Name:_____ Date:_____

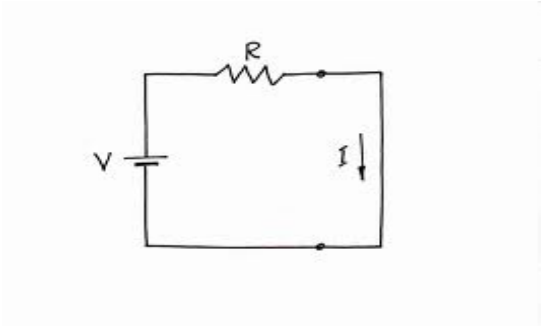
Partner:_____

Science Connections: How do Scientist use models to learn about the natural world?

In this activity you will use ohm's law form models of various devices.

Skill Goals:

1. Generate a model of one of the following devices and determine if it is Ohmic or NonOhmic.
    a. Resistor
    b. LED
    c. Diode
    d. Light bulb
2. Determine the voltage of an unknown source using you model.



Common Core Alignment to Standards

- CCSS.Math.Content.HSF-LE.A.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
- CCSS.Math.Content.HSS-ID.C.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.
- CCSS.Math.Content.HSF-LE.B.5 Interpret the parameters in a linear or exponential function in terms of a context.
- CCSS.Math.Content.HSS-ID.A.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
- CCSS.ELA-LITERACY.W.9-10.7
  Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- CCSS.ELA-LITERACY.W.9-10.8
  Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
- CCSS.ELA-LITERACY.W.9-10.9
  Draw evidence from literary or informational texts to support analysis, reflection, and research.

Materials

- Two Multi-meters
- Variable voltage
- Diode, Resistor, LED and Light bulb
- Connecting Wires

Introduction

Ohm's Law is the relationship between current, voltage and resistance, as seen below:

$$I = \frac{V}{R}$$

Where I is the current, V is the voltage and R is the resistance of the device. Current is the measure of the amount of charge flow in a wire per second measure in Amps. One can image this as a physical count of how much charge passes by in a section of wire. Voltage is the amount of energy per charge measured in Volts, or as Joules/Coulomb. Voltage provides the energy in the circuit needed to do work. Resistance is how much current is slowed by a device measured in Ohms. Electrical resistance is needed in a circuit. It allows the energy to be transformed into heat, light, motion, etc. Without resistance, the power source will provide too much energy, overheat and become damaged.

A device is labeled as "Ohmic" if the relationship between current and voltage is linear. This implies that the resistance is constant and regardless of the input voltage, the current will change by the same rate. If an object is non-ohmic, then the voltage and the current are not linear. The slope will be changing forming a curved line.

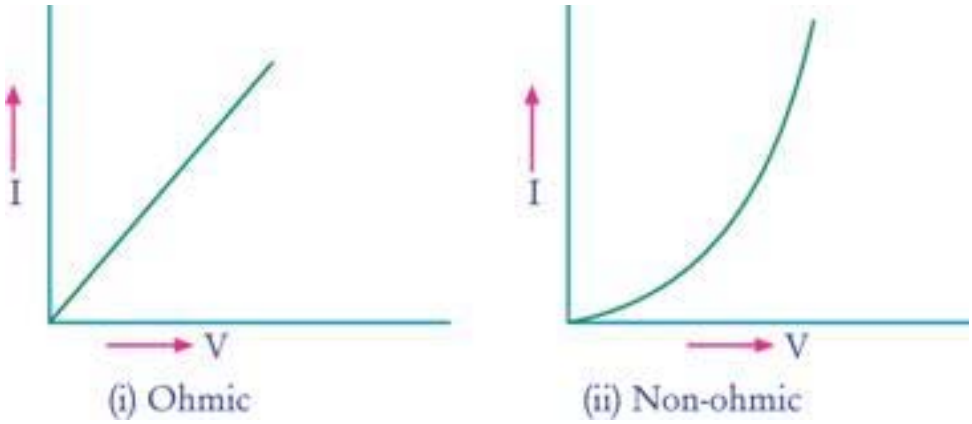


Figure 1: Example of an ohmic/non-ohmic behavior devices.

In Part 1 of the lab, you will determine how to model each type of device and categorize them as Ohmic, or Non-Ohmic. In Part 2 of the lab, you will use one of your models to determine the unknown voltage of a source.

Safety

• When plugging or unplugging wires, first turn off all electronics that are connected or will become connected to the circuit.

