Activity Introduction:
What factor other than length affects the resistance of a substance? In this activity you will measure the resistance of two sticks of graphite over the same distance to see if thickness alters the resistance in a conducting material.

Activity Background:
In the previous activity we notice that the length of the materials had an effect on the resistance of that material. There are other factors that also influence the resistance of material. Some materials offer so much resistance that they are generally considered non-conductors or insulators. Plastic is an example of such an insulator. When you look at the wires you they are covered with bright colorful plastic acting as electrical insulators.

Experimental Design Basics
An experiment is designed to search for cause and effect relationships. An experiment that is well-designed will change one factor (cause) in a very specific way to see if another factor responds (effect) to the change. The factors that are changed in this way are called variables.

There are three types of variables in an experiment: independent, dependent, and constants (controlled).

The independent variable in an experiment is the variable that is manipulated or changed by the experimenter. Thus, it is sometimes called the manipulated variable. A good experiment can only have one independent variable. In this experiment, think about what will be different about the graphite stick in each test group?

The dependent variable is the factor observed to see how it responds to the independent variable. It is also called the responding or outcome variable. Think about what may respond as you change the length of the graphite stick.

Constants are things that are kept the same in each test group of an experiment. In order to have a controlled experiment, all variables except the independent and dependent variables must be controlled. This is done by making sure that they are the same for all test groups.
In a good experiment, scientists must be able to measure the variables. Length, distance, and mass are easy to measure. Sweetness in foods or love are not as easy to measure. In planning an experiment, it must be determined how you will measure the variables in your experiment.

**Identify Variables:**

**Independent Variable:** ________________________________

**Dependent Variable:** ________________________________

**List 3 variables that must be made constant in this experiment.**

a. ____________________________________________________

b. ____________________________________________________

c. ____________________________________________________

**State Your Hypothesis:** Write a hypothesis that predicts how the independent variable may affect the dependent variable. Be sure to write the hypothesis as an “if, then” statement and explain why you think this will happen.

**Hypothesis:**

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Activity Materials: (per student or station)
- 1 Graphite drawing stick
- 1 Graphite pencil lead
- 1 Plastic Metric ruler
- 1 Analog multimeter
- 1 Copy Student Information Page
- 1 Copy Student Data Page

Activity Instructions:
1. Observe both pieces of graphite carefully, you will notice they differ in thickness.

2. Take out the multimeter and set it to measure the resistance of an object. If you have difficulty remembering what to do, go back to Instruction Card 2 to review. Make sure you are thoroughly familiar with this process before taking measurements.

3. Measure the resistance in 6 cm of each graphite sample and record in the Thickness vs. Resistance Data Table.

Activity Results:

Thickness vs. Resistance Data Table

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Resistance 1 (Ω)</th>
<th>Resistance 2 (Ω)</th>
<th>Average Resistance (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thick Graphite Sample</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thin Graphite Sample</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Processing Out:
1. Look at your data carefully. How does the resistance differ between the thick and thin pieces of graphite?
2. Why did you measure the resistance in exactly 6 cm of each graphite stick?

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3. Do you accept or reject your hypothesis based on the data? Explain.

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4. If you wanted to know exactly how thickness affected resistance, how would you need to change the procedure you used in this part of the activity?

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5. If you were to measure the resistance in a human arm or leg, how might the relationship between thickness and resistance be important?

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