

# Resistance and Ohm's Law

Textbook pages 290–301

## Before You Read

Do you think electrons can move through all conducting substances equally well? Give your reasons why or why not on the lines below.

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### Create an Outline

Make an outline of the information in this section. Use the headings in the reading as a starting point. Include the bold terms and any other terms that you think are important.

### What is resistance?

**Electrical resistance** is the property of a substance that slows down the movement of electrons and converts electrical energy into other forms of energy. For instance, the resistance of the tungsten filament in a light bulb is more than 400 times greater than the resistance of copper connecting wires. When current moves through the high-resistance filament of the light bulb, the filament converts much of the energy carried by the current into light and heat. When the same current moves through the copper wire, the amount of energy converted into heat is much smaller.

The unit used for measuring resistance is the **ohm** ( $\Omega$ ). An ohmmeter can be used to measure resistance.

### How is resistance related to voltage and current?

Voltage, current, and resistance are closely related.

- ◆ Current is the movement of electrons (charges) through a conductor.
- ◆ Voltage is what makes the electrons move through the conductor.
- ◆ Resistance works against and slows down the motion of the electrons.

Good conductors have low resistance, which means that electrons flow through them easily. Poor conductors have high resistance, which means electrons are slowed down.

## How does Ohm's law relate voltage, current, and resistance?

**Ohm's law** is a mathematical equation that shows how voltage, current, and resistance are related:

$$\text{resistance} = \frac{\text{voltage}}{\text{current}} \text{ or } R = \frac{V}{I},$$

where  $R$  stands for resistance,  $V$  stands for voltage, and  $I$  stands for current.

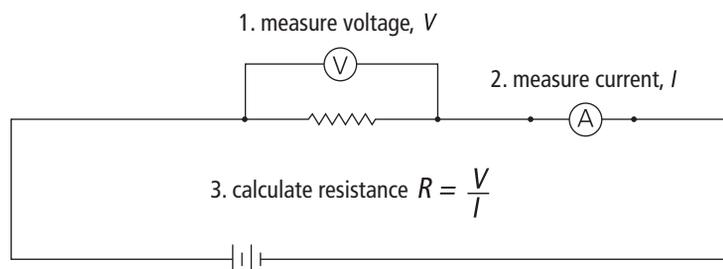
You can rewrite this equation to solve for any of the variables in it. Thus:

$$\text{voltage} = \text{current} \times \text{resistance} (V = IR); \text{ and}$$

$$\text{current} = \frac{\text{voltage}}{\text{resistance}} (I = \frac{V}{R}) \checkmark$$

## What is a resistor?

A **resistor** is a component in a circuit that has a specific resistance. Resistors are used to control current or voltage to suit the needs of other electric devices in the circuit. The circuit symbol for a resistor looks like this:   $\checkmark$



Using Ohm's law, you can calculate resistance from current and voltage measurements.

### Reading Check

1. State Ohm's law in words.

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### Reading Check

2. What is a resistor?

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Use with textbook pages 290–297.

## Voltage, current, and resistance

Follow the directions below to demonstrate what you know about voltage, current, and resistance.

1. Define the following terms.

(a) current \_\_\_\_\_

\_\_\_\_\_

(b) voltage \_\_\_\_\_

\_\_\_\_\_

(c) resistance \_\_\_\_\_

\_\_\_\_\_

(d) Ohm's law \_\_\_\_\_

\_\_\_\_\_

(e) resistor \_\_\_\_\_

\_\_\_\_\_

2. Complete the following table. The table has been partially completed to help you.

	Current	Voltage	Resistance
<b>Symbol</b>	/		
<b>Unit</b>			ohm ( $\Omega$ )
<b>Meter used for measurement</b>			
<b>Formula</b>			

Use with textbook pages 290–297.

## Calculations with Ohm's law

Use Ohm's law to complete the following table. Write the formula you will use and substitute the known values into the formula. Show all your work and include the correct unit with your answer. The first question has been done to help guide you.

	Question	Show your work	Answer
1.	A current through a resistor in a circuit is 1.5 A. If the potential difference across the resistor is 6 V, what is the resistance of the resistor?	$R = V \div I$ $= 6 \text{ V} \div 1.5 \text{ A}$ $= 4 \Omega$	4 $\Omega$
2.	A toaster is plugged into a 120 V outlet. What is the resistance of the toaster if the current in the toaster is 10 A?		
3.	A light bulb with a resistance of 30 $\Omega$ is connected to a battery. If the current in the light bulb is 0.2 A, what is the voltage of the battery?		
4.	What is the current in a flashlight bulb with a resistance of 24 $\Omega$ if the voltage provided by the flashlight battery is 3 V?		
5.	An electric iron plugged into a wall socket has a resistance of 20 $\Omega$ . If the current in the iron is 6 A, what is the voltage provided by the wall socket?		