• If you are color blind or suspect that you are, you may find the color codes on the resistors difficult. Please consult your lab instructor for advice or help

Part 1: Generating a Model of Electrical Devices

1. Set up your circuit as seen below:

2. Turn dial all the way to zero on the power supply.
3. Inform your instructor to turn on power supply (if power supply is not already turned on).
4. Note the voltage maximum of your current setup: Do no exceed max voltage. You could damage the device if you go over the voltage.

Max Voltage:_____ Device:_____

5. Construct your data table to measure 10 Voltages measured in Volts (V) and Currents measured in Amps. Based on the maximum voltage, select 10 even-incremented Voltage measurements. Choose both positive and negative voltages.
6. Plug in two wires in to power supply.
7. Set your variable voltage supply to your first voltage measurement. Record the current in Amps.
8. Repeat this process for all voltage values.
9. Set your voltage to zero and turn off the voltage supply.
10. Unplug the wires to the voltage supply.
11. Change the device (light bulb, resistor, diode, LED).
12. Repeat steps 2-11 for each device.

GRAPHING RELATIONSHIPS

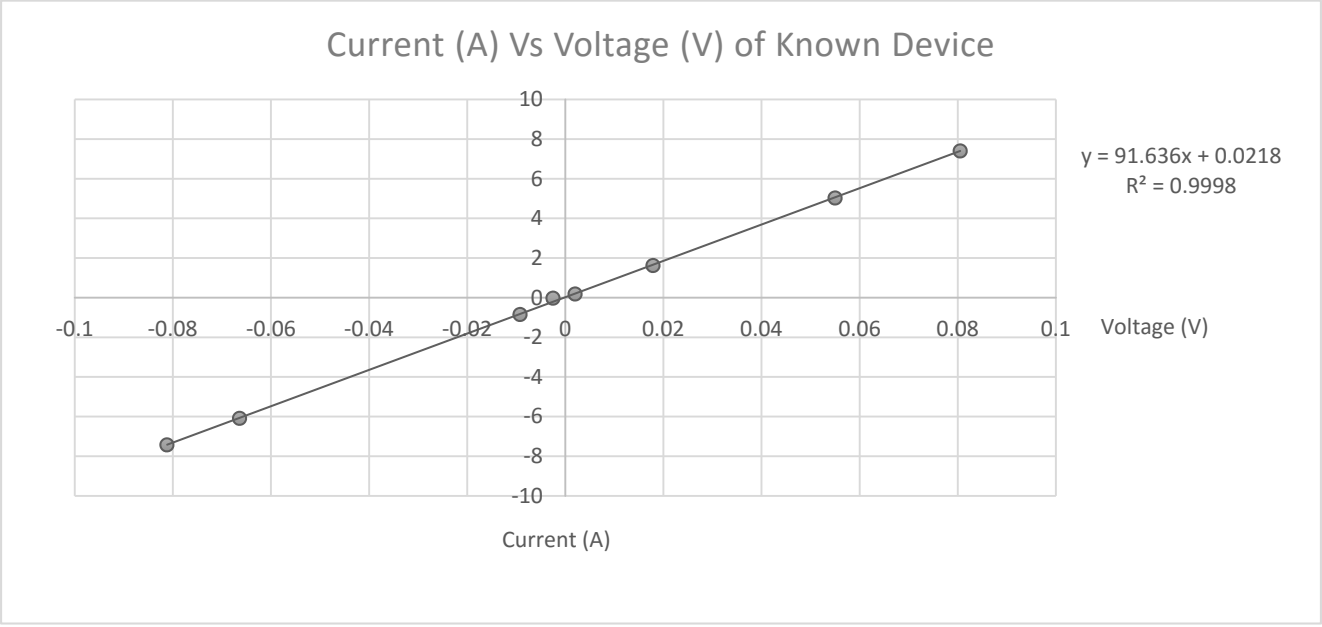
You must make your own graph: No copies of graphs from your partner will be accepted.

Graph the Current vs. Voltage data in excel.

Open EXCEL.
Enter in “Current (A)” and “Voltage (V)” into columns on excel.
Select the INSERT tab at the top.
Select SCATTER PLOT.
Select the option with just the dots, no line.
Right click on blank graph
Select “Select data”
Select “ADD”
Series Name = Title of Graph; Insert title here
Series X Values = Your “X” axis values. Select the graph icon toward the right of the input. Select your “x” column and then press the graph icon again.
Series Y Values = Your “Y” axis values. Select the graph icon toward the right of the input. Select your “y” column and then press the graph icon again.
Select OK
Select OK
Select LAYOUT tab at the top
Select Trendline
Select More trendline options
Select “LINEAR” if not already done so
Select “Display equation on Chart”
Select “R2 Value on chart”
Move items around to make sure they are neat and organized.

Be sure the graph is large enough to take up half the page. The equation and the linear regression should also be on the graph.

