Select all" questions, in which any number of the choices may be correct, have square bubbles (☐): select all correct answers. Select your choice by filling the circle or square: please do not "X", check, circle, or otherwise mark your choice. Do not mark bubbles for rejected options.

If the point value of a question is not indicated, it is worth one point.

## Constants and equivalents

Elementary charge $e$: $1.602 \times 10^{-19}$ C
Coulomb's constant $k$: $8.988 \times 10^{9}$ N·m$^2$/C$^2$
Permittivity of free space $\varepsilon_0$: $8.854 \times 10^{-12}$ C$^2$/(N·m$^2$)

## Questions

1. A 75-watt light bulb dissipates energy at the rate of 75 joules per second when the voltage across it is 120 volts.

   A. What is the resistance of the light bulb?

   B. What is the current through the light bulb?

   C. How many coulombs of electric charge pass through the light bulb in one hour?

2. A 100-watt light bulb dissipates energy at a rate of 100 joules per second when the voltage across it is 120 volts. How does the current through the 100-watt bulb compare to the current through a 75-watt bulb operating at 120 volts?

   ○ a. There is more current through the 100-watt bulb.

   ○ b. The same current runs through the 100-watt and 75-watt bulbs.

   ○ c. There is more current through the 75-watt bulb.

3. (4 points) I want to design a heating element for an electric stove that will dissipate heat at the rate of 1.20 kilowatts at a voltage of 240 volts when the element is 80.0 centimeters long. The material of the element has an electrical resistivity of $1.10 \times 10^{-6}\ \Omega \cdot \mathrm{m}$. What must the cross-sectional area of the element be?

4. (4 points) Tell me the voltage across each resistor and the current through each resistor in the circuit diagrammed below.

$V_1$: _____ V

$V_2$: _____ V

$V_3$: _____ V

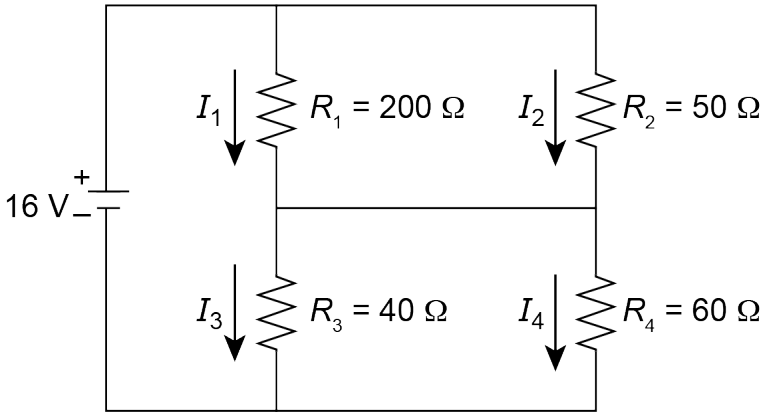
$V_4$: _____ V

$I_1$: _____ A

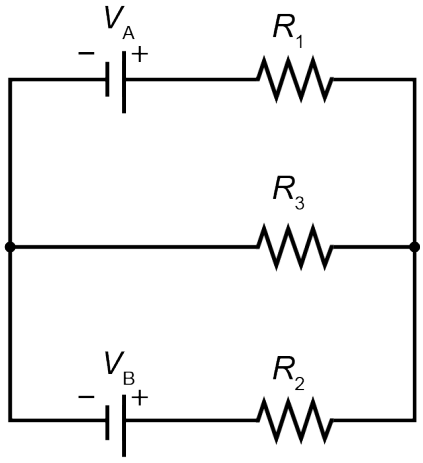
$I_2$: _____ A

$I_3$: _____ A

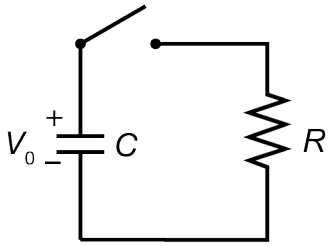
$I_4$: _____ A



5. (4 points) Set up a system of independent simultaneous equations to find the voltages across each of the three resistors in this circuit. Assume that the two voltages $V_A$ and $V_B$ are known, as are the three resistances $R_1$, $R_2$, and $R_3$. Identify the $N$ unknowns in the equation(s) and explicitly write down the $N \times N$ coefficient matrix **A**, the $N \times 1$ column vector of unknowns **x**, and the $N \times 1$ column vector of constants **b**, so that your system of equations is $\mathbf{Ax} = \mathbf{b}$. If the unknowns in your system of equations are not the resistor voltages, give the formulas to find the resistor voltages from the unknowns.



6. In the circuit illustrated at right, the capacitor has capacitance $C = 150$ microfarads and the resistor has resistance $R = 12.0$ kilohms. The capacitor is initially charged to a voltage of $V_0 = 20.0$ volts. The switch closes at time $t = 0$.




A. What is $I_0$, the current through the circuit immediately after the switch closes?

B. What is the time constant $\tau$ of this circuit?

C. In how much time after the switch closes will the current equal $I_0/6$?

D. In how much time after the switch closes will the voltage across the capacitor equal $V_0/6$?