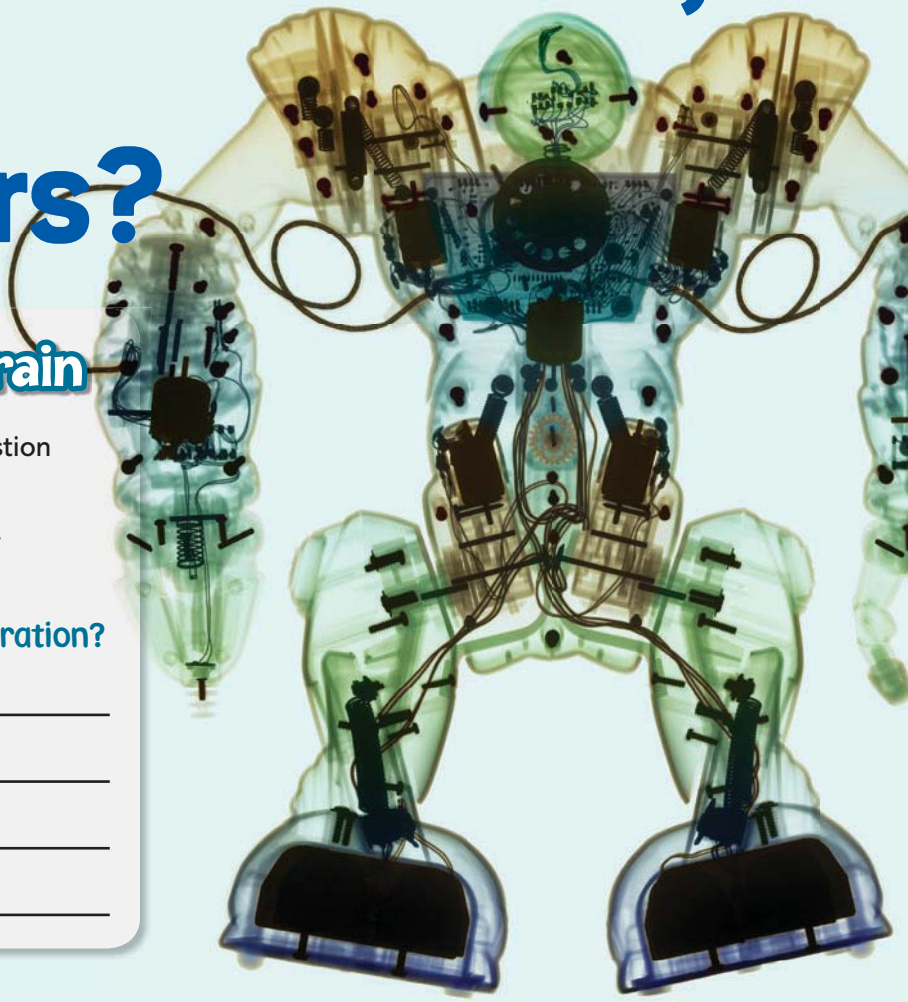
SC.5.P.11.1 Investigate and illustrate the fact that the flow of electricity requires a closed circuit (a complete loop). **SC.5.P.11.2** Identify and classify materials that conduct electricity and materials that do not.

LESSON 2

ESSENTIAL **QUESTION**

What Are Electric Circuits, Conductors, and Insulators?



Engage Your Brain

Find the answer to the following question and record it here.

This picture shows the inside of a robot. What do the dark lines have to do with the robot's operation?

_____

_____

_____

_____

ACTIVE **READING**

Lesson Vocabulary

List the terms. As you learn about each one, make notes in the Interactive Glossary.

_____

_____

_____

Compare and Contrast

When you compare things, you look for ways in which they are alike. When you contrast things, you look for ways in which they are different. Active readers stay focused by asking themselves, How are these things alike? How are these things different?

