TechLab: Ohm, Ohm on the Digital Range

an investigation of voltage, current, and resistance

PERIOD	1.		
	2.		
GROUP	3.		
	4.		

• Prerequisite •

Successful completion of *PhyzLab: Ohm, Ohm on the Range.*

• Purpose •

In this activity, you will configure a current sensor and voltage sensor to monitor a resistor in an electric circuit. You will also configure data analysis software to plot a voltage vs. current graph.

• Apparatus •

___ computer (PhyzMac iBook or equivalent)
___ data analysis software (DataStudio or equivalent)
___ current sensor (PasPort current and voltage sensor or equivalent)
>>> WHAT IS THE MAXIMUM CURRENT ALLOWED BY THIS SENSOR? ____________________ A.
___ voltage sensor
>>> WHAT IS THE MAXIMUM VOLTAGE ALLOWED BY THIS SENSOR? ____________________ V.
___ interface device (USB Link or equivalent)
___ regulated, low-ripple, variable DC power supply
___ connecting wires
___ 3 resistors with known resistance
>>> RECORD THE RESISTANCE VALUES: _________ , _________ , __________
___ resistor with unknown resistance
>>> RECORD THE UNKNOWN RESISTOR ID/NAME:____________________________
___ minibulb (#1487 14.4 V) in blue socket

• Procedure •

1. CONFIGURE THE CONNECTION

a. Turn the computer on.

b. While the computer completes its start-up cycle, connect a basic circuit using the lowest-resistance resistor, the power supply, and two wires. Make sure the power supply is turned down and/or off.

c. Replace one of the wires with the two leads of the current sensor so that the current sensor is connected in series with the resistor.

d. Connect the leads of the voltage sensor in parallel with the resistor.

e. Connect the current and voltage sensor to the interface device and connect the interface device to the computer. When the computer asks what you would like to do, Launch DataStudio. This should give you a blank experiment document with digital displays for current and voltage.

f. From the Experiment menu, select “Monitor Data.”

g. Turn the power supply on and slowly increase the power. Keep the current and voltage value less than the sensor’s maxima (as determined in the Apparatus section). Both current and voltage readings should have positive values. If they do not, turn the power supply back down / off and switch the circuit connections as needed. When the connections are correct, the current and voltage readings will be positive and will increase when the power is increased.

h. Stop the data monitoring.

2. SETTING THE VOLTAGE VS. CURRENT GRAPH

a. Close the digital current and voltage display window.

b. Create a graph of voltage vs. time. You can do this by dragging the graph **display** icon onto the voltage **measurement** and releasing it there.

c. When the graph appears, maximize the graph window.

d. Change the time axis to a current axis. To do this, drag the current measurement onto the time axis and release it there.

   i. If the graph window shows one graph (voltage vs. current), this step succeeded.

   ii. If a second graph (current vs. time) appears, this step failed. Delete the second graph and try again.

e. Double-click inside the graph window to open the graph settings window. From the Appearance tab, deselect "Connect data points."

f. i. From the File menu, select "Save Activity."
   ii. Navigate to the correct location for saving the file; Student Work / Teachername / Periodname.
   iii. Give the file an appropriate name in the form of X.yy Conceptname PG where X is the physics level (1 or 2), yy is the two-digit unit number (from 01 to 14), P is the period (1-6) and G is the group (A-H). For example, "2.08 Ohm on the Range 3E."

3. COLLECTING THE DATA

a. i. Click the on-screen "Start" button to begin data sampling.
   ii. Slowly increase the power, but keep the current and voltage below the limits of the sensors*. When you reach the maximum power possible, slowly decrease the power to zero again. The process should take at least 30 seconds. It should also leave a fairly even track of data points on the graph.
   iv. When you have turned the power all the way down, click the on-screen "Stop" button to end data sampling.
   v. From the File menu, select "Save Activity" to resave the file with the new data set included.

*If you exceed the current limit of the sensor, an audible alarm will sound. Turn the power off, stop the data run, delete the data run, and attempt the trial again.

b. Disconnect the low-resistance resistor from the circuit and install the medium-resistance resistor.

c. Repeat step 3.a. Be careful about the sensors' current and voltage limits.

d. Replace the medium-resistance resistor with the high-resistance resistor.

e. Repeat step 3.a. Don't forget to resave (3.a.v.). Be careful about the sensors' current and voltage limits.

f. Replace the high-resistance resistor with the unknown resistor (Mystery Sister or Mr. Resistor).

g. Repeat step 3.a. Be careful about the sensors' current and voltage limits.

h. From among the graph tools displayed along the top of the graph window, click "Scale to Fit."

4. LABELING THE DATA SETS
The data analysis software labeled the data sets as “Run #1,” “Run #2,” etc. Relabel them according to the resistor used in each data set.

a. Click any data set labeled “Run #1.” It doesn’t matter if it’s a voltage measurement, a current measurement, etc. The title of the data set will be highlighted.

b. Click the highlighted title again to make it editable.

c. Now type the value of the low-resistance resistor that was used during run #1. For example, “Two Ohms,” or “Five Ohms.” It is better to write out the value as a word (Five) than as a number (5).

d. When asked if this new label should be applied to all measurements, select “Yes.”

e. Repeat the process for the other resistors. For the unknown resistor, simply label the data set with the name of the resistor.

f. Resave the file (File: Save Activity).

5. DETERMINING THE SLOPE OF EACH DATA SET
a. In the legend of the graph window, select the name of the first plot (the one made with the low-resistance resistor).

b. From among the graph tools displayed along the top of the graph window, click down on the one labeled “Fit.” A pop-up menu will appear.

c. Select “Linear” from the pop-up menu under “Fit.”

d. A line of best fit will be plotted on the data set, and a note will appear, showing various numerical values associated with the fit.

e. Repeat this process for the other data sets.

f. Move the notes as needed. Within the limitations of the space you have, try to make sure each note is completely visible and does not cover data points. It’s acceptable for a note to cover part of a best fit line.

g. From the File menu, select “Page Setup.” Select the landscape (horizontal) orientation.

h. Resave the file (File: Save Activity).

i. Secure a PhyzBlessing and print a copy of the graph for each member of the lab group.

• Analysis •
1. How does this process reveal the resistance value of the resistor?

2. What is the resistance value of the unknown resistor? R = ____________________

3. What is the accepted resistance of the unknown resistor? R = ____________________

4. What is the percent error in your measurement?

• Extension •

1. Using the techniques described in the lab, complete a trial using the 14.4 V bulb as the resistor. The greatest challenge here is getting all the connections made. Don't forget to resave the file to include the new data set. Do not print the new graph.

2. Sketch and describe the resulting plot. Discuss similarities to and differences from the plots of the known resistors.

3. Interpret the resulting plot. What does it tell you about the resistance of the bulb, and how is the bulb different from the resistors?