AP Physics C Name: _____

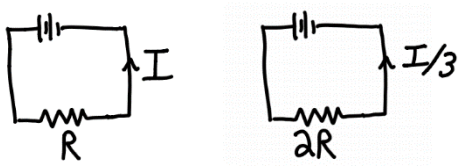
Unit 4 Test: Circuits

You must show all steps required to arrive at the correct answer for the problem below, including any diagrams. **All answers must be given with correct units.**

1. A battery is connected to a 5.0 **Ω** resistor to a variable power supply. The voltage given by the power supply is given by $V(t) = 10e^{-0.5t}$ How many electrons pass through the resistor from t = 0 to t = 2 s?

2. A computer is connected to a 120 V power source and is left on for 10 hours while it runs Rome: Total War and plays "Africa" by Toto at full blast. If the total cost to run the computer is $0.25 and electricity costs $0.10 per kW-hr, what is the approximate current that runs through the computer?

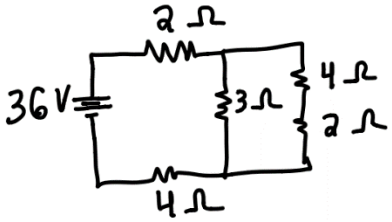
3. When a battery is connected to an external resistance R, as shown on the left, there is a current I in the circuit. When the external resistance is changed to 2R, the current changes to I/3, as shown on the right. What is the internal resistance of the battery?



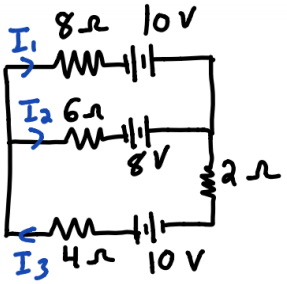
4. Elon is testing a power source and applies a fixed voltage to a copper wire ($\alpha = .00393\ /°C$), creating a current of 3.0 A when the wire is at room temperature (22 °C). What temperature must the wire be at in order to produce a current of 2.7 A with the same voltage applied?

5. Two identical resistors are connected in parallel to the battery. In this case, the current is I. If both resistors are doubled in length (with the same material and cross-section area), and then wired in series, what would the new current be? (assume the voltage source is the same)

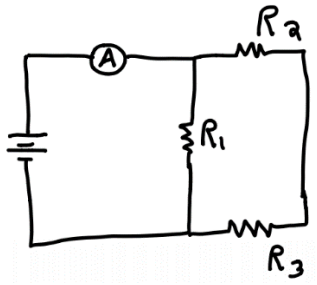
6. Check out that circuit to the right.
   a) Calculate the current in:
      i. The 3 ohm resistor
      ii. 2 ohm resistor on the **left.**
      iii. The 4 ohm resistor on the **right.**
   b) In which resistor is heat being generated at the fastest rate? Justify your answer.



7. Look, it's another circuit on the right. This one has loops. Calculate the values of $I_1, I_2, and\ I_3$. Also specify the direction of each (CW or CCW).



8. In the circuit shown, an ideal DC power supply is connected to an ammeter and three resistors. The resistances of two of the resistors $R_2 = R_3 = 40\ \Omega$ are known and labeled, but R_1 is unknown.



a) Outline why the ammeter is wired in series.

Data is collected on the potential difference across the power supply and the current measured by the ammeter. The data is given in the charge below. Using the data from the chart, calculate the value of R_1.

Potential Difference (V)	1		2	4	6	8	10
Current (A)	0.03		.04	.06	0.10	0.14	0.16

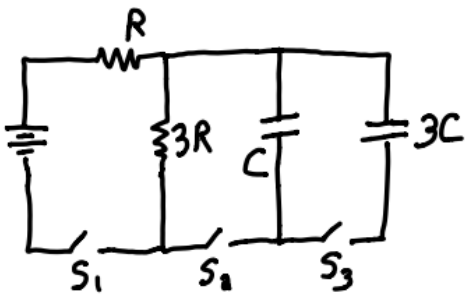
b) Using the data from the chart, calculate the value of R_1.

The power supply is now fixed at 20 V.

b) Calculate the current through R_2.

c) Calculate the amount of energy dissipated in R_2 in one minute.

9. Consider the circuit shown on the right. The batter has a voltage of 120 V. The current has 2 resistors and 2 capacitor as shown, with $R = 100\ \Omega$ and $C = 2\ F$.



Switches $S_1, S_2, and\ S_3$ are initially open.

a) Switches S_1 and S_2 are closed at time t = 0.

i. What is the steady state voltage stored in the capacitor?

ii. Determine an expression for the voltage in the capacitor vs time using integral calculus.

iii. Calculate the time at which the voltage stored in the capacitor reaches 20 V.

b) Now, switches S_1 and S_2 are closed. Switch S_3 is now closed.

i. Calculate the steady-state charge on the rightmost capacitor (3C).

ii. Determine the energy dissipated as the capacitors reach a steady state.