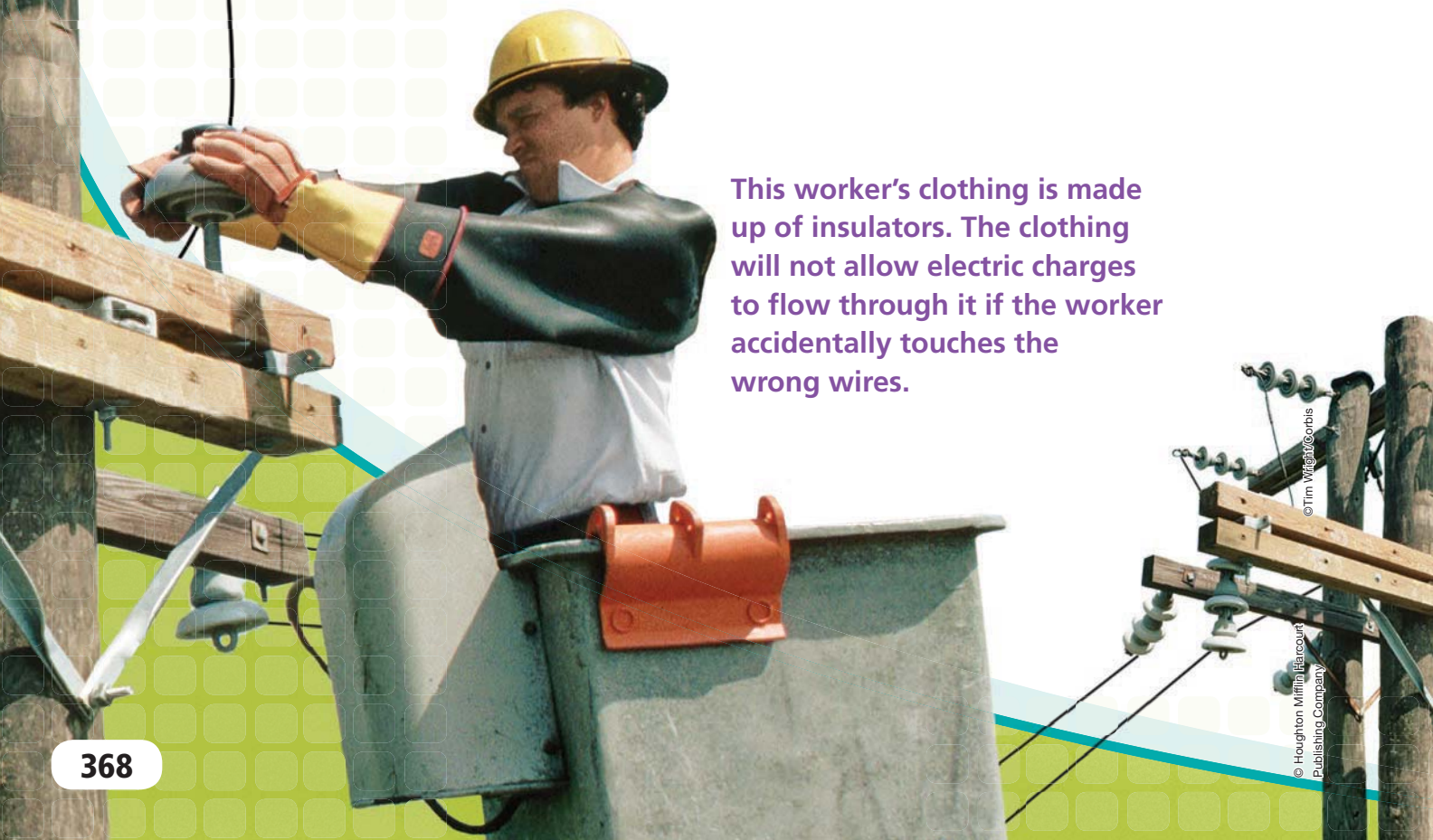
It's Shocking!

Working around electric utility lines is dangerous! How does a line worker stay safe?

ACTIVE READING Draw a box around the sentences that contrast conductors and insulators.

Even on a hot day, a worker who repairs electric utility lines must be bundled up in protective clothing. The thick gloves, the bulky boots, and the hard plastic hat are heavy; however, these clothes protect the worker from an electric shock!

