PHY 152/252

Ohm's Law – Laboratory 2

OBJECTIVE

The objective is to measure the currents through, and voltages across resistors connected in series or parallel in simple DC circuits, and then use Ohm's law and the characteristics of series and parallel resistor circuits to determine the expected values and to compare them with the measured values.

Equipment List:

Power Supply
Beckman Multimeter
Extech Multimeter
Fixed Resistors: 200Ω (1), 100Ω (1), 50Ω (2)
Connection wires (7)

THEORY

Ohm's law states that the voltage (V) across a conductor is equal to the current (I) through the conductor multiplied by the resistance (R) of the conductor.

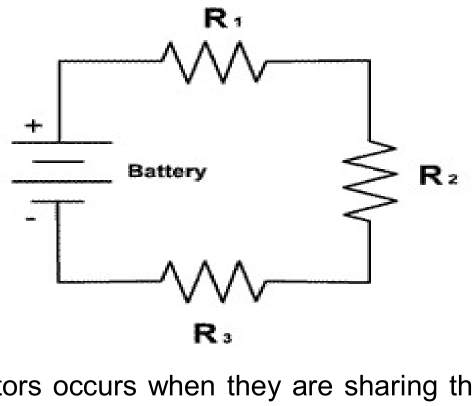
$$\mathbf{V = IR}$$

This simple relationship can be used to solve for one of voltage, current, or resistance if the other two values are known.

Multiple resistors can be combined in two basic ways: series or parallel. A series combination of resistors occurs when the resistors in question make up the only path that current can go. This means all resistors connected in series will have the same current flowing through them. The sum of the voltage drops across the individual resistors will equal the total voltage applied to the circuit from the EMF (shown below as a battery). A circuit with multiple resistors in series can be simplified into an equivalent circuit with one resistor that has a resistance equal to the sum of the resistance of the others. The equation is:

$$\mathbf{R = R_1 + R_2 + R_3 + \ldots}$$

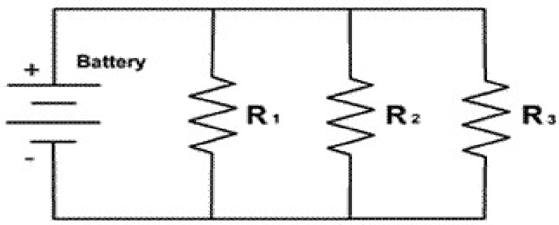
A series combination of resistors is depicted below.



A parallel combination of resistors occurs when they are sharing the same two nodes or points of connection within a circuit. Voltage is measured by a difference from two locations; and since resistors in parallel will be at the same two nodes they will have the same voltage across them. The total current in a parallel resistor circuit can be found by adding the currents going through each resistor. A circuit containing resistors in parallel can be simplified into a circuit with a single resistor by adding the resistance values inversely. The equation is:

$$1/R = 1/R_1 + 1/R_2 + 1/R_3 + \ldots$$

A parallel combination of resistors is depicted at the top of the next page.



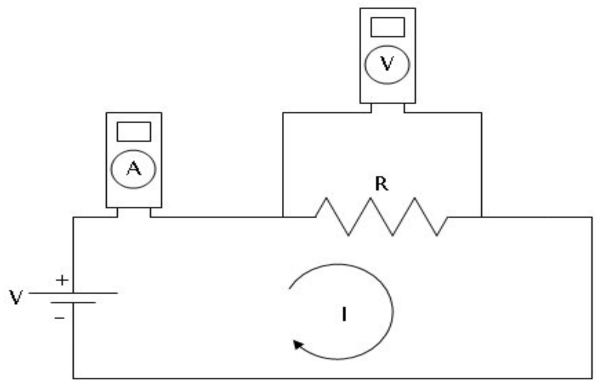
PROCEDURE

Use the Beckman multimeter as the ammeter and the Extech multimeter as the voltmeter. Use the **COM** port and the port labeled **A** when using the Beckman as the ammeter; and use the **COM** port and the far right port labeled for voltage when using the Extech as the voltmeter. Label your circuit diagrams with the color of wire you used for that portion of the circuit; so the instructor can check your circuit faster. On the Extech meter, turn the large knob 2 "clicks" clockwise to the DCV position and leave it there throughout the experiment. Turn the large knob on the Beckman meter counterclockwise until it points to the DC amps range at the position labeled "2" (2 amps maximum). If at any time during the experiment this reading is less than 0.2 amps, you may turn the knob one more click counterclockwise to the 200M (200 milliamps maximum) position, giving you one more decimal point of accuracy.

