



ESSENTIAL QUESTION

# What Are Electric Circuits, Conductors, and Insulators?



## Engage Your Brain

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

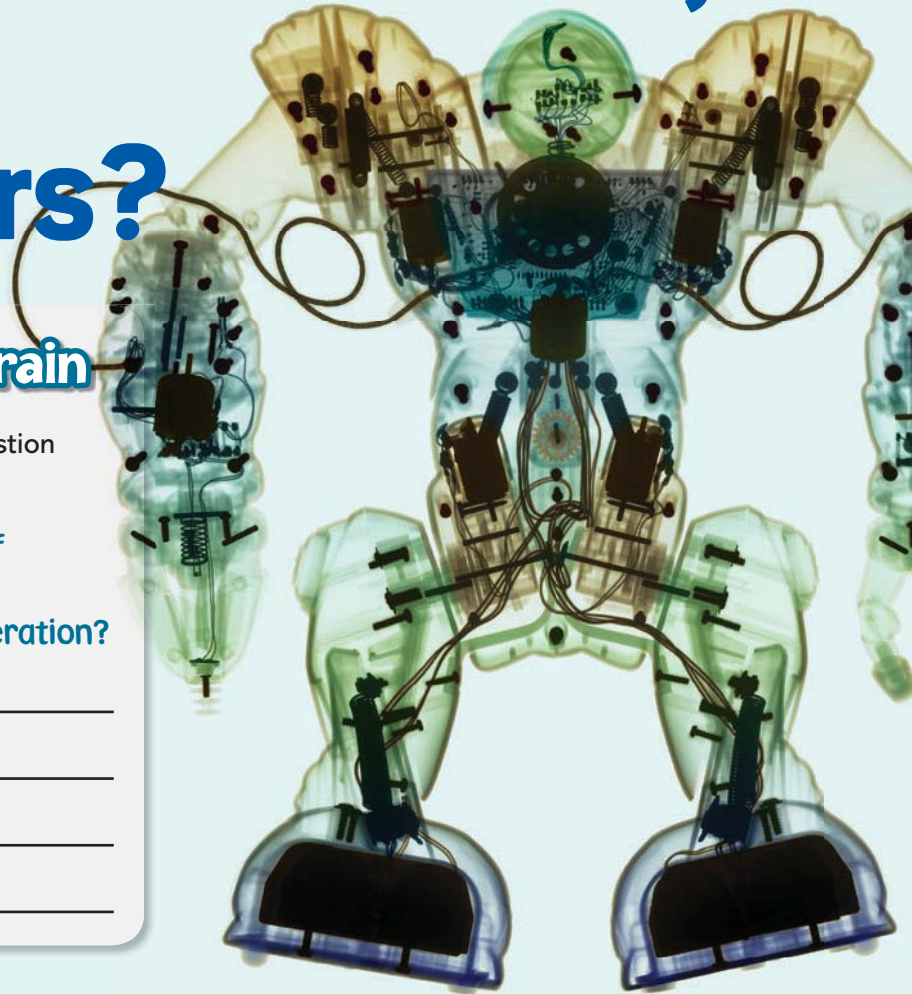
This picture shows the inside of a robot. What do the dark lines have to do with the robot's operation?

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## ACTIVE READING

### Lesson Vocabulary

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

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### 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.

