Ohm's Law

Equipment

Qty	Item	Part Number
1	AC/DC Electronics Laboratory	EM-8656
1	Current Sensor	CI-6556
1	Multimeter	
4	Patch Cords	
2	Banana Clips	
1	100Ω Resistor	

Purpose

The purpose of this activity is to learn about Ohm's Law, and to examine the different behaviors of Ohmic, and non-Ohmic materials when a voltage is applied to them.

Theory

Ohm's Law tells us that resistance of an object is proportional to the voltage applied to it, and inversely proportional to the induced current passing through it.

$$R = \frac{\Delta V}{i}$$

A material is said to be **Ohmic** if the resistance of the material is independent of the applied voltage, meaning the ratio of $\frac{\Delta V}{i}$ is constant. However, a material is said to be **non-Ohmic** if its resistance varies for changes in the applied voltage, meaning the ratio of $\frac{\Delta V}{i}$ is not constant. The equation $\Delta V = iR$ is sometimes referred to as Ohm's Law, but only in cases where the resistance is independent of the applied voltage. Ohm's Law is not really a 'law of nature' but really just a description of a subclass of materials. Even for these materials if the temperature is changed enough the resistance will start to change for changes in the applied voltage.

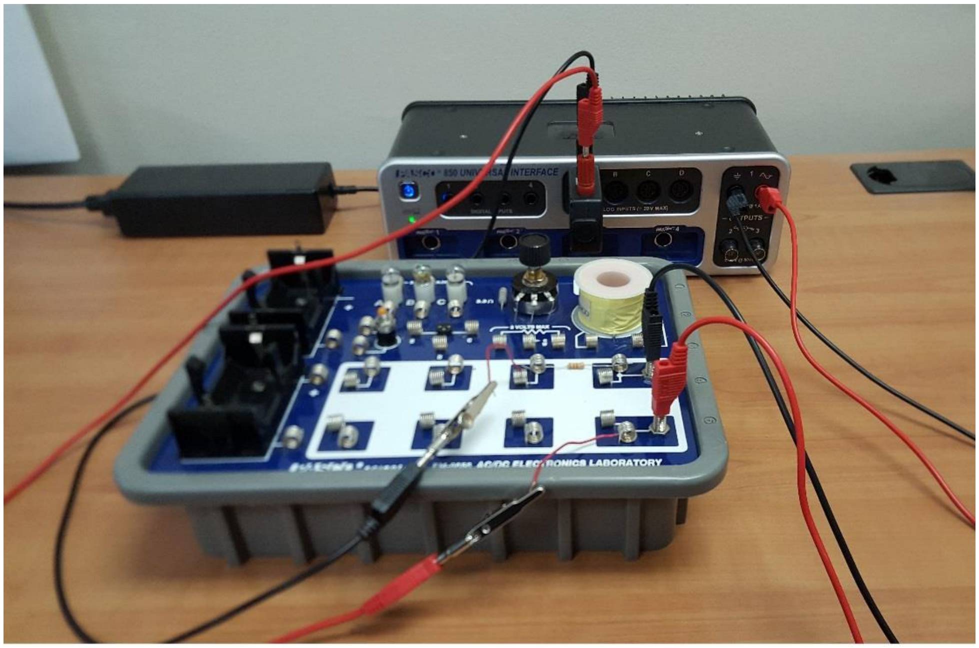
Setup

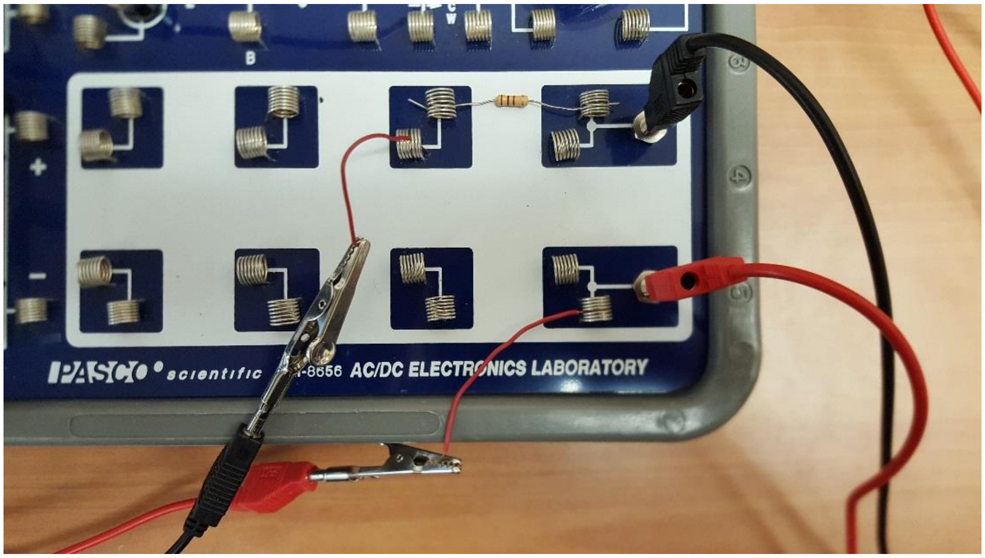
1. Using the provided multi-meter measure the resistance of the provided resistor, and record its measured value in the table. (If the measured value is significantly different that the theoretical value of 100Ω notify your TA/Instructor, and they will give you a new one.)
2. Double click the PASCO Capstone icon to open the Capstone software.
3. On the Tool Bar, on the left side of the main screen, click on 'Hardware Setup". This will open the Hardware Setup window, and a picture of the 850 Interface should be showing. (If it is not showing then make sure the 850 interface is plugged in, and turned on, then click 'choose interface' tab, then 'automatically detect'.)

4. On the image of the 850 Interface click on ‘Output 1’, then select ‘Output Voltage-Current Sensor’. (Top left of the image)
5. One the image of the 850 Interface, click on Analog Ch (A) to open up the list of analog sensors.
