

**CONCEPTUAL PHYSICS****Experiment***34.5 Electric Current: Ohm's Law*

OHM, OHM ON THE RANGE

Purpose

In this experiment, you will arrange a simple circuit involving a power source and a resistor. You will attach an ammeter and a voltmeter to the circuit. You will measure corresponding values of current and voltage in the circuit. You will then interpret your observations to find the relationship between current, voltage, and resistance.

Required Equipment and Supplies

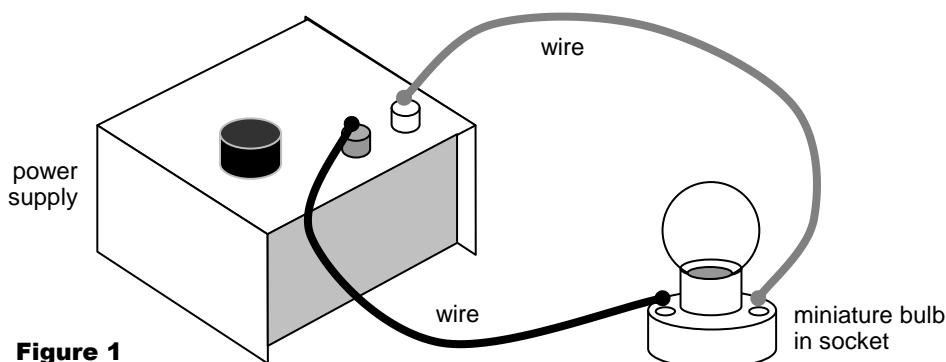
variable DC power supply (0–6 V)
2 power resistors with different resistances (values between 3 Ω and 10 Ω recommended)
power resistor with unknown resistance (for the Going Further section of experiment)
miniature light bulb in socket (14.4-V flashlight bulb recommended)
DC ammeter (0–1 A analog recommended)
DC voltmeter (0–10 V analog recommended)
5 connecting wires
graph paper

Discussion

The current, voltage, and resistance in an electric circuit are related to one another in a very specific way. Designers of electric circuits must take this relationship into account or their circuits will fail. This relationship is as important and fundamental in electricity as Newton's second law of motion is in mechanics. In this experiment, you will determine this relationship.

Procedure**Part A: Connecting the Meters**

Step 1: With the power supply turned down to zero, arrange a simple circuit using the power supply, the miniature bulb and two connecting wires as shown in Figure 1. If your power supply has "AC" terminals, do not use them; connect only to the "DC" terminals.



Step 2: Verify that the circuit is working properly by slowly turning the knob on the power supply to increase the power to the circuit. The bulb should begin to glow and increase in brightness as power is increased. If the circuit doesn't work, make adjustments so that it does. Ask your instructor for assistance if necessary.

Step 3: Turn the power down to zero.

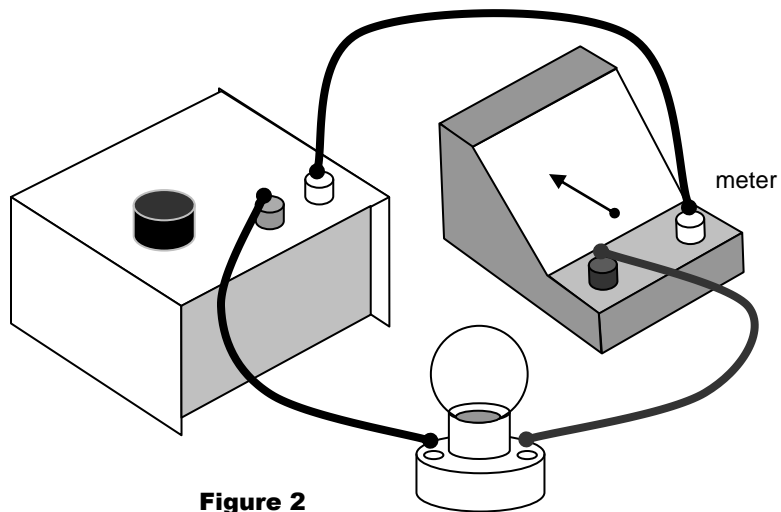


Figure 2

Step 4: Connect the ammeter in series as shown in Figure 2. Slowly increase the power to the circuit and observe the ammeter and the bulb. If the needle on your ammeter ever moves in the wrong direction (that is, tries to “go negative”), reverse the connections and try again.

1. When the connections are correct, what do you observe?

Step 5: Turn the power back down to zero. Disconnect the ammeter and restore the circuit to its original configuration (shown in Figure 1).

Step 6: Connect the ammeter in parallel as shown in Figure 3. Slowly increase the power to the circuit and observe the ammeter and the bulb.

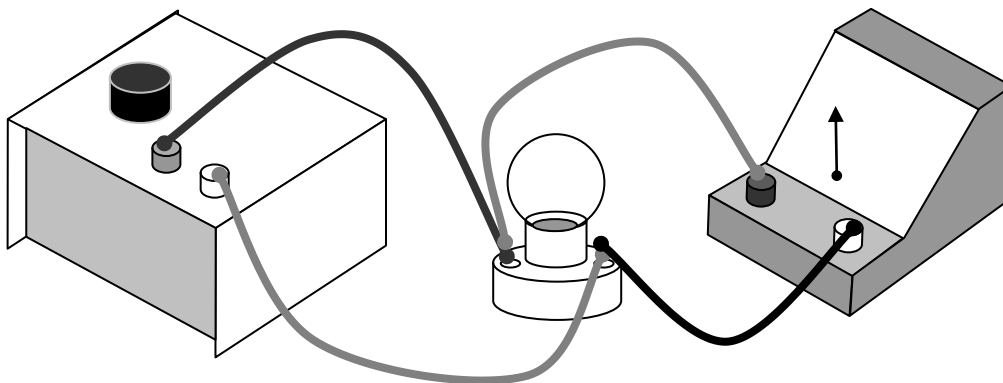


Figure 3

2. What do you observe?

Step 7: Turn the power back down to zero. Disconnect the ammeter and restore the circuit to its original configuration (shown in Figure 1.)

