Lab 3 – Resistance and Resistively

Name _____

Partner's Name _____

I. Introduction/Theory

All electrical conductors have resistance (excluding superconductors) to the flow of current through them. The resistance of any conductor can be summarized as:

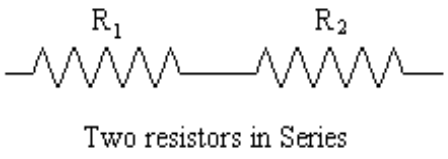
$$R = \rho \frac{L}{A} \qquad (1)$$

The parameter R is the conductor's resistance measured in ohms (Ω). The parameter ρ is the conductor's resistivity that has units of ohm-m. The resistivity is an intrinsic property of the material that the conductor is made of. The parameter L is the conductor's length measured in meters. And the parameter A is the conductors cross sectional area perpendicular to the flow of the current.

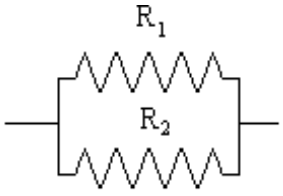
In this lab the relation given in (1) will be experimentally verified by examining the effects of resistance with ρ, L, A.

A conductor with resistance R_1 can be connected to another conductor with resistance R_2 to form a conductor with effective resistance R_{eff}. In Figure 1, if the two conductors (R_1 and R_2) in *Series* with the same resistivity ρ and cross sectional area A, then $R_{eff} = \rho\frac{L_1+L_2}{A} = \rho\frac{L_1}{A} + \rho\frac{L_2}{A} = R_1 + R_2$. And likewise in Figure 1, if the two conductors (R_1 and R_2) in *Parallel* with the same resistivity ρ and length L, then

$$\frac{1}{R_{eff}} = \frac{1}{\rho}\frac{A_1+A_2}{L} = \frac{1}{\rho}\frac{A_1}{L} + \frac{1}{\rho}\frac{A_2}{L} = \frac{1}{R_1} + \frac{1}{R_2} \text{ or } R_{eff} = \frac{1}{\frac{1}{R_1}+\frac{1}{R_2}}.$$



Two resistors in Series



Two resistors in Parallel

Figure 1.

II. Equipment

Set of Resistance Coils (10-143 Resistance Coils)
Multimeter
Clip leads (3) and connector cables

III. Procedure/Data

Resistance vs. Length

1. The set of resistance coils includes several lengths of 30-gauge nickel silver wire conductors. Complete Table 1 by measuring the resistance of each conductor and combination of conductors. Conductors connected in series will effectively increase the length!

Length (m)	Resistance (ohms)
0.4	
0.8	
1.2	
1.6	
2.0	
2.4	
2.8	
3.2	
3.6	
4.0	

Table 1

Resistance vs. Cross Sectional Area

2. The set of resistance coils includes several gauges of 200 cm length of nickel silver wire conductors. Complete Table 2 by measuring the resistance of each conductor and combination of conductors. Conductors connected in parallel with the same length will effectively increase the cross sectional area of the conductor.

Gauge	Diameter of a single wire (mm)	Effective Cross Sectional Area (m^2)	1/ Area ($1/m^2$)	Resistance (Ω)
#28 NS at 2 m	0.321			
#30 NS at 2 m	0.255			
Double a #30 NS at 2 m*	0.255			
Triple a #30 NS at 2 m**	0.255			

Table 2

* Two #30 NS 200 cm conductors wired in parallel.

** Three #30 NS 200 cm conductors wired in parallel. This setup will require you to create an additional #30 NS 200 cm conductor from the 80 +120 cm or 40 +160 cm conductors.

III. Analysis

1. On a separate sheet of paper attached (via a staple) to the end of this lab, construct a graph from a spreadsheet, Maple, etc. of the resistance vs. length of the data in Table 1. The plot will include a best fit line to the data on the graph. The equation of that best fit line will also be included on the graph. Comment below on how well your data fits a straight line.

2. What are the slope and intercept of the best fit line from the previous step? Based on eq'n (1), what is the physical meaning of the slope (HINT: what are the units of the slope?)? If the intercept is not zero, what information is provided by the intercept?

3. On a separate sheet of paper attached (via a staple) to the end of this lab, construct a graph from a spreadsheet, Maple, etc. of the resistance vs. 1/(cross sectional area) of the data in Table 2. The plot will include a best fit line to the data on the graph. The equation of that best fit line will also be included on the graph. Comment below on how well your data fits a straight line.

4. What are the slope and intercept of the best fit line from the previous step? Based on eq'n (1), what is the physical meaning of the slope (HINT: what are the units of the slope?)? If the intercept is not zero, what information is provided by the intercept?

5. Based on the analysis in the previous steps your are able to complete the picture for eq'n (1). Based on your analysis, determine your experimental value of the resistivity of nickel silver. Hint: the slope of each graph has the resistivity built in, thus you can determine two values of the resistivity of nickel silver. Compare your experimental value(s) of resistivity to CRC handbook value of 10^{-6} ohm-m.

V. Conclusions (include physical concepts and principles investigated in this lab, independent of your experiments success, and summarize without going into the details of the procedure.)