OHM'S LAW, RESISTANCE, AND RESISTIVITY

By definition the resistance, in ohms, of a circuit element is given by

$$R = V / I \,,$$

where V is the potential difference, in volts, across the element and I is the current, in amps, through the element. For some devices current may vary in a complicated way with voltage. But for those devices which we call resistors, at least ideally, the resistance is constant. Therefore resistors fall in the class of conductors which are described by Ohm's Law. (The word "Law" is really a bit too strong here.) Ohm's Law is the assertion that the current "flowing" through a device is directly proportional to the potential difference applied to the device. Conductors obeying Ohm's Law are said to be ohmic. For such conductors a graph of I vs. V will be a straight line with slope 1/R and a graph of V vs. I will be a straight line of slope R. In this experiment we will use such graphs to determine whether various circuit elements obey Ohm's Law and, for some that do, we will determine the resistance.

PREPARATION OF THE EQUIPMENT

First click on the file "Ohms Law" on the desktop of your computer (and make sure that your *750-Interface* is turned on). This will open up a *Data Studio* file for running this experiment. Look at the signal generator box and confirm that it is set up for a 1-volt, 0.1-Hz triangular waveform. You should also have a graph on the screen that has voltage on the y-axis and current on the x-axis. You will connect two wires to run from your 2-Ohm resistor to the "OUTPUT" connections on your interface (this is the signal generator for the interface).

COLLECTING AND PLOTTING THE DATA

You will use the following data collection procedure for most of the rest of the experiment. Click the "Start" button, let it run for a couple of seconds, then click "Stop". You should have obtained a graph of current vs. voltage. For any circuit element that is an ohmic conductor the graph will be a straight line.

HAVING THE COMPUTER DETERMINE RESISTANCE

For devices that prove to be ohmic we can have the computer give us the resistance as the slope of a graph of voltage vs. current. Lets confirm the resistance for this first 2-Ohm resistor. On the top of the graph click on the "Fit" button and choose "Linear Fit". This will ask the computer to draw the best straight line through your data and compute its slope. Is the slope approximately 2? The "r" value in the linear fit box is not the resistance; this is a correlation coefficient that gives a measure of how well your data fits a straight line. The closer this coefficient, "r", is to 1 the better the fit.

CHECKING FOR OHMIC DEVICES

Now you use this data collection and plotting procedure to examine the current vs. voltage behavior of the devices in the small aluminum box. You will first want to delete your previous data. The easiest way to do this is to click on the "Experiment" tab at the top of the screen and choose "Delete ALL Data Runs". You should also delete your Linear Fit box. Click on the "Linear Fit" box in the top left window and hit the backspace key to delete (this should remove it from your graph). Note that the way that you hooked up the resistor and the way you will hook up each load in this aluminum box is such that the "output" voltage and current is the same as the voltage across and current through your device.

One by one connect each of the four loads in the aluminum box to your interface. You are to sketch what each of these four loads looked like in your lab write-up. Each time that you finish checking a load, again go to the "Experiment" tab and choose "Delete ALL Data Runs". Which devices were ohmic? Which devices were not ohmic? For the ones that were not ohmic, try to explain why the resistance is not constant.

DETERMINING THE RESISTIVITY OF WIRE

First you will need to go to your signal genrator box again and change the output voltage to 0.1-volt. You will use the "Linear Fit" method, from earlier, to determine the resistances of the five wire spools. Four of the spools are copper. Considering the following information, do the ratios of their resistances make sense? Explain.

Spool	Material	Length (m)	B&S Size	Diameter (m)
A	copper	10	22	6.44×10^{-4}
B	copper	10	28	3.21×10^{-4}
C	copper	20	22	6.44×10^{-4}
D	copper	20	28	3.21×10^{-4}
E	Nickel-Silver	10	22	6.44×10^{-4}

From the equation

$$R = pL/A ,$$

where L is length and A is cross-sectional area, determine the resistivity, p, of the two materials. The result should be in ohm-meters. Later you can compare these values of resistivity to the theoretical values in your textbook.