# Union College Spring 2019

Physics 121-05 **Lab #4: Resistance.**

**Introduction**

In our previous two labs, we found that the current that passes through a carbon resistor for a given voltage difference depends on the stated resistance, i.e.

 . (1)

This relation is commonly referred to as Ohm’s law. This equation can also be taken as the definition of resistance, and a circuit device which obeys equation (1) for most voltages and currents, like a carbon resistor, is called *ohmic*. In this lab you will explore further the nature of resistance and whether equation (1) is always true.

**Experiment 1**:

Grab a thin and a thick piece of nichrome wire (in baggie) and a meter. Using the meter, measure (and record) the resistance of:

1) the thick wire between two points 40 cm apart: Rthick, 40cm  = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

2) the thick wire between two points 20 cm apart: Rthick, 20cm = \_\_\_\_\_\_\_\_\_\_\_\_\_

3) the thin wire between two points 40 cm apart: Rthin, 40cm = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

4) the thin wire between two points 20 cm apart: Rthin, 20cm = \_\_\_\_\_\_\_\_\_\_\_\_\_

**Analysis:**

Examine your data and answer the following questions.

1) How does resistance depend on the length of the wire?

2) How does resistance depend on the thickness of the wire? The cross-sectional area of the thick wire is twice that of the thin wire.



**Experiment 2**:

1) Use an ohm-meter to measure the resistance of a light bulb.

2) Connect a ceramic resistor and light bulb into a series circuit, as shown in the figure.

3) Arrange one DMM to measure the current, saving the other to measure voltages across the resistor and across the lightbulb. **Have your instructor inspect your circuit before continuing**.

4) Vary the voltage of the power supply in roughly 1.5-V increments, measuring the current and voltages across both resistor and light bulb for each setting.

5) Watch the bulb and *note and record the current when the bulb first begins to glow faintly red*. **Stop before** **current passes 250 mAmps**.

**Analysis:**

1) Make graphs of *V* vs *I* (*V* on the y-axis) for the resistor and for the light bulb. Add linear trendlines, including the equations on the graphs. Do regression analyses to obtain uncertainties in the slopes.

Examine your plots and consider the following questions:

2) What is the principle difference you see between the two graphs?

3) How does the slope of the graph for the light-bulb compare with its measured resistance? How well does the line fit to the data?

4) Characterize each device by how close they are to being *ohmic*, at least in terms of the range of measurements you made.

5) If non-ohmic, determine the slope (with uncertainty) for just the 3 highest currents. Calculate the amount of deviation from Ohm’s law, i.e., the different between the slope of *V vs. I* and the measured resistance when disconnected from the circuit? What is the percent difference?

A deviation from Equation 1 often occurs because a larger current heats up the device and for most materials a substantial change in temperature causes a change in its resistivity. The temperature dependence of resistance typically follows the following equation

 , (2)

where  is the resistance at temperature  and $α$ is a property of the resistive material called the *temperature coefficient of resistance*.

6) Re-arrange Equation (2) to give an expression for T. The temperature coefficient of Tungsten has been measured to be 4.5x10-3 K-1. Let T0 and R0 equal room temperature and the resistance you measured when the filament was disconnected.

7) According to these results, what is the temperature of the light bulb filament when it was glowing brightly (i.e. when it had the largest current)? Does this suggest to you the reason the bulb glows?