

ACTIVITY 36 Measurement of Resistivity Introduction

Different materials offer different amounts of resistance to an electric current. The resistance of a circuit element is a function of the material from which it is made as well as its length, l , cross-sectional area, A and temperature. For any given temperature, the resistance is given as:

unit length.

$$R = \frac{\rho l}{A}$$

where ρ is the resistivity of the material expressed in ohms per

In this exercise, resistance spools will be used to investigate the variation of resistance with length when cross-sectional area is held constant for a certain type of wire.

Equipment Required

- CBLunit
- TI-83 graphics calculator with a unit-to-unit link cable
- Vernier current and voltage probe with CBL DIN adapters
- **DC voltage source**
- Resistance spools (preferably 30-gauge nickel-silver wire ranging in lengths from 40 centimeters to 200 cm)
- Switch
- Connecting wires

Program Listing

This experiment requires that you download or enter the Physics program, to your TI-83 calculator. It should already be in the school's calculator.

Equipment Setup Procedure

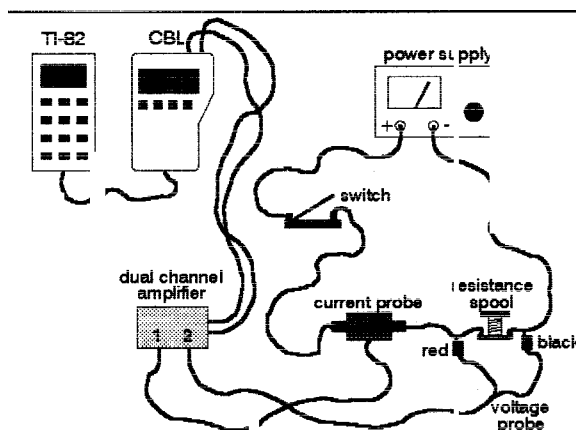
1. Connect the CBL unit to the TI-83 calculator with the unit-to-unit link cable using the I/O ports located on the bottom edge of each unit. Press the cable ends in firmly.
2. Connect the Vernier dual channel amplifier leads marked I and 2 to the Channel 1 (CH1) and Channel 2 (CH2) inputs on the top edge of the CBL unit
3. Connect the Vernier current probe to the probe 1 port on the amplifier box.
4. Connect the Vernier voltage probe to the probe 2 port on the amplifier box

5. Turn on the CBL unit and the calculator.
The CBL system is now ready to receive commands

from the calculator.

Instructions

1. Connect the voltage source, open switch, and a resistance spool in series as shown in the setup diagram. Connect the current probe in series with the resistor and place the voltage probe in parallel across the resistor. Leave the switch open until the wiring connections have been approved by your instructor. You may be using the LOGGER PRO Program..Physics with computers folder-exp 25 Ohm's law
2. After your circuit has been checked, start the PHYSICS program on the TI-82 calculator. When setting up probes be sure to select CV current and CV voltage. On the Data Collection menu, select monitor input. With the switch closed, to read the circuit voltage and current. The current should be the first reader and the voltage should be the second.
3. Record the voltage and current values that appear on the TI-82 display in your lab notebook as V and I , respectively. Also, make note of, the length (in centimeters) of the wire wound on the resistance spool. Organize this data in a table.
4. Without disassembling the entire circuit, remove the resistance spool from the circuit and replace it with a different spool. Repeat the experimental procedure outlined above and record all relevant data in your lab notebook.



5. Complete at least four trials, using different spool lengths for each trial.

Analysis

1. For each trial, compute the spool's resistance, R , using the data collected in this experiment and the relationship $V = IR$. Record these values in your table.
2. Press STAT ENTER to access the list editor on your calculator. Move to the top of each list and press CLEAR ENTER to clear all data from lists L1 and L2. Based on the table data you recorded earlier, enter the wire lengths in list L1 and the corresponding resistances in list L2.
3. Press 2nd [STAT PLOT] 1 ENTER to turn on Plot 1. Select: Type = scatter, Mist = Li, Ylist = L2, and Mark = \circ . Press ZOOM 9 to see a scatter plot of the resistance versus wire length.
4. Select LinReg from the STAT CALC menu and enter the appropriate regression command at the home screen, LinReg L1, L2. Record the regression equation and correlation coefficient in your lab notebook. Does this equation agree with the equation relating resistance and length described in the introduction section?
5. What significance does the slope of the regression line found in Step 4 have? Determine the resistivity, ρ , of nickel-silver wire by multiplying the slope of the regression line by the cross sectional area of 30-gauge wire, $5.093 \times 10^{-4} \text{ cm}^2$. How does this value compare to the actual resistivity of nickel-silver wire, $33 \times 10^{-6} \text{ ohms} \cdot \text{cm}$? Calculate a percentage error.
6. Press Y= and move the cursor to the first available function register. Press VAR 5 EQN Regeqn to copy the regression equation to the cursor position. Press GRAPH to see the scatter plot and regression line together. You may be asked to compute a regression on your test
7. Create a graph using Graphical Analysis. Be sure to show the best fit line and do a regression analysis. In the ANALYSIS window choose AUTOMATIC CURVE FIT and choose a function which best fits the data. Decide whether you should modify the fit in order to force the intercept and/or change the slope. Also, select the data and choose regression from the ANALYSIS window to show the correlation coefficient for the data.
8. **Using a multimeter (set to measure resistance), measure the resistance of several lengths of the same composition and gauge wire. Complete at least four trials, using the same spool lengths as before. Create a data table of resistance and length. Determine an appropriate method of graphical and regression analysis. Determine the resistivity, ρ , of nickel-silver wire by multiplying the slope of the regression line by the cross sectional area of 30-gauge wire, $5.093 \times 10^{-4} \text{ cm}^2$. How does this value compare to the actual resistivity of nickel-silver wire, $33 \times 10^{-6} \text{ ohms} \cdot \text{cm}$? Calculate a percentage error.**
9. Create a graph using Graphical Analysis. Be sure to show the best fit line and do a regression analysis. In the ANALYSIS window choose AUTOMATIC CURVE FIT and choose a function which best fits the data. Decide whether you should modify the fit in order to force the intercept and/or change the slope. Also, select the data and choose regression from the ANALYSIS window to show the correlation coefficient for the data.
10. **Complete a standard lab report based upon this year's handout (Introduction to experimental evaluation). In the results and conclusion section of your lab report, be sure to discuss some of the procedural differences in the 2 methods. Be sure to discuss why/if one method of calculating resistivity was better than the other. Be sure to use numbers and correlation coefficients. You will be expected to write a good "results and conclusion" section.**
11. GOOD LUCK