**E**ven 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!

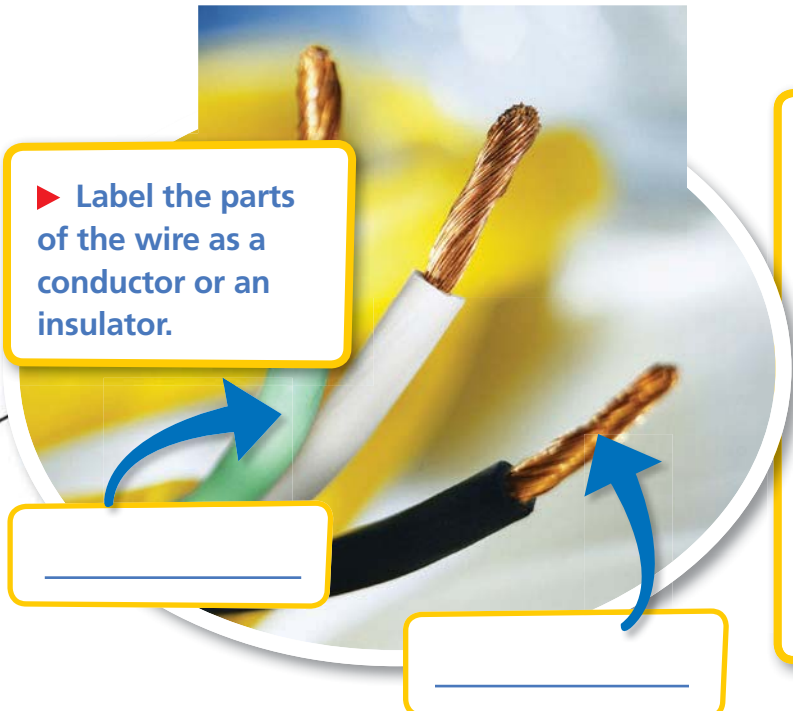
The rubber and plastic used in the protective clothing do not allow electric charges to flow through them. A material that resists the flow of electric charges is called an **insulator**. Electric charges flow easily through metals and some liquids. A material that readily allows electric charges to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

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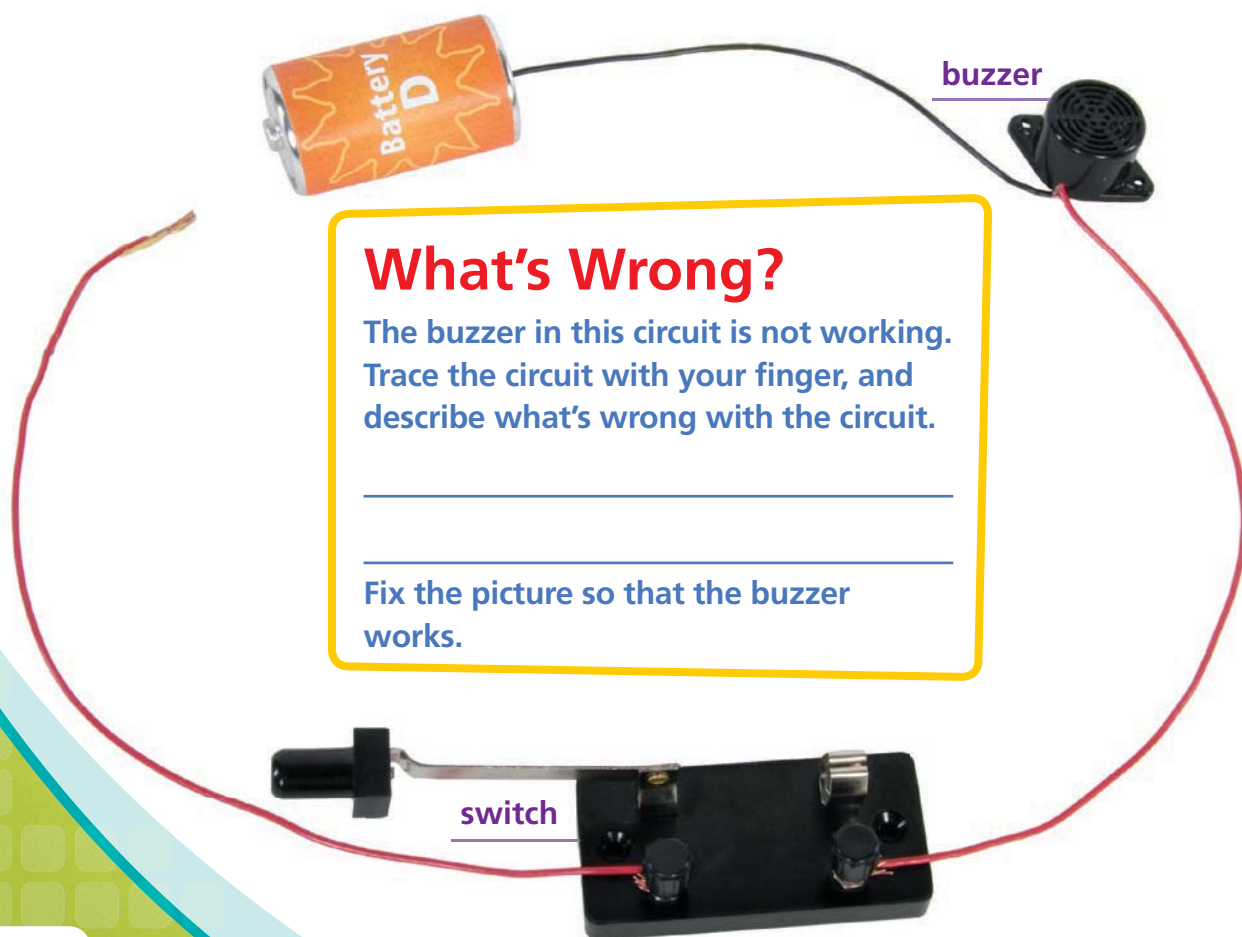
# A Path to Follow

