GENERAL SCIENCE LABORATORY 1110L Lab
Experiment 6: Ohm's Law

OBJECTIVES: To verify Ohm's law, the mathematical relationship among current, voltage or potential difference, and resistance, in a simple circuit.

APPARATUS: Windows 7 PC, Vernier LabPro Interface, Vernier Current & Voltage Probes, Vernier Logger Pro Software 3.8.*, two resistors (about 36 and 100 Ω), Banana Plug Wires, alligator clips to connect resistors to banana plug wires, Variable DC Power Supply.

THEORY

The electrical quantities can be difficult to understand because they cannot be observed directly. To clarify these terms, some people make the comparison between electrical circuits and water flowing in pipes. Here is a chart of the three electrical units we will study in this experiment.

Electrical Quantity	Description	Units	Water Analogy
Voltage or Potential Difference	A measure of the Energy difference per unit charge between two points in a circuit.	Volts (V)	Water Pressure
Current	A measure of the flow of charge in a circuit.	Amperes (A)	Amount of water flowing
Resistance	A measure of how difficult it is for current to flow in a circuit.	Ohms (Ω)	A measure of how difficult it is for water to flow in a pipe.

The fundamental relationship among voltage, current, and resistance was discovered by Georg Simon Ohm.

Georg Simon Ohm (16 March 1789 – 6 July 1854) was a [Bavarian](#) (German) [physicist](#) and [mathematician](#). As a high school teacher, Ohm began his research with the new [electrochemical cell](#), (Is a device used

for generating an [electromotive force](#) ([voltage](#)) and current from [chemical reactions](#) (A Battery), invented by Italian scientist [Alessandro Volta](#).

Using equipment of his own creation, Ohm found that there is a direct proportionality between the potential differences ([voltage](#)) applied across a conductor and the resultant [electric current](#). This relationship is known as [Ohm's law](#).

The relationship and the unit of electrical resistance were both named for him to commemorate this contribution to physics. One statement of Ohm's law is that the current through a resistor is directly proportional to the voltage across the resistor

$$V/I = R \qquad (1)$$

V is the voltage in volts, I is the current in amperes, and R is the resistance in ohms. A graph of V vs. I should yield a straight line with the slope of the line being the resistance.

PROCEDURE
1. Turn on the Computer.

2. Make sure the computer has booted up completely.

3. Double click on Logger Pro (3.8.*).

4. Choose Open from the File menu.

5. Double click on Physics with Vernier.

6. Select and click open "Exp 22 Ohm's Law". A graph of potential vs. current will be displayed. The vertical axis is scaled from 0 to 6 V. The horizontal axis is scaled from 0.0 to 0.6 Amperes.

7. Make sure the LabPro Interface is plugged into the USB port of the computer, its power supply is plugged in, and the interface is turned on.

8. Plug the Current probe into Channel 1 and the voltage probe is plugged into Channel 2.

9. Plug in the DC power supply. Make sure the power supply is turned off.

Figuure 1: Circuit Setup
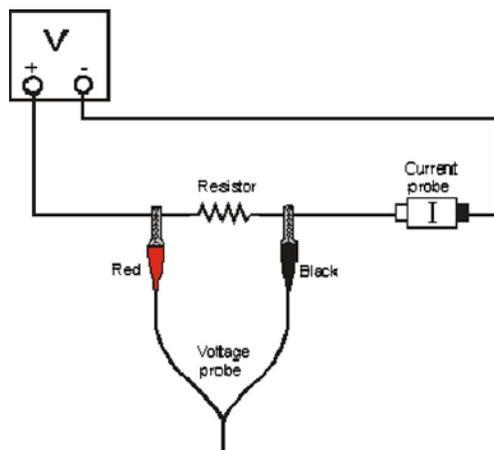
10. Connect the power supply, 100-Ω resistor, wires, and clips as shown in Figure 1 above. The positive lead from the power supply and the red terminal from the Current & Voltage Probe are connected as shown. Note: Attach the red connectors to the positive side of the power supply.

