Series & Parallel Circuits
Spring 2008

Introduction

The purpose of this experiment is to observe the behavior of current & voltage for *two* resistors connected in series and in parallel, and to measure the equivalent resistance of these pairings. Also, you will observe the results of a short circuit and an open circuit.

Recall that voltage is measured *across* a circuit element, and current is measured *through* the element. Be sure to connect the voltmeters and ammeters *after* the circuit has been assembled. This will ensure that the circuit is connected properly for your measurements. And remember not to pull on the wires, only the end connectors.

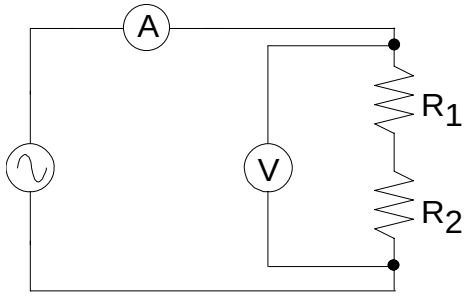
Experiment

1. *Resistors in series:*

a. Set the multimeter so that it can measure resistance directly. Measure the resistance of each resistor *without* connecting them to a circuit.

b. Connect the two resistors together in *series* (don't connect the resistors to any voltage source or other meters at this time). Use the multimeter to measure the *equivalent resistance* for the pair of resistors. Compare this reading to the sum of the measured resistances from the previous step.

c. Now connect the two resistors and an ammeter in series to the voltage source as shown at right, and set the current to 0.5 A. Draw a circuit diagram, and measure the *voltage* at these three locations:



i. Across the *pair* of resistors (as shown).

ii. Across *each* resistor.

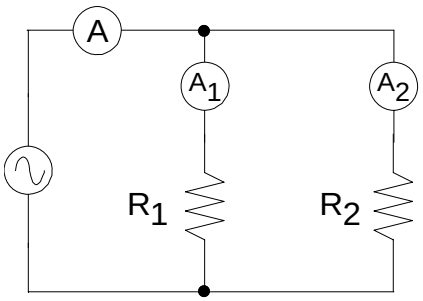
iii. Across the battery.

How are these voltages related? What can you say about voltages in series? *Be sure to show the position of the voltmeter in your diagram as it was moved around the circuit.*

d. Remove the voltmeter from the circuit. Check that the current is set to 0.5 A. Turn off the variac by pressing the power button, and move the ammeter *between* the two resistors. Turn on the variac, and record the current. Repeat once again, this time moving the ammeter to the *other* side of the pair of resistors. How are the currents through R_1 and R_2 related? Draw another circuit diagram that shows the position of the ammeter as it was moved around the circuit.

2. *Resistors in parallel:*

a. *Turn the knob on the variac down to zero, and turn it off.* Connect the two resistors in parallel, and place the ammeter in position **A**, as shown in the figure to the right. Turn on the variac, and adjust the knob until the current through the circuit is 0.6 *A*. Also measure the voltage across each resistor, without changing the variac setting. How are the voltages across the resistors in parallel related?



b. Turn off the variac (leave the knob in position), and move the ammeter to position $\mathbf{A_2}$. Turn the variac back on, and measure the current through resistor 2.

c. Again turn off the variac (still leaving the knob in position), and move the ammeter to position $\mathbf{A_1}$. Check with your instructor that the meter is connected correctly, turn on the variac and measure the current through resistor 1.

d. How are the currents you measured related? Calculate *I* from your measured currents through each resistor.

e. Disconnect the two resistors from the rest of the circuit, but leave the pair connected to each other. Measure the equivalent resistance for the pair of resistors as before, and compare your reading to the expected value.

3. *Open circuits:*

a. Obtain two bulbs of the same wattage, and connect them in *series* (*no meters are necessary for this circuit*). Draw a circuit diagram, and turn up the variac to the 100 setting on the dial. Unscrew one of the bulbs a few turns. What happens? Screw this bulb back in, then unscrew the other. Use your circuit diagram to briefly explain what you observed (represent the bulb that was unscrewed by omitting it from the diagram and leaving a gap in its place).

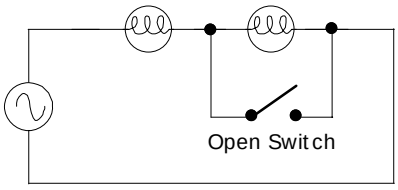
b. Turn off the variac using the power button, leaving the dial set to 100. Connect the two bulbs in *parallel*, draw a circuit diagram, and turn on the variac. Repeat the experiment above, record your observations, and use your circuit diagram to explain the results. Describe the appearance of the bulbs at each step, and compare to their appearance when connected in series.

c. Based upon your observations, explain whether you think the light bulbs in your house are wired in parallel or series. Why are the lights brighter when connected in parallel?

4. *Short circuits – Bulbs in series:*

Important Note: Have your instructor check your circuit before turning on the variac!

a. Connect two *AC* light bulbs in series, as shown in the sketch (again, no meters are required). Your instructor will show you how to connect a knife switch across one of the bulbs; draw a diagram of the connections. Make sure the switch is open, turn on the variac (set to 100 on the dial), and observe the results. Close the switch, and record your observations. Use your circuit diagram to briefly explain what you observed (draw a *closed* switch!).



5. *Short circuits – Bulbs in parallel:*

Important Note: This experiment cannot be performed when the bulbs are connected in parallel! Unplug the variac from the AC power before proceeding!

a. **Unplug the variac's power cord before connecting this circuit.** Connect the two bulbs in parallel, and include a switch to short out one of the bulbs. Draw a circuit diagram, and use it to explain why we can't turn the variac on without disastrous results.

Discussion:

- Summarize what you observed about the voltages of circuit elements in parallel. Likewise, what did you observe about currents of circuit elements in series?
- Also summarize what you observed about the equivalent resistance of a pair of resistors connected in series and in parallel.