Step 8: Connect the voltmeter in series as shown in Figure 2. Slowly increase the power to the circuit and observe the voltmeter and the bulb. If the needle on your voltmeter ever moves in the wrong direction (tries to “go negative”), reverse the connections and try again.

3. When the connections are correct, what do you observe?

Step 9: Turn the power back down to zero. Disconnect the voltmeter and restore the circuit to its original configuration (shown in Figure 1.)

Step 10: Connect the voltmeter in parallel as shown in Figure 3. Slowly increase the power to the circuit and observe the voltmeter and the bulb.

4. What do you observe?

When the ammeter is connected correctly, the circuit behaves as it did when no meters were connected (increasing the power increases the brightness of the bulb). When the power is increased, the ammeter shows increased current in the circuit. When the ammeter is connected incorrectly, the bulb remains dim or does not light at all although the ammeter shows significant current.

5. The correct method is to connect the ammeter to the circuit in ___series or ___parallel (select one).

When the voltmeter is connected correctly, the circuit behaves as it did when no meters were connected (increasing the power increases the brightness of the bulb). When the power is increased, the voltmeter shows increased current in the circuit. When the voltmeter is connected incorrectly, the bulb remains dim or does not light at all although the voltmeter shows significant voltage.

6. The correct method is to connect the voltmeter to the circuit in ___series or ___parallel (select one).

Step 11: Connect a circuit that includes the bulb, the ammeter, and the voltmeter. Connect the ammeter and voltmeter correctly, based on your findings. Sketch a diagram in the space below to show how the wires connect the various circuit elements.

Step 12: Verify that the circuit is working correctly. When the power is increased, the bulb should get brighter, the ammeter reading should increase, and the voltmeter reading should increase. Show your instructor your working circuit.

Part B: Collecting Data

Step 1: Turn the power down to zero. Replace the bulb with one of the known resistors. (Remove the bulb and socket from the circuit; connect the resistor in its place.)

Step 2: Increase the power until the current indicated on the ammeter is 0.10 A.

Step 3: Record the corresponding voltmeter reading in the appropriate space the data table.

Step 4: Repeat Steps 2 and 3 for current values of 0.20 A through 0.60 A.

Step 5: Turn the power down to zero. Replace the first resistor with the second resistor.

Step 6: Repeat Steps 2 through 4 to complete the data table for the second resistor.

Data

Current I (amperes)	First Known Resistor Voltage V (volts)	Second Known Resistor Voltage V (volts)
0	0	0
0.10		
0.20		
0.30		
0.40		
0.50		
0.60		

Step 7: On your graph paper, plot graphs of voltage versus current for both resistors. Plot all three data sets on one set of axes. Voltage will be the vertical axis; current will be the horizontal axis. Scale the graph to accommodate all your data points. Label each axis as to its quantity and units of measurement.

Step 8: Make a line of best fit for each data set plotted on the graph.

Step 9: Determine the slope of each best-fit line.

1. What is the slope of each best-fit line? Identify each slope by its corresponding resistor value. Don't forget to include the correct units for each slope value.

_____ Ω resistor best-fit line slope = _____

_____ Ω resistor best-fit line slope = _____

Observe the similarity between the values of the slope and the values of the corresponding resistance.

Going Further

Obtain a power resistor with an unknown resistance from your instructor. Using the techniques of this experiment, determine the resistance of the resistor. Record your data and calculations in the space below.

Once you determine the resistance of the unknown resistor, ask your instructor for the accepted value. Record that value and calculate the percent error in your value.

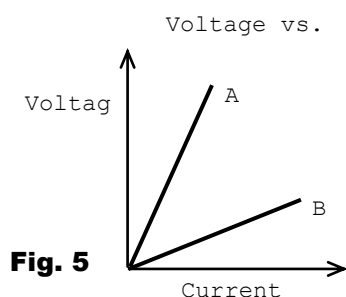
Summing Up

1. Which mathematical expression shows the correct relationship between current, voltage, and resistance?

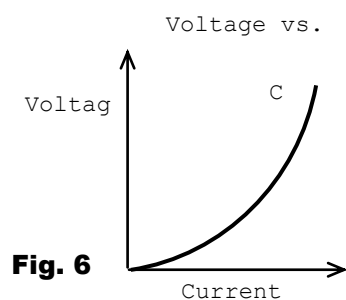
___ $R = IV$ ___ $R = I/V$ ___ $R = V/I$

The correct answer is one form of the equation known as Ohm's Law.

2. Suppose voltage versus current data were taken for two devices, A and B, and the results were plotted to form the best-fit lines shown in Figure 5. Which device has the greater resistance? How do you know?



3. Suppose the voltage and current data for electrical device C produced graph C shown in Figure 6. How does the resistance of device C change as the current increases? Explain.



4. Suppose the voltage and current data for electrical device D produced graph D shown in Figure 7. How does the resistance of device D change as the current increases? Explain.