Note: where the word "battery" or the battery symbol appears in any circuit, you will use a regulated power supply. For best results, instead of relying on the power supply meter to validate 12 V or 6 V, use the Extech meter and measure the voltage directly at the output of the power supply. Your instructor can help you with this task if needed.

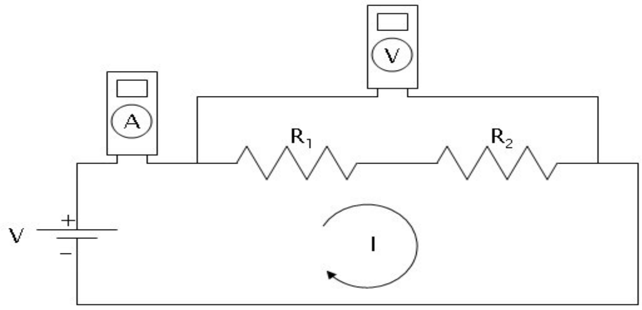
Caution: Do not switch on power at any time during this experiment until your lab instructor has approved your circuit, and do not exceed 12.0 V operating voltage for any part of this experiment.

1. Make sure the voltage control knob (the upper knob) is turned completely off (counterclockwise) and turn the current-limit knob fully clockwise. Set up the circuit shown below with the resistance value of R = 100 Ω. Have your circuit approved by your instructor.



2. Switch on the power supply. Measure the current through and voltage across the resistor for 11 values of input voltage, in one volt increments, ranging from 2 V through 12V. Make a table for your voltage and current values associated with this resistor to include in your lab report.

3. Switch off the power supply. Set up the circuit shown below using 50 Ω resistors for both R_1 and R_2. Have the circuit approved by your instructor.

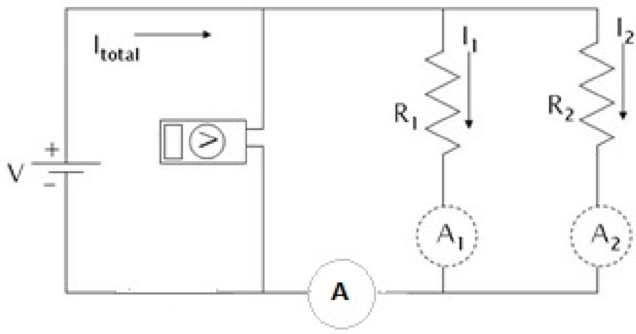


4. Switch the power supply on and adjust the voltage to 6 V. Record the current and voltage values as measured by your multimeters.

5. Reconnect the voltmeter across the two ends of R_1, leaving the rest of the circuit as is. Record the voltage drop across R_1 and the current through the circuit. Repeat this step for R_2

6. Repeat steps 3 - 5 with R_1 = 50Ω and R_2 = 100 Ω

7. Switch off the power supply. Set up the circuit shown below. Place the ammeter initially at point A. At this time, A_1 and A_2 are merely connections. Let R_1 equal 100 Ω and R_2 equal 200 Ω. Have your circuit approved by your instructor.



8. Switch on the power supply and adjust the voltage to 6 V. Record the total current and voltage values. Again, it's wise to use the Extech meter to validate this voltage.

9. Switch off the power supply, move the ammeter to position A_1, and close the circuit where the ammeter was located previously. Have the circuit approved. Switch on the power supply and leave the voltage at 6 V. Record the current I_1 through R_1 and the voltage across R_1. Note that the voltage across R_1 will be 6 volts if we neglect the voltage drop across the ammeter.

10. Repeat step 9 with the ammeter at position A_2. Record the current I_2 through R_2 and voltage across R_2. Again, the voltage across R_2 should be 6 volts if we neglect the effects of the ammeter.

CALCULATIONS

1. Plot the values obtained in procedure step 2 using Excel with the voltage, in volts, on the y-axis and the current, in amps, on the x-axis. Calculate a linear regression fit and display the slope of the

line on your graph. Determine the value of R from this slope. Compare it to 100 ohms by calculating the percent difference.

2. Using the circuit diagram in procedure step 3, calculate the expected current through the resistors and voltages across them using Ohm's Law. Use 6 V for the input voltage and your known resistance values. Compare both your calculated currents and voltages using Ohm's Law with your measured (experimental) results with percent differences.

3. Using the circuit diagram shown for procedure step 7, calculate the expected current through each resistor and the voltage across each resistor using Ohm's Law. Use 6 V for the input voltage and your known resistance values. Compare your calculated results with your measured (experimental) results with percent differences.

4. State possible sources of error for all parts of this experiment. For all parts of this experiment discuss the effects of the multimeters, which are known to be imperfect.