I. INTRODUCTION AND OBJECTIVES

The resistance of an electrical conductor depends on several factors. Its physical shape is one factor. The type of conductor material is another, as might be expected. That is, two conductors with the same physical shape, but of different materials, have different resistances. This important material characteristic of resistance is expressed in terms of a quantity called resistivity. Temperature is another factor affecting resistance. However, the temperature dependence of resistance is not investigated here. In the present experiment, the factors of shape or dimensions and resistivity will be considered.

After performing this experiment and analyzing the data, you should be able to:
1. Explain on what factors the resistance of a wire depends and why.
2. Describe how the resistivity of a material may be determined from a graph.

II. THEORY

The resistance of an electrical conductor depends on several factors. Consider a wire conductor. The resistance, of course, depends on the type of conductor material, and also on (a) the length, (b) the cross-sectional area, and (c) the temperature of the wire. As might be expected the resistance of a wire conductor is directly proportional to its length $L$ and inversely proportional to its cross-sectional area $A$:

$$R \propto \frac{L}{A}$$

For example, a 4-m length of wire has twice as much resistance as a 2-m length of the same wire. Also, the larger the cross-sectional area, the greater the current flow (less resistance) for a given voltage. These geometrical conditions are analogous to those for liquid flow in a pipe. The longer the pipe, the more resistance to flow. But, the larger the cross-sectional area of the pipe, the greater the flow rate or the smaller the resistance to flow. The material property of resistance is characterized by the resistivity $\rho$, and for a given temperature,

$$R = \rho \frac{L}{A} \quad (1)$$

To determine the resistivity of some hypothetical material, a PhET Computer Simulation called “Resistance in a Wire” will be used to generate data which can then be graphed using Excel program. http://phet.colorado.edu/en/simulation/resistance-in-a-wire

EXPERIMENTAL PROCEDURE. Play with the Phet before you start to see how it works. Then set a fixed resistivity for taking your data. You will use this as the ‘true’ value to compare with your experimental values obtained with the simulation and graphing.

1. For a wire with fixed resistivity and cross-sectional area $A$, the slope of $R$ vs $L$ graph will be the resistivity/area (see Eq 1). The resistivity of the conductor can be calculated by multiplying the slope by the area. Create a table in Excel. Find $R$ for at least 10 lengths. Plot $R$ vs $L$ and find the resistivity.

2. If we graph $R$ vs $A$ for a wire of fixed length $L$, the fit constant of the resulting inverse proportion graph will be the resistivity*length (see Eq 1). The resistivity the conductor can be calculated by dividing the fit constant by the length. Create a table in Excel. Find $R$ for at least 10 areas. Plot $R$ vs $A$ and find the resistivity.

For both graphs, compare the slope times area value with the value of the resistivity set in the simulation by calculating a % error. Type up a summary. Your report should have summary first, two tables, two graphs, showing fits and labeled. Name, date, etc.