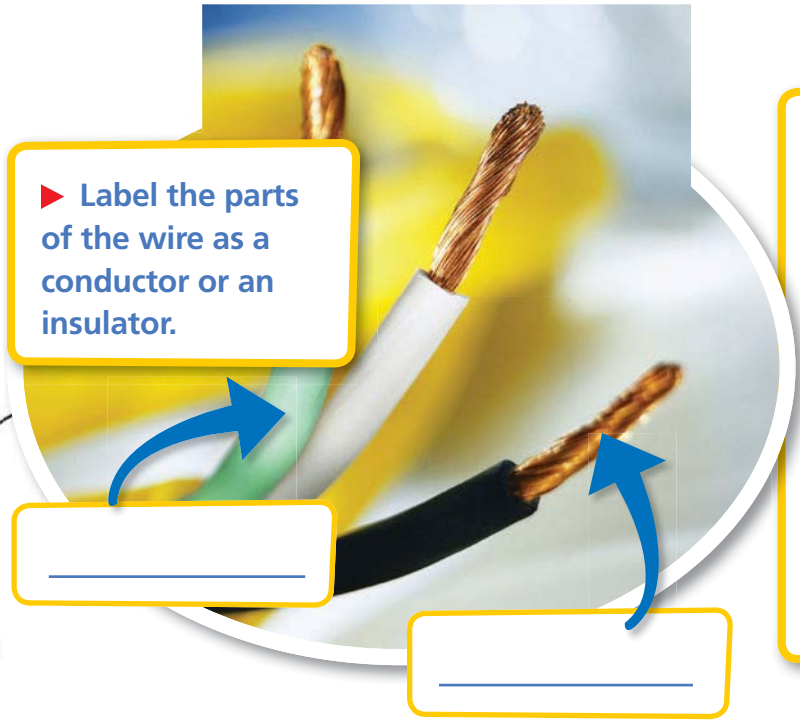
The rubber and plastic used in the protective clothing do not allow electric charges to flow through them. A material that resists the flow of electric charges is called an **insulator**. Electric charges flow easily through metals and some liquids. A material that readily allows electric charges to pass through it is called a **conductor**.



This worker's clothing is made up of insulators. The clothing will not allow electric charges to flow through it if the worker accidentally touches the wrong wires.

The parts of a plug that you hold and the covering on the wire are insulators. The metal prongs that go into the outlet are good conductors.

Electrical appliances work when electric charges flow through them. The parts that carry electric charges are made from conductors. Insulators are wrapped around the conductors to make appliances safe to handle.



▶ Label the parts of the wire as a conductor or an insulator.

_____

_____

▶ Why are insulators used?

