Your name: _____ TA name: _____

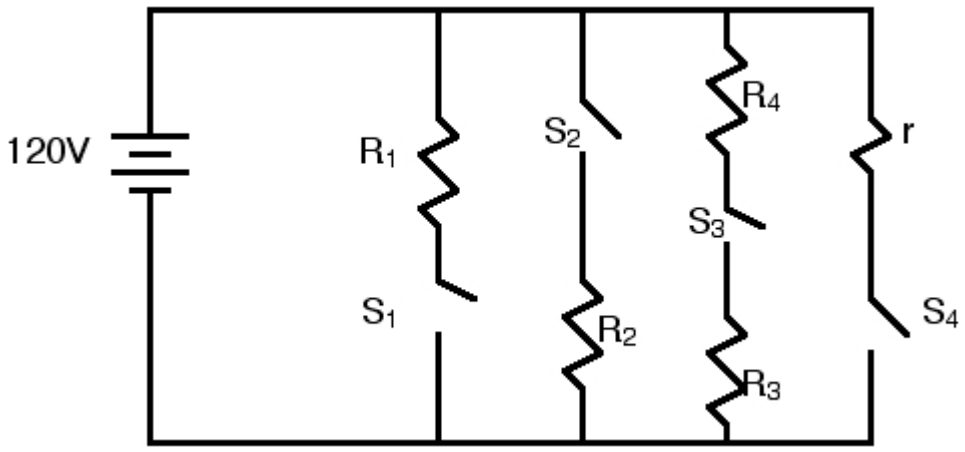
Written HW 3: Home wiring
(due Thurs, Sep 30 2010 at 5 PM)

Turn in this written homework in the appropriate slot in the brown Homework Cabinet at the entrance of the HelpRoom, Duane G2B90. Please STAPLE pages together, and **put your name and TA name at the top of every page!**

In all written homework, you will be graded on the clarity and completeness of your answer. ***No credit*** *will be given for an answer in a calculation without a derivation, even if the answer is correct. A calculation without units is also incorrect.*

You wish to wire some lights and a hairdryer together with some switches in your apartment (not a great idea unless you know what you are doing). You wire two 60 watt light bulbs, a 100 watt light bulb and a 1500 watt hairdryer together with four switches as shown. The voltage supply is from a plug in the wall (120 volts). (That supplies AC current, but let's assume for simplicity it is DC as shown.)

Note that the wattage value listed on the bulb package assumes that 120 volts will be applied across the bulb. If a different voltage is applied to the bulb, a different amount of power will be used. The same holds for the dryer. What's constant for each, regardless of the voltage applied, is its *resistance*. So we can think of each appliance as a resistor sitting in the circuit.



Switches S_1, S_2, S_3, and S_4 can be open (no current will flow) or closed (current flows through the switch freely). Resistors R_1 and R_3 are the 60 watt bulbs, R_2 is the 1500 watt hairdryer and R_4 is the 100 watt light bulb. Switch S_4 is open for now. The resistor r is 1 Ω. It represents a possible short-circuit that develops if switch S_4 is closed.

1. Discuss what happens when just switch S_1 is closed. Explain the path of the current in the circuit. Determine the total current and power produced by the voltage supply. How much power is dissipated in resistor R_1? Does it matter whether the switch is above or below the resistor in the schematic (Why or why not)?

2. Discuss what happens when just switch S_3 is closed. Explain the path of the current in the circuit. Determine the total current and power supplied by the voltage supply. How much power is dissipated in resistors R_3 and R_4? Do the bulbs light up properly? Which one is brighter? Why? Would it matter if you switched the positions of R_3 and R_4 in the schematic (Why or why not)?

3. Discuss what happens when switches S_1 and S_2 are *both* closed and the other switches are open. Determine the total current and power supplied by the voltage supply. Explain the path of the current in the circuit and how the current divides up in order to power the bulb and the hairdryer. What is the power dissipated in each resistor? Do both the bulb and the hairdryer operate normally?

4. Suppose switches S_1 and S_2 are closed as in the previous part, so the 60 watt bulb and the hairdryer are both on. Also suppose your cat chews on the power cord. When the insulation between the two wires is scraped away, the effect is the same as closing switch S_4 so that the 1 Ω short-circuit resistance becomes part of the circuit when the two sides of the wire in the cord touch. (If the cat is quick he can get away safely.) Explain what happens. Determine the current and power supplied by the voltage supply. Where in the circuit is almost all of the power dissipated? What happens to the wire the cat chewed through? Explain why this is very hazardous. Would your analysis change if the short-circuit was on the left side rather than the right side of the schematic?

5. Why is home wiring protected by a **circuit breaker** switch? Look up and explain what a circuit breaker does and why it prevents fires (there is a good explanation in Giancoli section 18-6). Show where you would wire the circuit breaker into this circuit to protect against a short-circuit anywhere in the wiring.