Resistance Lab

Part A: Ohm's law

Procedure:

Set up a simple circuit with a resistor, then connect an ammeter into the circuit so that the current through the resistor can be measured. Measure the voltage across the resistor and record the value. Measure the current through the resistor and record the value. Repeat this step 2 more times to have 3 values total for current and voltage.

Questions:

1. Plot a graph of voltage versus current for the resistor and connect the data points with a best fit line.
2. Based on your results, what is the resistance of the resistor? Explain how you found it.

B. Wire length and Diameter

For this activity, use three different gauges of wire, each in three different lengths. The gauge of a wire represents the thickness of the wire; 19 gauge wire has a larger diameter than 24 gauge wire.

When experimenting with three like wires of different lengths, it may be helpful to tape the three pieces to a meterstick. This will keep the wires neatly in place and allow you to verify their lengths.

Materials Needed:
1 Circuit board
3 D-batteries
2 Alligator clips, with banana plugs on one end
24 Gauge white covered wire cut into three pieces 12", 24" and 36" long, ends stripped
19 Gauge copper wire cut into three pieces 12", 24" and 36" long, ends stripped
28 Gauge steel wire cut into three pieces 12", 24" and 36" long, ends stripped
1 Multimeter set up to measure current in milliamps
1 Meterstick

Procedure:

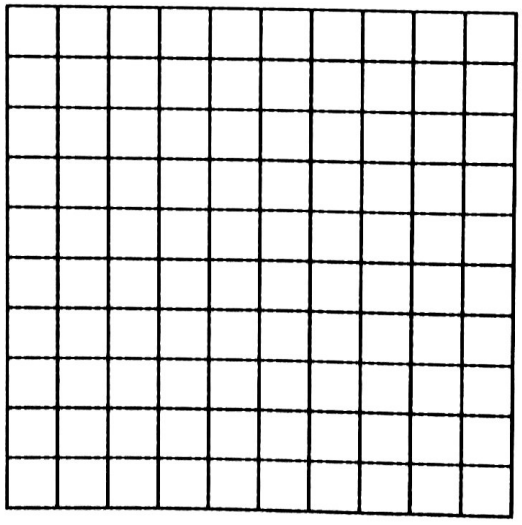
1. Using the 24 gauge white wire, make up the three lengths as described in the **Materials Needed** section. It may assist the process to attach these different sized wires to a meter stick.
2. Measure the voltage across the three batteries and record the data in **Data Table 4C**.
3. Connect each length of wire individually to the batteries and ammeter. Measure the current through each length of wire and record in **Data Table 4C**.

   Note: When you connect the wire to measure the current, wait two seconds and record the current, then disconnect the circuit. The current will change if you leave it connected longer. This will be investigated in a later activity.
4. Using Ohm's Law, calculate the resistance of each length of wire. Record these values in **Data Table 4C**.
5. Repeat steps 1 - 4 for the 19 gauge copper wire and the 28 gauge steel wire.

Data Table 4C: Resistance based on Wire Gauge and Length									
	24 Gauge White			19 Gauge Copper			28 Gauge Steel		
Wire Length	Voltage (V)	Current (A)	Resistance (Ω)	Voltage (V)	Current (A)	Resistance (Ω)	Voltage (V)	Current (A)	Resistance (Ω)
12"									
24"									
36"									

Questions:

1. Draw a graph for the length versus the current of the 19 gauge copper wire. On the same graph, plot the data for the wires of other gauges.



2. Based on your results, describe how the length of the wire affects the current moving through a conductor.

3. Based on the results of all three gauges of 12" wire, describe how the diameter of the wire affects the current and resistance.

4. Describe the qualities that would make a good conductor, in terms of a wire's diameter and length. Remember, the best conductor would minimize resistance and maximize current.

C. Heat Effect on Resistance

For this activity, you will be using 36" of wire to investigate how electrical energy is transformed into heat energy and the effect heat has on resistance.

Safety Note: The wire will get warm while performing this experiment. Exercise caution handling the wire during the experiment.

Materials Needed:
1 Circuit board
3 D-batteries
2 Wire leads with alligator clips and banana plugs
24 Gauge white-covered wire, cut into 36" long piece, ends stripped
1 Multimeter set up to measure current in milliamps
Voltmeter
Stopwatch

Procedure:

1. Set up a circuit using three batteries, ammeter, and the 36" piece of wire. Leave one wire disconnected from the battery. You will reconnect it once the experiment begins.
2. Measure the voltage across the batteries and record in **Data Table 4D**.
3. During this activity, you will be recording the current and voltage through the wire every 30 seconds for 3 minutes.
4. Connect the one disconnected wire to the battery, start the stopwatch and record the initial current in **Data Table 4D**. Record the current and voltage every 30 seconds in **Data Table 4D**.
6. At the end of 3 minutes, disconnect the battery.
7. Use Ohm's Law to calculate the resistance of the wire for each time and record in **Data Table 4D**.

