Ohm's Law and Resistors

Introduction

The purpose of this experiment if to verify and to examine the limits of the Ohm's Law for commercially manufactured devices. In particular, we will collect and analyze data for resistors and light bulbs.

Theory

Different devices that are subject to electrical currents and voltages can be characterized by a parameter that is called *electrical resistance* (R). By definition, the resistance of a device that is subject to a potential difference V and an electrical current I is given by

$$R = \frac{V}{I} \, . \tag{1}$$

Based on this definition, the electrical resistance units are

$$[R]_{SI} = 1\Omega \;\; (ohm); \qquad 1\Omega = 1\frac{V}{A} \tag{2}$$

In certain materials (for example metals like aluminum or copper), the ratio V/I is always a constant over a wide range of voltages and currents. In this case, the device's electrical resistance is a *constant* and the relation $R = V/I$ is referred to as **Ohm's law**. This law was discovered experimentally by the German physicist Georg S. Ohm. Note that Ohm's law is not a fundamental physics law of nature like for example Newton's second law of motion. In other words, Ohm's law is a statement that refers to the way of how certain materials (for example metals) behave in electrical circuits. Other materials (semiconductors, superconductors) do not obey Ohm's law.

Experiment

Goals: Observe ohmic and non-ohmic behavior in resistors, learn how to set up and operate circuits; learn how to use wireless sensors without damaging them.

Equipment

- DC power supply
- PASCO SPARK LXi interface
- PASCO wireless current probe
- PASCO wireless voltage probe
- Connecting wires
- 2 Resistors
- Light Bulb

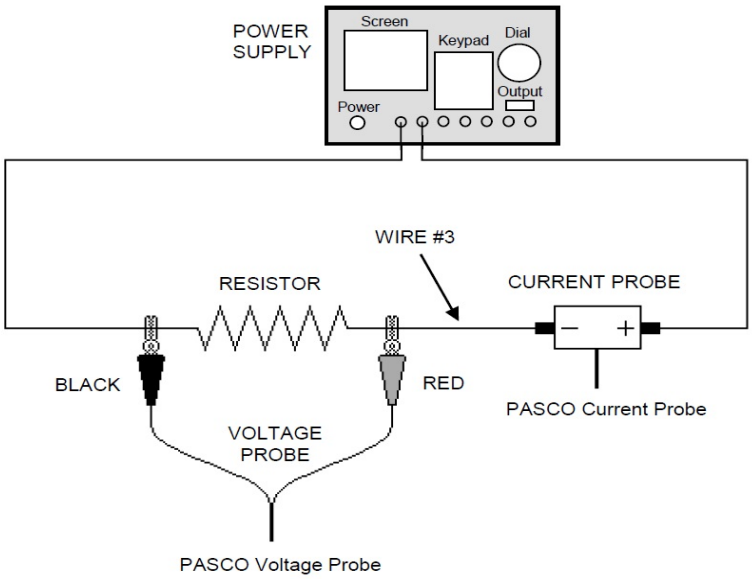

Figure 1: Circuit Diagram

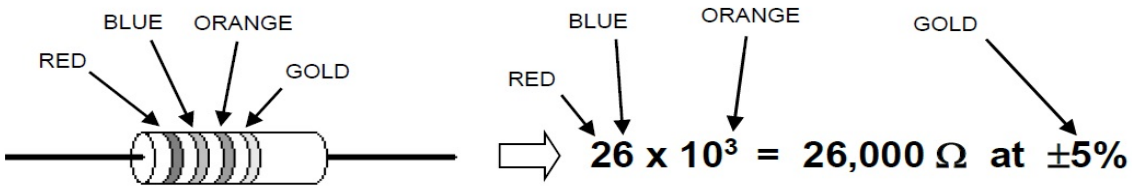

Figure 2: A resistor and its value

Setup

1. Setup the circuit shown in Figure 1 using the brown or red-violet-brown-gold band resistor. The gold band on the resistor means it is accurate to within 5 %. Find the value of the resistor by using a resistor chart which is posted on one of the walls in your lab.

2. Turn on the power supply and use recall button to select Voltage = 0 V and Current = 0.5 A. Then press **OUTPUT** button. Voltage can be controlled by typing it on the keypad or using the dial. Using the keypad is highly recommended. To change voltage press **V-SET** button, enter the voltage, and press **Enter. Your TA should go over how to use the power supply**

3. In PASCO SPARK LXi interface, open SPARKVue app, open PASCO experiments, select PHYSICS 212L, select Ohm's Law.

4. Connect the wireless voltage and current probes by pressing **Bluetooth** icon on the top right area of the screen. **Each sensor has it's unique Bluetooth ID. Make sure they match with your interface.** You can use Proximity Connect to detect the sensors around you.

5. Make sure that you have Current in your x-axis and Voltage in your Y-axis, and data collection mode is **Manual**.

Procedure

1. Set voltage to 0 V in your power supply and press **Start** on your PASCO interface. You will see a data point with a dot. Press check sign next to **Manual**.

2. Repeat the process with voltage increment of 0.5 V from 0 V to 5.0 V. **Do not forget to press enter in your power supply and press check in your PASCO supply after every increament.**

3. Analyze your graph. Steps are provided in the analysis section below. Record the data in **Table 1** of the handout provided. Using the resistor color band chart provided, record manufacturer's stated resistor value in **Table 1.**

4. Set the power supply to 0 V.

5. **Tolerance:** Check if your average experimental resistance value falls within the specified tolerance of the resistor in **Table 2**. For example, if you have a gold banded resistor then take 5% of the color band value and add it back to the same color band value to calculate the upper limit. Does the average experimental value fall within the range? Answer in the appropriate box.

6. Replace brown resistor with blue or blue-gray-black-red band resistor. Repeat steps 1 to 5.

7. Replace blue resistor with a light bulb and repeat steps 1 to 4.

Analysis

1. **SPARKVue** software defaults to analysis mode, when you press **Stop**. You can expand the graph icon to view all the options available in graph toolbar. **Your TA should go over how to use SPARKVue in detail**

2. Click the dotted rectangle on the graph toolbar, then select data on graph, and click Linear Fit to find the slope.

3. Record the slope value.

4. Repeat steps 1 to 3 for the second resistor.

5. **Lightbulb:** Repeat steps 1 to 3. However, you will have to measure two slopes. One for the first 4 data points and second for last 4 data points.