    - Then scroll down and select the Current Sensor.
6. Connect the current sensor to Analog Ch (A) of the 850 Interface.
    - Plug in two patch cords to the current sensor, and attach alligators clips to the other ends of the patch cords.
7. At the bottom center of the main screen select ‘common rate’, and set the rate to 1 Hz.
8. At the bottom center of the main screen (directly to the right of ‘common rate’), click on ‘Recording Conditions’. This will open the Recording Conditions window, click on ‘Stop Conditions’.
    - For ‘Condition Type’ select ‘Time Based’.
    - For ‘Record Time’ set to ‘1.0 second’.
9. On the Tool Bar on the left side of the main screen, click on ‘Signal Generator’. This will open the Signal Generator window.
    - Click on ‘850 Output 1’ tab.
    - Set the ‘waveform’ to DC.
    - Set the ‘voltage’ to 0.10 V.
    - Set to ‘voltage limit’ to 5.0V.
    - Set the ‘current limit’ to 1.5A.
    - Then click on the ‘Auto’ tab to set the voltage to start and stop when you start and stop collecting data.
10. Click on the Push Pin icon at the top right of the Signal Generator window to rescale the page one. Keep the Signal Generator window open.
11. On the main screen, now select ‘Two large Digits’ from the quickstart templets.
    - On the top, click ‘Select Measurements’ and select ‘Output Voltage, Ch 01 (V)’.
    - On the bottom, click ‘Select Measurements and select ‘Current (A)’.
    - On the current part of the templet, ‘right click’. This will open a window, and in this window click on ‘properties’ which will open the properties window for the current sensor.
    - In the properties window, click on ‘Numerical Format’ and set Number of Decimal Places to 4, then click ‘ok’ to close the window.
    - Repeat for the voltage display to set its decimal places to 4 as well.
12. Use two of the provided patch cords to connect Output 1 to the AC/DC Electronics Laboratory.
13. Use two of the provided patch cords, the two alligator clips, and two small jumper wires to connect the Current Sensor to the circuit board as shown in the picture. Do NOT

attach the alligator clips directly to the metal springs on the board as they will damage the springs.