_____

_____

_____

_____

_____

_____

_____

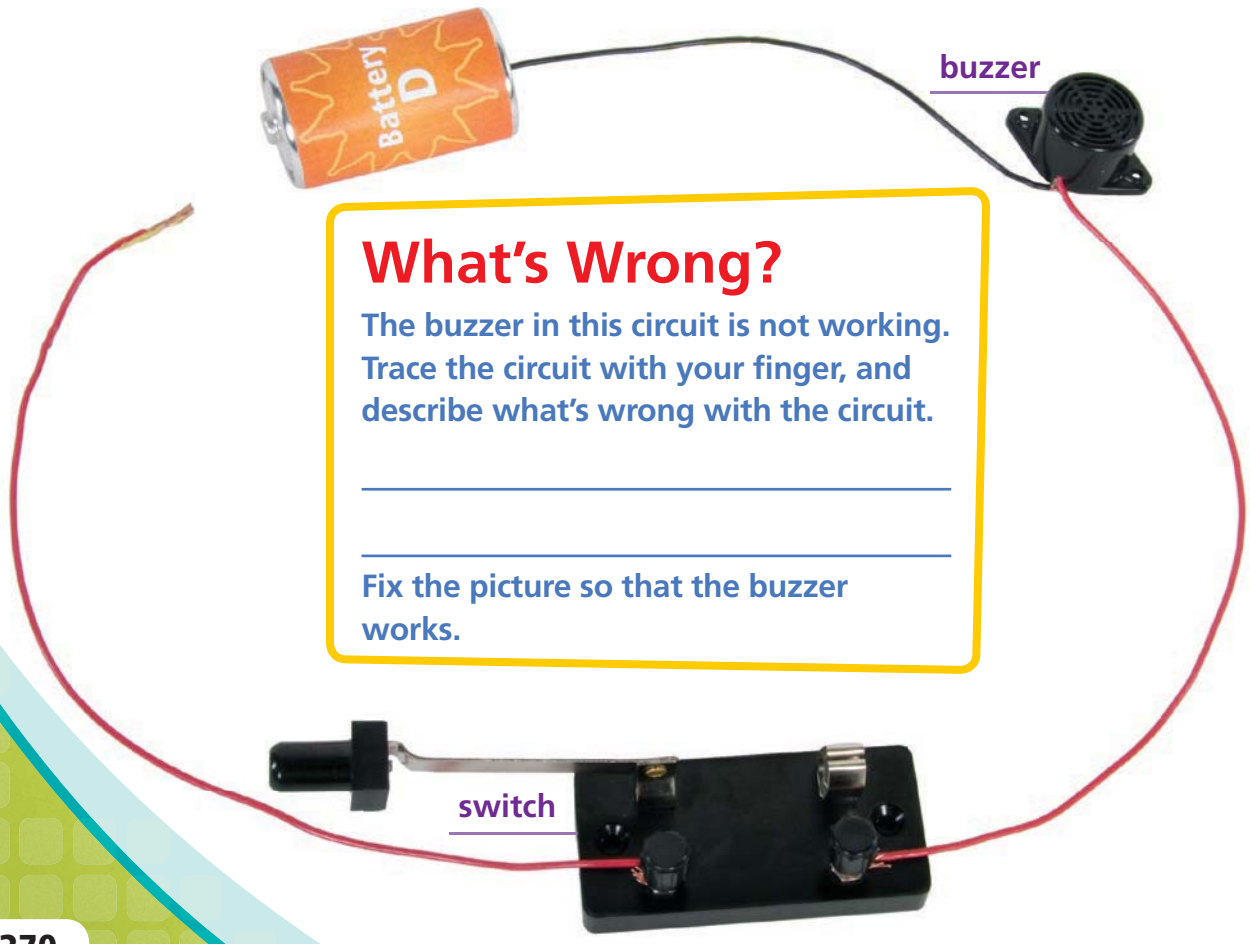
A Path to Follow

If the wiring in a lamp does not change, why isn't the lamp on all of the time?

ACTIVE READING Draw a box around the sentences that tell you how a closed circuit and an open circuit are different.

When you go to school and back home, your path is a loop. A **circuit** is a path along which electric charges can flow. For an electrical device to work, the circuit must form a complete loop. This type of circuit is called a *closed circuit*. There are no breaks in its path.

What happens if a loose wire gets disconnected? The path is broken, and charges cannot flow. This type of circuit is called an *open circuit*. Many circuits have a switch. A switch controls the flow of charges by opening and closing the circuit.



What's Wrong?

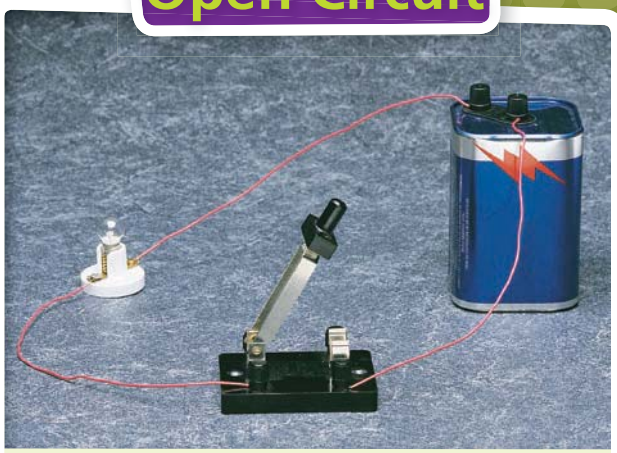
The buzzer in this circuit is not working. Trace the circuit with your finger, and describe what's wrong with the circuit.