11. Make sure the power supply is turned off. Click on "zero" Θ button on the toolbar above the graph. A dialog box will appear. Click "zero all sensors". This sets the zero for both probes with no current flowing and with no voltage applied.

12. Record the resistance (labeled on the resistor) in data table #1.

13. Have your instructor check the connected circuit before proceeding.

14. Click on the Green "collect" button on the toolbar to begin data collection. Turn on the power supply. Turn the control knob on the power supply counterclockwise all the way down to 0 V if it's not done so already. Gradually increase the power supply to approximately 0.5 volt. Use the indicator for POTENTIAL displayed on the bottom left of the computer screen to set the voltage. Monitor the voltage and current. Click on "keep" button when the readings are as stable as they can be. Both voltage and current readings will display in the data table on the screen.

15. Slowly increase the voltage to about 1.0 V. Click on "keep" when the readings are as stable as they can be again. Repeat this process with an increment of 0.5 V until you reach a voltage of 5.0 V. You should have 10 data points.

16. Click on "stop" button and set the power supply back to 0 V.

17. Click on "Analyze" on the menu bar, and then select "Curve Fit". Choose a Linear fit { y= mI + b}for your data. Click on the button "Try Fit". Click on the OK Button and a window will pop up over the Voltage vs. Current graph giving the parameters for the best fit equation to your data. The best fitted straight line graph from the collected data will display on the screen.

18. Record the slope (The Resistance) and *y*-intercept (V_o) of the line in data table #1, along with their units.

19. *NOTE:* You will be required to hand plot one graph on 10mm to 1 cm graph paper of V vs. I. Record this set of data in data table #2 now if you want to plot this graph. Otherwise, wait for next set of data with a different resistor.

20. For safety reasons, please turn off the power supply first before you replace the resistor with a different one.

21. Remove the 100 Ohm resistor from the circuit and replace it with the 36 Ohm resistor.

22. Repeat Steps 14 – 18 using the 36 Ohm resistor.

DATA TABLE 1

	Slope of straight line from computer (V/A or Ω)	Y intercept of the straight line from computer (V)
Resistor #1 100Ω (check value marked on the resistor)		
Resistor #2 36Ω (check value marked on the resistor)		
Resistance = _____Ω from your hand plotted data on the 10 mm to 1 cm graph paper		
% difference = _____		

DATA TABLE 2 RESISTOR_____Ω

Potential (V)	Current (A)

DATA ANALYSIS

1. Plot V vs. I graph on the 10 mm to 1 cm graph paper for one of the resistors using the recorded data in table #2. Determine the resistance which is the slope of the straight line. Record this value in data table #1.

2. Compare the resistance given by the computer to the value obtained by your graph and calculate the % difference. Enter this value in data table #1.

3. Resistors are manufactured such that their actual values are within certain tolerances. For most resistors used in this lab, the tolerance is 5% or 10%. Check with your instructor to determine the tolerance of the resistors you are using. Calculate the range of values for each resistor. For example: If the tolerance is 10 % for the 100 Ω resistor, then the

range of values is 90 Ω - 110 Ω.

QUESTIIONS

1. Does the resistance from the computer fit within the appropriate range of values for each resistor? Does the resistance from the hand plotted graph also fit within the appropriate range of value for the resistor?

2. From your data table, examine what happened to the current when the voltage was doubled, quadrupled, etc. What type of relationship do you believe exists between voltage and current? Is ohm's law proven to be correct?
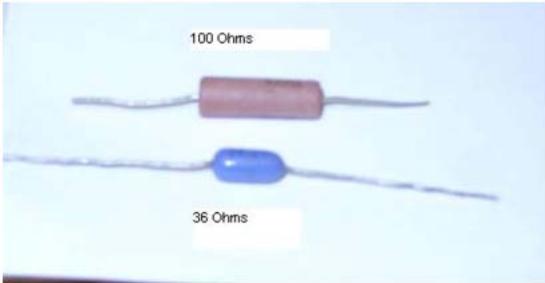
Figure 2: PASCO POWER SUPPLY. NOTE RED + and Black - connectors.

