PH102 Lab III: dc Circuits

Introduction

At this point you should have connected the lab box to a USB port and started the tutorial software.

In this experiment we will determine how voltages are distributed in resistor circuits according to Ohm's law, and explore series and parallel combinations of resistors.

Resistance is a measure of a device's ability to conduct electric current for a given potential difference. The higher the resistance, the lower the current for a given voltage. Resistors are passive electronic devices which have fixed values. The resistance follows Ohm's Law:

$$V = IR \qquad (1)$$

The SI unit of resistance is the ohm, 1 Ω = 1 V/A. In general, the resistance can be calculated knowing the geometry of the device. For most practical devices, the resistor consists of a thin film or wire of a specific material with cross sectional area, A and length, l. The resistance is then given by:

$$R = \rho l/A \qquad (2)$$

where ρ is a materials parameter called the resistivity in Ω-m. The schematic symbol for a resistor is 

As is the case for capacitors, there are two ways to connect two passive (no polarity) components in an electronic circuit—series or parallel connection. In a series connection the components are connected at a single point, end to end as shown below:

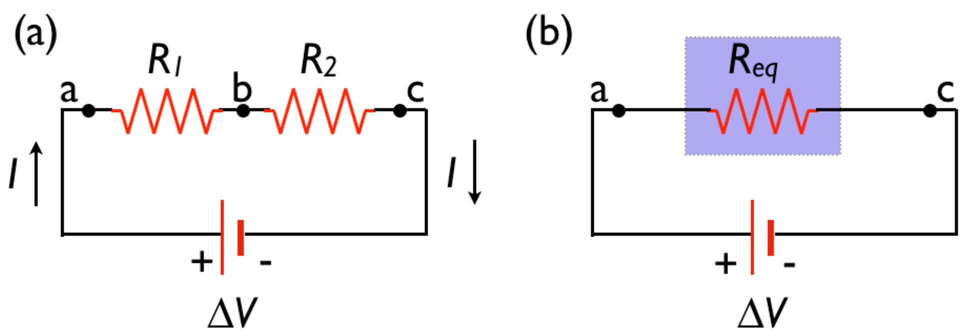

Figure 1: Series Resistors

For a series connection, the current through each resistor will be the same and the voltage drops will add. We can find the equivalent resistance, R_{eq}, from

$$IR_{eq} = V = V_1 + V_2 = IR_1 + IR_2 \quad (3)$$

So

$$R_{eq} = R_1 + R_2 \quad (4)$$

In the parallel connection, the components are connected together at both ends as shown below:

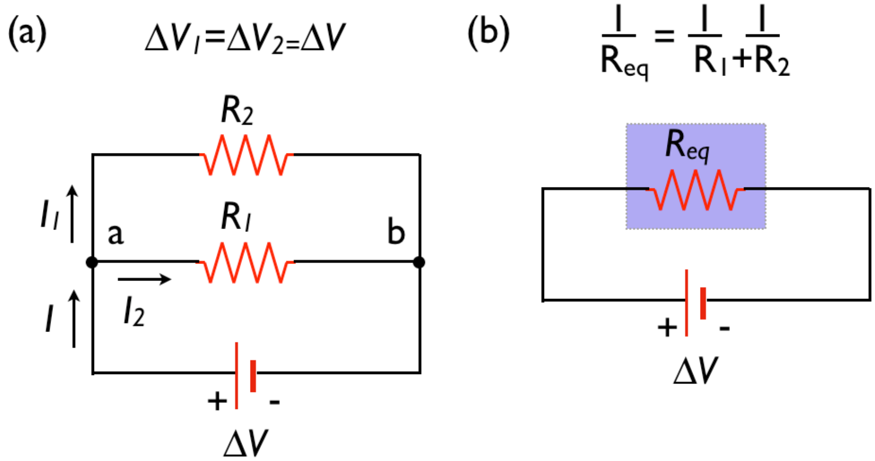

Figure 2: Parallel resistors

For a parallel connection, the voltage drops will be the same, but the currents add. Then the equivalent resistance can be calculated by adding the currents:

$$V/R_{eq} = I = I_1 + I_2 = V/R_1 + V/R_2 \quad (5)$$

So

$$1/R_{eq} = 1/R_1 + 1/R_2 \quad (6)$$

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Experiment I: Series resistors