_____

_____

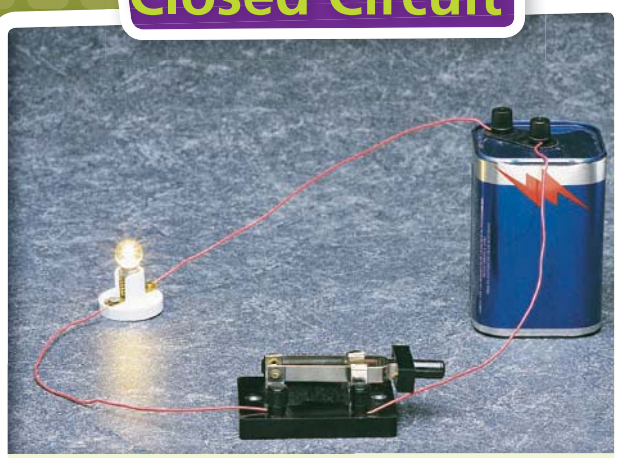
Fix the picture so that the buzzer works.

Open Circuit



When the switch in a circuit is open, the circuit is not complete. Electric charges cannot flow, so the light stays off.

Closed Circuit



When the switch is closed, the circuit is complete. Electric charges can flow through it to light up the bulb.

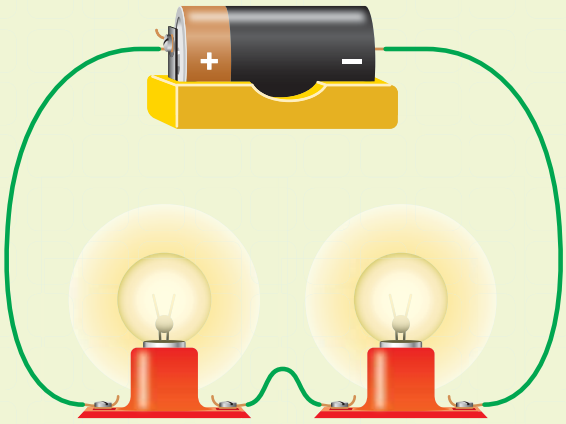
▶ The filament in a light bulb is a tiny wire. It is part of the circuit. If the filament breaks, the circuit will be _____.

Who Needs a Map?

To travel from point A to point B, you usually take the shortest route. What if one of the roads on that route is blocked? Simple! You just take another road. What would happen if there were only one road between point A and point B?

ACTIVE **READING** Underline the sentences that compare series circuits and parallel circuits.

Series Circuits



In a series circuit, electric charges must follow a single path. The charged particles move from the battery's positive terminal to its negative terminal.

▶ **Draw arrows to show how charges flow in this circuit.**

If one light bulb in a series circuit burns out, all of the lights go out, because the circuit is broken.

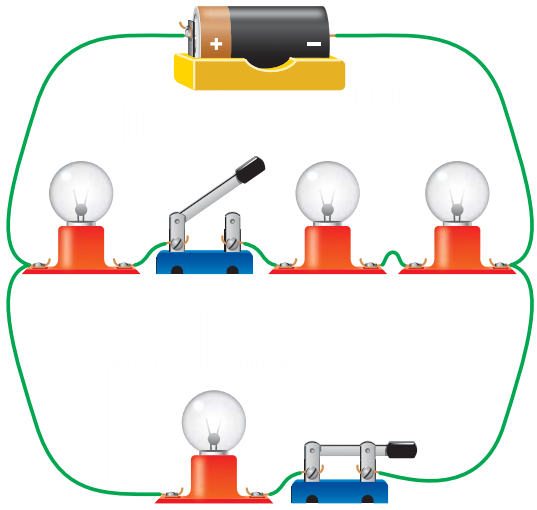
Suppose that the television and all the lights in a room are part of the same circuit. What would happen if one of the light bulbs burned out? It would depend on how the circuit is wired.

A **series circuit** has only one path for electric charges to follow. If any part of the path breaks, the circuit is open. Nothing works!