Figure 3: BANANA PLUG WIRES

Figure 4: Alligator Clip

100 Ohms

36 Ohms

Figure 5: RESISTORS

Figure 6: Vernier Current Probe. Note Positive (RED) and Negative (BLACK) ends of the probe. See Figure 1

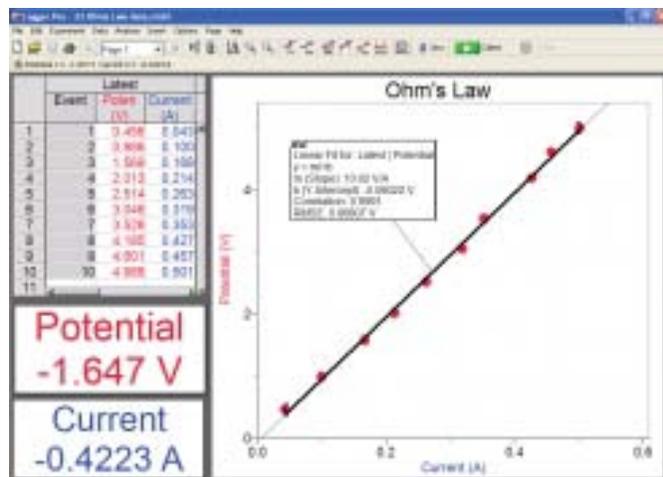**Figure 7: Vernier Voltage Probe. Note Red and Black connectors, See Figure 1**

Figure 8: Example Data from Ohms Law.

Lab Report Format:

Your lab report for this experiment should contain the following sections:

1. Title of experiment in center of the first page. Date to the left of the title. Experimenters name with partners name(s) under experimenters name to the right of the title.

2. Objective

3. Apparatus

4. Original Data: Neatly filled out data page.

5. Sample calculations and graph: For this lab an example (ONE) needs to be shown for each of the following calculations: Slope hand plotted data, % difference between value of the resistance of the unknown resistor found using the graph paper and the resistance determined by the computer for the same resistor. Show the tolerance calculations for your two resistors to determine the range of possible values for each. Graph for Voltage vs. Current for one of your resistors.

6. Results: State your results (in the form of a **very short** sentence). Make sure the numerical results are properly rounded and have the correct number of significant digits. Report the experimental resistance for both resistors using the computer. Report the resistance from the hand plotted data. What is the per cent difference between the resistance from the hand plotted data and that obtained by the computer. Range of possible values of your resistors given their tolerances.

7. Conclusions: Address the answers to the three discussion questions on page 6 of the handout..

PROPER MATERIALS, ETC. FOR YOUR REPORTS

1. ALL DATA IS TO BE RECORDED <u>DIRECTLY</u> IN YOUR LAB NOTEBOOK. ==**NO SCRATCH PAPER IS TO BE USED.**==

2. YOU ARE TO USE BLUE OR BLACK <u>INK ONLY</u> FOR RECORDING DATA AND DOING YOUR REPORTS IN YOUR NOTEBOOK.

3. REMEBER, ONLY THE FRONT OF THE PAGES IN YOUR LAB NOTEBOOK ARE TO BE USED FOR DOING YOUR LAB REPORT. <u>I WILL NOT LOOK AT ANY INFORMATIION ON THE BACKSIDE OF THE NOTEBOOK PAGES</u>.

4. ==<u>DO NOT TEAR OUT ANY PAGES</u>== FROM YOUR NOTBOOK.

5. <mark>**DO NOT ERASE OR USE WHITEOUT FOR MISTAKES!!!!**</mark>
All observations taken under the same experimental condition are equally valid and should be retained for analysis. Do not erase readings. If you must change a reading, draw a single line through it and then record the new measurement next to the old one.