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

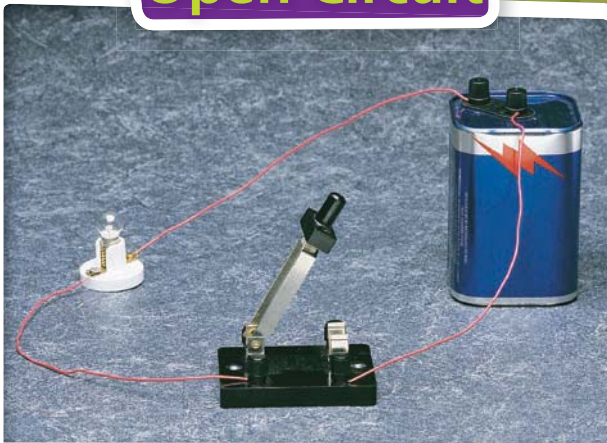
**ACTIVE READING** Draw a box around the sentences that tell you how a closed circuit and an open circuit are different.

**W**hen 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.

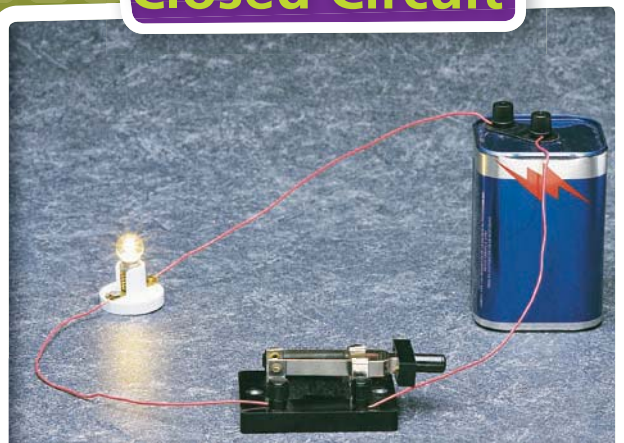