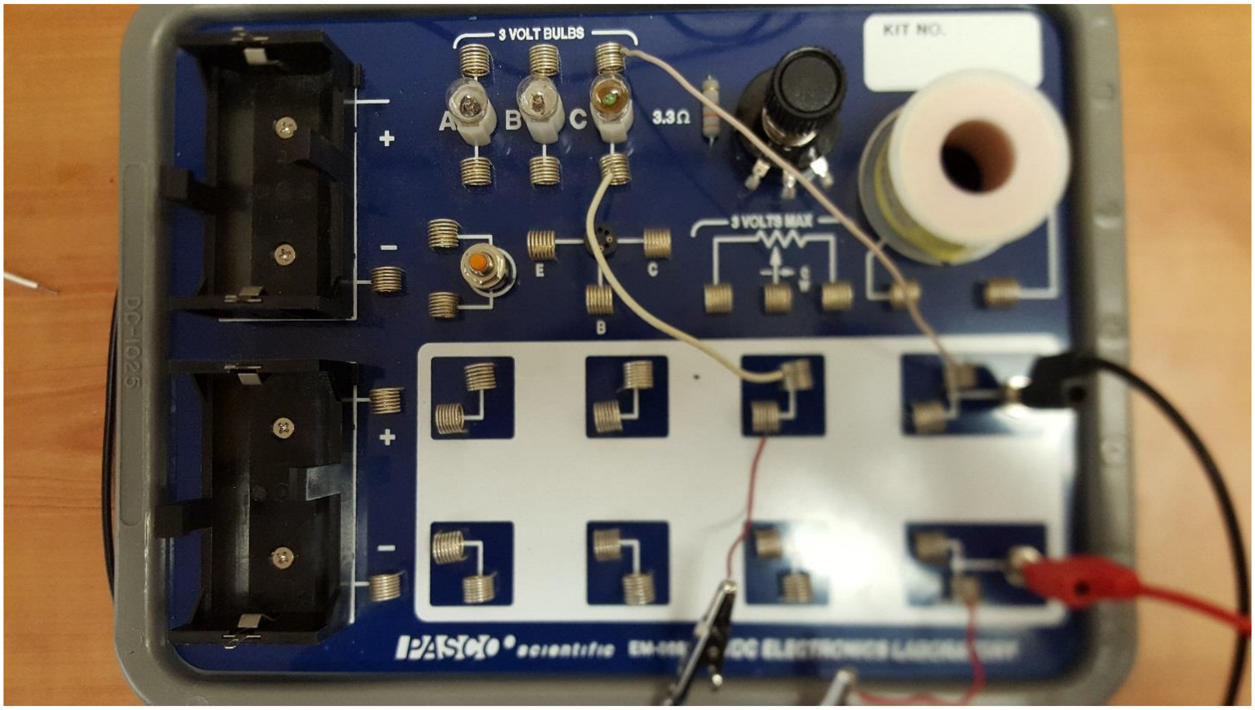
- Then insert the 100 Ω resistor into the AC/DC Electronics Laboratory to complete the simple circuit. Your physical setup should now look like the following.





Procedure

1. Click the record button near the bottom left of the screen.
    - Record the measured current, and measure voltage in Table 1 for the 100 Ω resistor.
2. Repeat for voltages 0.25 V, 0.50 V, 1.00 V, 2.00 V, 3.00 V, 4.00 V, 5.00 V.
3. Remove the 100 Ω resistor.
4. Using two long jumper wires, build the simple circuit consisting of a voltage source, and one of the light bulbs on the AC/DC Electronics Laboratory as shown.
5. Now repeat procedure for the light bulb circuit for all the same voltages as before.
    - Record the measured current, and measured voltages in the Table for the light bulb.



Analysis of Ohm's Law Lab

Name____ **Group#**________

Course/Section_______________________________________

Instructor____

Table (20 points)

Measured resistance R(Ω):		**Light Bulb**	
$V(V)$	$i(A)$	$V(V)$	$i(A)$

1. Using Excel and the data for the 100 Ω resistor, plot $V\ vs\ i$, with the equation for the trendline showing on the graph. (15 points)

2. What is the value of the slope of this graph? What physical quantity does the slope represent? (10 points)

3. Is the slope constant? Is the material the resistor is made from Ohmic or non-Ohmic? (5 points)

4. Using Excel and the data for the light bulb, plot $V\ vs\ i$, with the equation for the trendline showing on the graph. (15 points)

5. What physical quantity does the slope represent? (5 points)

6. Is the slope constant? Is the material the light bulb is made from Ohmic or non-Ohmic? (5 points)

7. Elaborate on the light bulb's wire filament and how this contributes to it being Ohmic or non-Ohmic. (10 points)

8. Did our experiments verify Ohm's Law? Why or why not? (10 points)