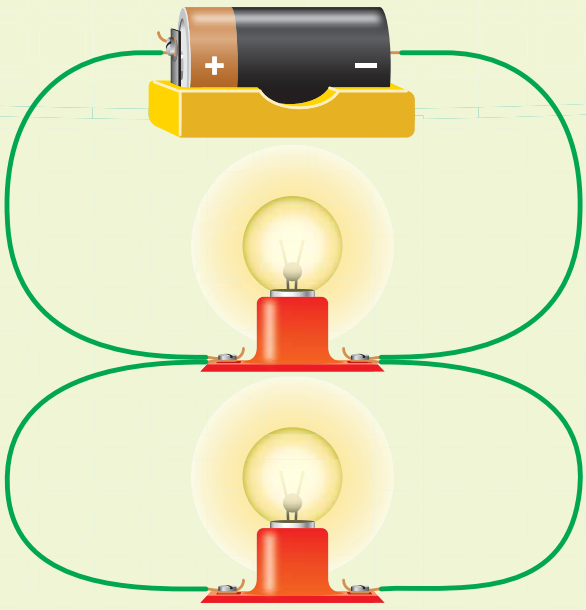
A circuit with several different paths for the charges to follow is called a **parallel circuit**. If one part of the circuit breaks, the charges can still flow along the other parts.

Color a Complex Circuit

1. Look at the circuit below. Color the bulb or bulbs that should be lit.
2. Draw an *X* on the switch that is open. Draw an arrow above the closed switch.



Parallel Circuits



In this parallel circuit, electric charges can flow through both the top loop and the bottom loop.

If one part of a parallel circuit breaks, only that part of the circuit stops working.

Why It Matters

Circuit Overload!

Some house fires are caused by overloaded electrical wiring. How can you use electrical appliances safely?

television
3 amps

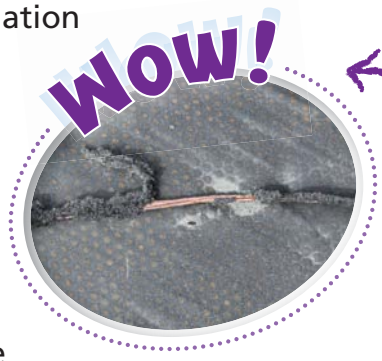
hair dryer
12.5 amps

As electric charges flow through conductors, they produce heat. Insulation protects the materials around these conductors from the heat—up to a point! If the conductor gets too hot, the insulation can melt.

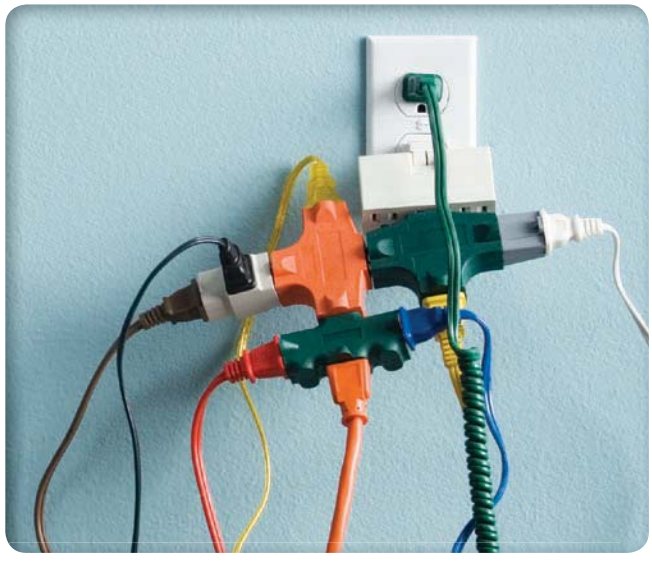
To protect against fires, a fuse or a circuit breaker is added to each circuit. Fuses and circuit breakers are switches that work automatically. They open if charge flows too quickly through a circuit. The flow stops and the wires cool, which prevents a fire.

Circuit overload takes place when too many devices in one circuit are turned on. Each device needs a certain flow of charge. This flow of charge, or current, is measured in units called *amperes*, or amps.

Circuit breakers open when the number of amps is greater than a certain value. Suppose the value for a breaker is 15 amps. The breaker will open if all plugged devices draw more than 15 amps.



This wire got so hot that it melted the insulation around it. It could have started a fire.