This laboratory uses the tutorial software and hardware you were introduced to last time.

a) Connect two resistors in series by stacking the "banana" plugs.

b) Connect one side of one resistor to the "+Iout" terminal on the black "Labjack" box, and the other side of the second resistor to "-Iout". Do this such that current can go into one resistor, through the second, and back to the source.

c) ***Flip the switch on the side of the box to the "on" position***. No current is flowing yet.

d) Connect ***one of your resistors only*** "+Vin" and "-Vin" terminals. The +Vin connection should be on the same side of the resistor as the +Iout connection. The idea is to measure the voltage drop across only one resistor at a time.

d) In the tutorial software, choose "Voltage vs. Current"

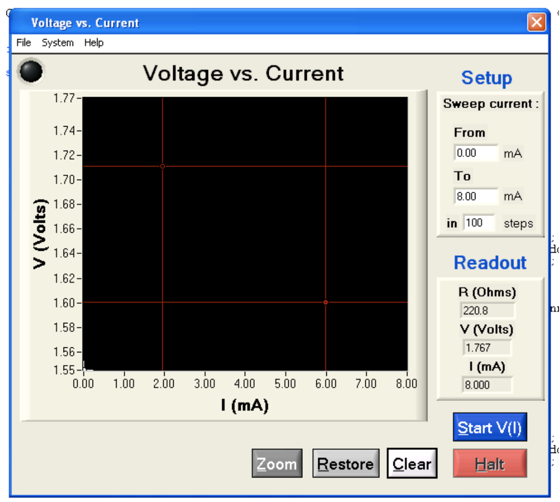

Figure 3: The voltage *vs.* current panel.

e) Sweep the current from zero to a few mA, until you generate a nice straight-line characteristic. From the "File" menu, save your data.

f) In Excel, plot the data as "X-Y scatter" and add a (linear) trendline. Print this plot (properly labeled).

g) From your trendline, record the slope of your line and the resistance.

Slope = ________________ V/A $\qquad$ R_1 = ___________________ Ω

h) repeat parts e-g for your second resistor.

Slope = _______________ V/A R_2 = __________________ Ω

i) repeat parts e-g while measuring the voltage across ***both resistors at once***

Slope = _______________ V/A R_{eq} = __________________ Ω

How well does your data support the rule for combining series resistors?

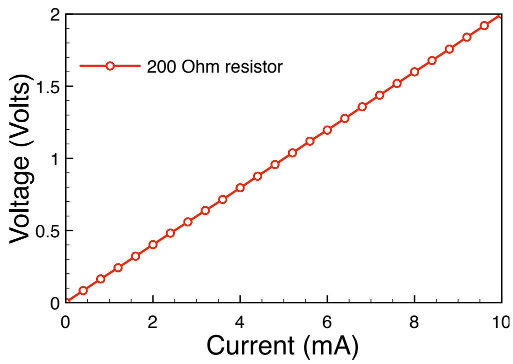

Figure 4: Example Voltage-Current plot.

Experiment II: Parallel Resistors

a) Using the same two resistors from Experiment I, now connect them in parallel.

b) repeat parts e-g above while measuring the voltage across both resistors.

Slope = _______________ V/A R_{eq} = __________________ Ω

Given the values of R_1 and R_2 from Experiment I, how well does your data support the rule for combining parallel resistors?

When you are finished:

- *Turn the switch on the side of the box "off."*
- *Straighten up your components and wires*
- *Turn in a hard copy of your report and plots*