CONCEPT 1

Voltage, current, and resistance in a circuit are related by Ohm's law.

Activity

Comparing Current and Resistance

The table shown here lists the resistance of some common home appliances. The last column shows the current that passes through each appliance when connected to a 120 V source (standard household voltage). Draw a graph of resistance versus current for these items. Put resistance on the *x*-axis and current on the *y*-axis. Study your graph. How is current related to resistance? For example, when the resistance increases, what happens to the current?

Appliance	Resistance (Ω)	Current (A)
Lamp	150	0.8
Laptop computer	60	2.0
Toaster	20	6.0

Connect to Investigation 3-F on page 244

It is critical that too much current does not flow through the conductors in a circuit. If the current is too high, the wires can get extremely hot and start a fire. Fortunately, it is possible to predict what the current will be in a circuit.

Ohm's Law

German physicist Georg Ohm studied the relationship among electrical potential difference, current, and resistance in electrical circuits. He discovered that when he raised the electrical potential difference, the current increased for a given resistance in a conductor. He developed the relationship now known as **Ohm's law**, shown in the box below.

Ohm's Law law stating that the electrical potential difference between two points in a circuit is equal to the current times the resistance between those two points

Ohm's Law

The electrical potential difference between two points in a circuit is equal to the current times the resistance between those two points.

$$V = IR$$

V is the symbol for electrical potential difference, I is the symbol for current, and R is the symbol for resistance.

By rearranging the variables in Ohm's law, it is possible to calculate any of the variables if the value of the other two is known.

Activity

Using Ohm's Law

Study the following sample problem to learn how to use Ohm's law. Then solve the following problems. More sample problems are provided in Appendix A on page 397.

Sample Problem

Imagine that you are testing an electrical toy. You are going to plug it into your home outlet, which provides an electrical potential difference of 120 V. The wires are small and you do not want the current to go above 1.5 A. How high must the resistance of the electrical toy be?

Solution

Because you want to determine a resistance, you will need to rearrange the formula $V = IR$ into the formula $R = \frac{V}{I}$.

Substitute the values into the formula.

$$R = \frac{V}{I}$$

$$= \frac{120\ \text{V}}{1.5\ \text{A}}$$

$$= 80\ \Omega$$

The electrical toy must have a resistance of at least 80 Ω to ensure that the current does not go above 1.5 A.

1. A television that is plugged into a wall socket has an electrical potential difference of 120 V. If a current of 1.25 A is flowing through the television, what is its resistance?
2. The filament of a flashlight bulb has a resistance of 40 Ω. If a 6.0 V battery is used in the circuit, what is the current?
3. A circuit board has a resistance of 12 Ω and requires a current of 0.25 A. What electrical potential difference is required to operate the circuit board?

Before you leave this page . . .

1. List the three symbols used in Ohm's law. Explain what each symbol represents and give the units for each of the variables.