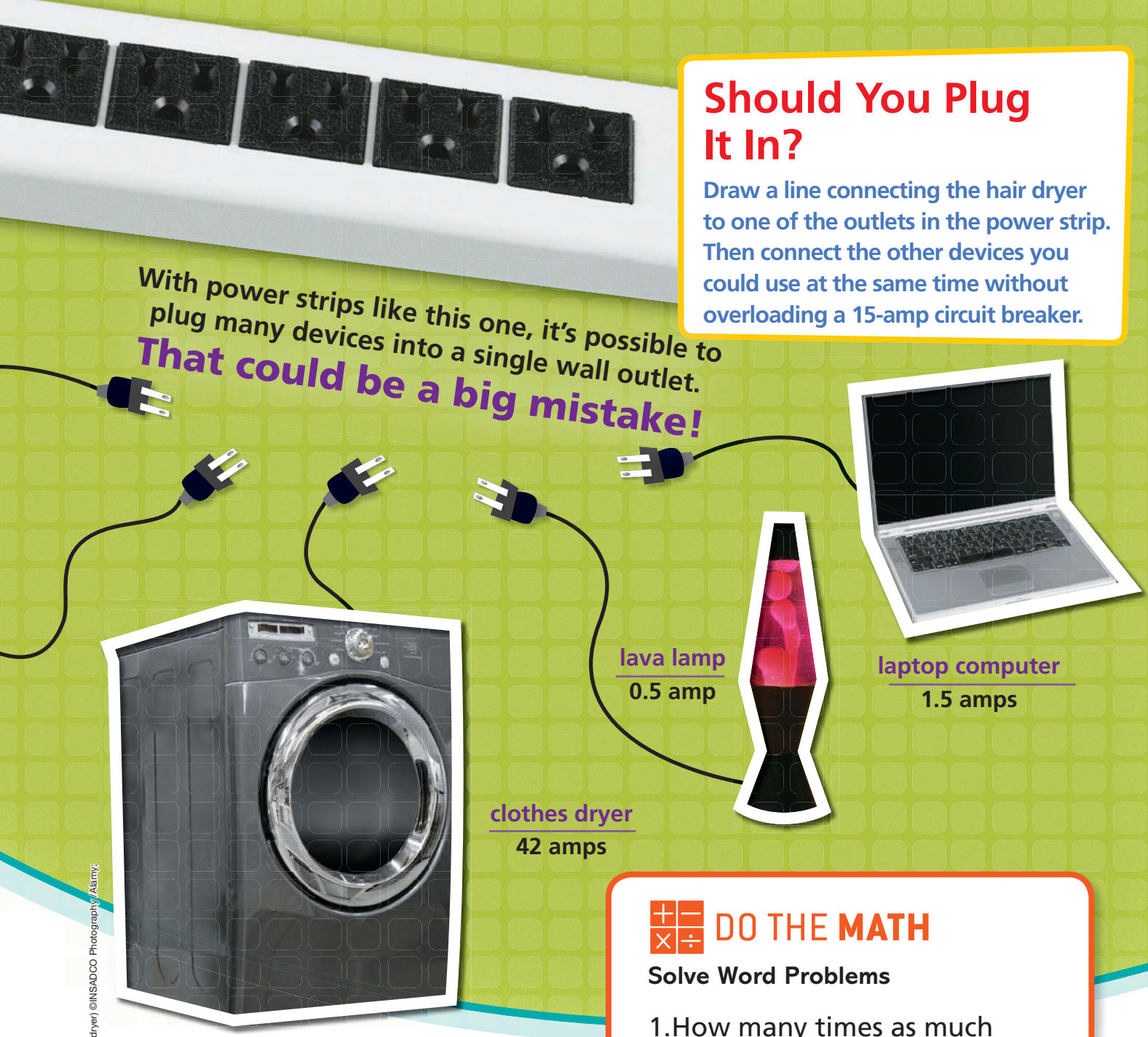
Never plug more appliances into a circuit than it is designed to handle!

Should You Plug It In?

Draw a line connecting the hair dryer to one of the outlets in the power strip. Then connect the other devices you could use at the same time without overloading a 15-amp circuit breaker.

With power strips like this one, it's possible to plug many devices into a single wall outlet.

That could be a big mistake!



lava lamp
0.5 amp

laptop computer
1.5 amps

clothes dryer
42 amps

This panel contains circuit breakers. Each breaker allows a certain number of amps of electric current to pass through one circuit.

DO THE MATH

Solve Word Problems

1. How many times as much current does a television need than a lava lamp?

2. Circuit breakers are made in increments of 5 amps. What size breaker would you need for a circuit with a television, two laptops, and a lava lamp?