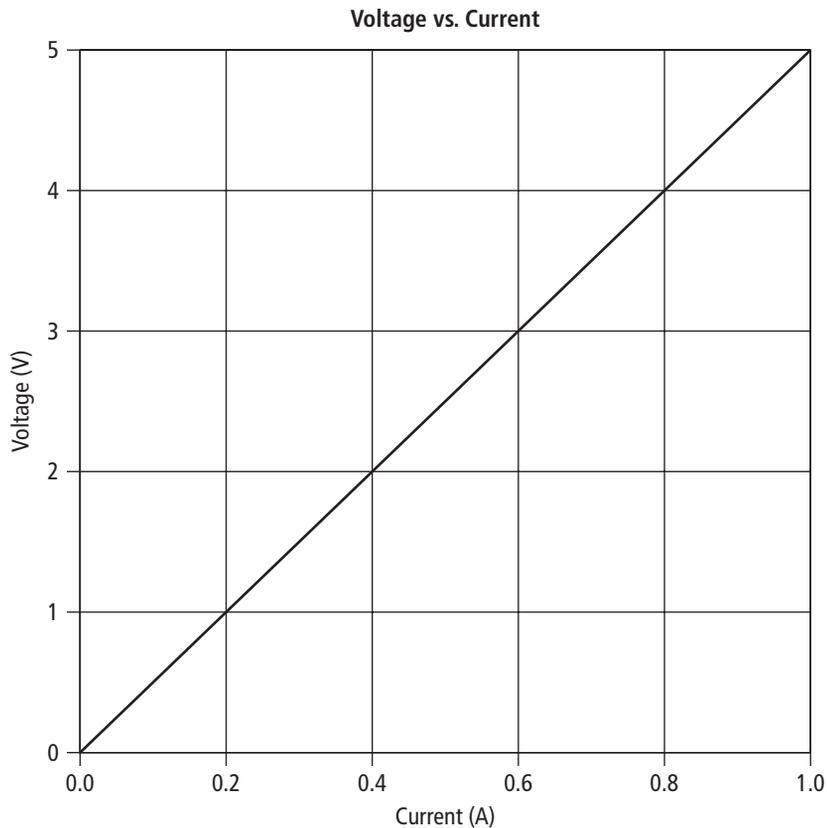
Name \_\_\_\_\_

Date \_\_\_\_\_

Use with textbook pages 290–297.

## Relationship between current, voltage, and resistance

Use the graph below to answer the questions that follow.



1. (a) What happens to the voltage as the current increases?

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- (b) What does this suggest about the relationship between voltage and current?

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2. According to the graph, what happens to the voltage when the current is doubled?

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Name \_\_\_\_\_

Date \_\_\_\_\_

Use with textbook pages 290–297.

# Resistance and Ohm's law

Match the Formula or Unit on the left with the best Descriptor on the right. Each Descriptor may be used only once.	
Formula or Unit	Descriptor
1. _____ $I = V \div R$	<b>A.</b> unit for voltage
2. _____ $R = V \div I$	<b>B.</b> unit for current
3. _____ $V = I \times R$	<b>C.</b> unit for resistance
4. _____ volts (V)	<b>D.</b> formula for voltage
5. _____ ohms ( $\Omega$ )	<b>E.</b> formula for current
6. _____ amperes (A)	<b>F.</b> formula for resistance

Circle the letter of the best answer.

7. Which of the following correctly matches the devices with what they measure?

	Ammeter	Ohmmeter	Voltmeter
<b>A.</b>	current	voltage	resistance
<b>B.</b>	resistance	current	voltage
<b>C.</b>	voltage	resistance	current
<b>D.</b>	current	resistance	voltage

8. What is the name of the law given to the mathematical relationship between voltage, current, and resistance?

- A.** Ohm's law
- B.** Voltage's law
- C.** Ampere's law
- D.** Electricity's law

9. Which of the following describes resistance?

I.	It resists the flow of electrons.
II.	It speeds up the current flow in a circuit.
III.	It causes the electron's electrical energy to be converted to heat and light energy.

- A.** I and II only
  - B.** I and III only
  - C.** II and III only
  - D.** I, II, and III
10. Which of the following occurs if resistance is increased in a circuit?
- A.** Both voltage and current will increase.
  - B.** Both voltage and current will decrease.
  - C.** Voltage will increase and current will decrease.
  - D.** Voltage will decrease and current will increase.
11. What does the symbol  represent?
- A.** a load
  - B.** a resistor
  - C.** a voltmeter
  - D.** an ammeter
12. A 6 V battery is connected to a 10  $\Omega$  resistor. What is the current flowing in the circuit?
- A.** 0.6 A
  - B.** 1.67 A
  - C.** 4 A
  - D.** 60 A