Data Table 4D: Effects of Heat on Resistance			
Time (sec)	Current (A)	Voltage (V)	Resistance (Ω)
0			
30			
60			
90			
120			
150			
180			

Questions:

1. Electrical current moves through thin wires in order to heat a toaster to make toast. Describe how the electrical energy is used to make toast.

2. Describe how the heating of the wire affects the current and resistance.

3. Predict how the current would change in a circuit if it were placed in a freezer and allowed to cool.

D. Resistors – Length of a Conductor with a Graphite Rod and Steel Wool

For this activity, you will be investigating how the length of a conductor can be used to act as a dimmer switch for a light bulb. With the addition of a 6 V lantern battery you can also investigate how a fuse works.

This may be performed as a teacher demonstration.

Safety Note: The steel wool strand will burn and may cause a spark to fly. Use goggles and appropriate safety measures when performing this part of the experiment.

Materials Needed:
1 Circuit board
3 D-batteries
2 Wire leads with alligator clips and banana plugs
1 Graphite rod
1 Light bulb connector
1 Light bulb
Steel wool
1 Multimeter set up to measure current in milliamps
1 Meter stick
6V Lantern battery

Procedure:

1. Set up three batteries and connect the banana plug wires to the ends of the battery terminals.
2. Connect a multimeter to measure the current to one wire. One probe is connected to the alligator clip and one probe will be free to make contact to a graphite rod.
3. Gently connect the other alligator clip to the end of a graphite rod. This will give you an incomplete circuit.

4. Set a meter stick next to the graphite rod. You will be touching the probe from the multimeter to the graphite rod at different positions from the alligator clip. This will allow you to measure the current through different lengths of the graphite. See **Figure 6**.

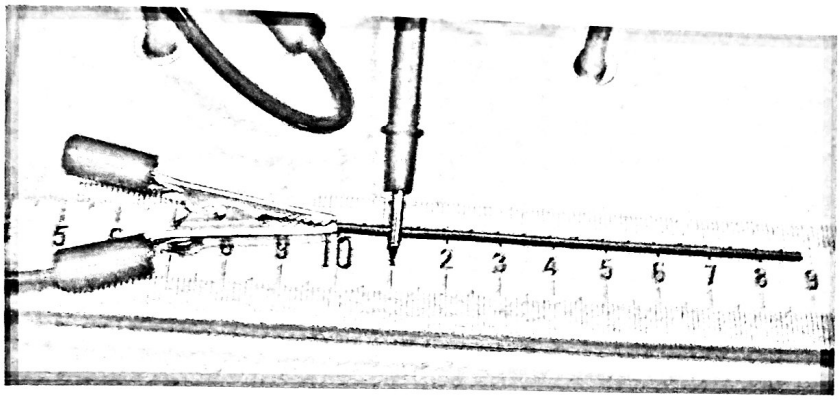


Figure 6: Graphite Rod

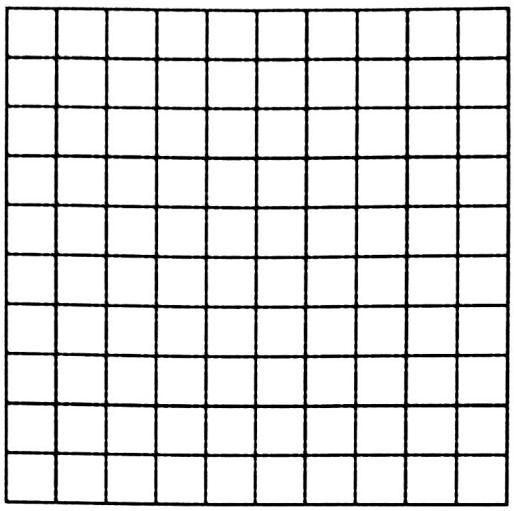
5. Touch the multimeter probe to the graphite rod 10 mm from the alligator clip. Record the current of the 10 mm section in **Data Table 4E**. If the current reading jumps around, hold the probe firmly against the graphite rod. Take care that you do not break the rod.
6. Move the probe to 15 mm and record the current in **Data Table 4E**.
7. Continue moving the probe in 5-mm increments and recording the current until you reach 55 mm.

Data Table 4E: Change in Resistance of Graphite Rod	
Length (mm)	Current (Amp)
10 mm	
15 mm	
20 mm	
25 mm	
30 mm	
35 mm	
40 mm	
45 mm	
50 mm	
55 mm	

8. **Teacher Demonstration**: Steel wool is used as a variable resistor and as a fuse.

Questions:

1. Draw a graph of the current versus the length on the graphite rod.



2. Explain the relationship between the length of a resistor and current as illustrated in the graph.

3. Explain the qualities of a good conductor. Take into account a low resistance in terms of its length.

4. Based on the demonstration with the steel wool strand, describe how a dimmer switch for a light bulb works.

5. Explain what happens to a fuse if too much current flows through it.

6. Explain why the burning out of a fuse is a good safety feature to have in a circuit.