Sample Graph with Sample Data



Analysis:

1. Determine which device based on the graph is an ohmic device and nonohmic. Use evidence from your data, including the R^2 value to elaborate your claim.

Reflection:

1. What are the limitations of the experiment?
2. Give solutions to your limitations

Extensions:

1. When Ohm's law is linearized, we will find that the slope of the linear is represented by 1/R, where R is the resistance of the device.

$$I = V / R \quad \text{Ohms Law}$$

$$y = mx \quad \text{Linear Line}$$

$$y = I, \quad x = V, \quad m = 1/R$$

Determine the resistance of your device by using the slope of the graph (use the value from the equation of the best fit line on the graph, not from data points). Solve for "R" in the equation below (not the R^2 value on graph). Regardless if it is linear, put a linear fit the graph. If the graph is not linear, use the data points that are most linear (ask instructor for help).

$$Slope = \frac{1}{R}$$

Part 2: Using a Model of to determine an unknown voltage

1. Have your instructor set an unknown voltage value at your variable supply. Do not look at the value, as you do not want to be influenced.

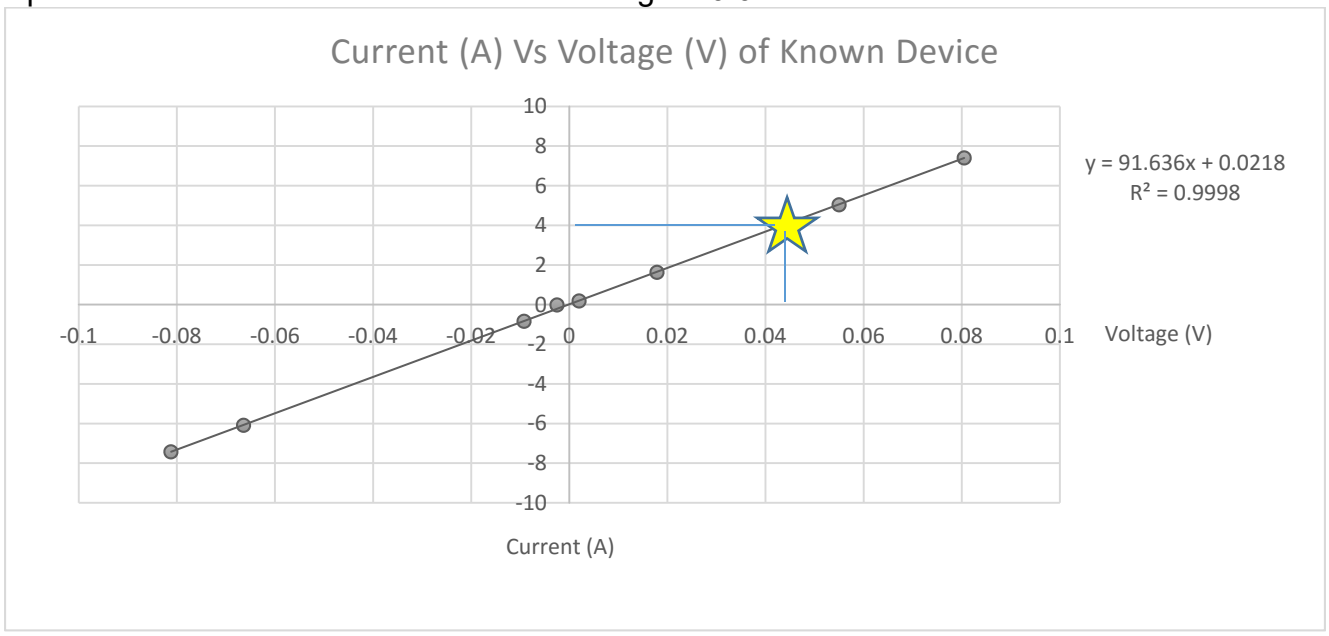
2. Select the best model and device for testing your unknown voltage. Describe what make it's the best model for this purpose?

3. Insert the device you chose into your circuit.

4. Inform your instructor to turn on power supply (if power supply is not already turned on).
5. Plug in two wires in to power supply.
6. Record the current in Amps.
7. Use the model you chose in step 2 to find the voltage based on the current.
8. Put a star on your best fit line on the corresponding current to determine the voltage. Determine the voltage of your unknown device.

Extension: Use the equation of your graph to numerically determine the voltage of your device.

Example: Measured current = 4A Voltage = 0.044 V



9. Ask your instructor to remove the tape/allow you to measure the actual voltage.
10. Calculate your percent difference of your measured voltage (measurement in step 9) and your experimental voltage (measurement in step 8).