## Open Circuit

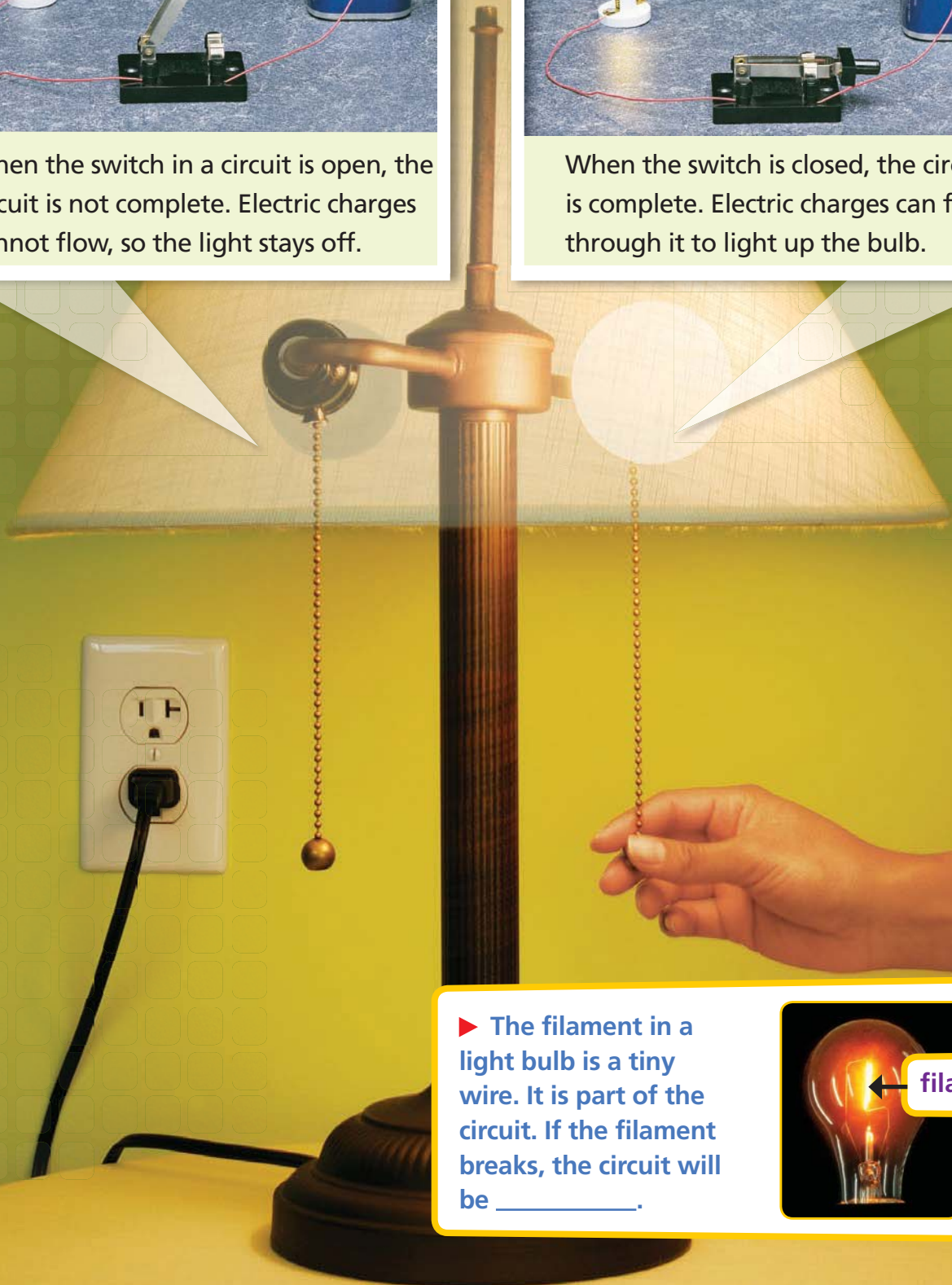


When the switch in a circuit is open, the circuit is not complete. Electric charges cannot flow, so the light stays off.

## 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 \_\_\_\_\_.



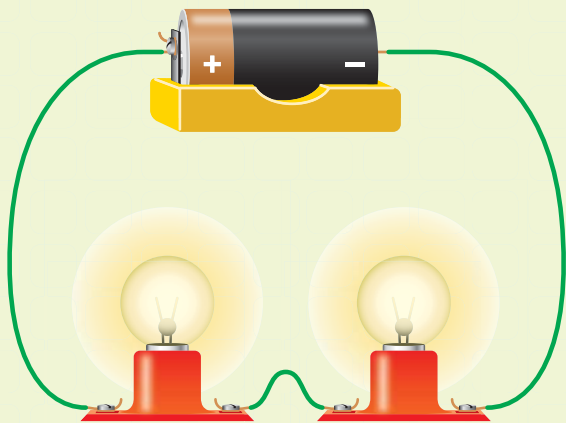
filament

# 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.



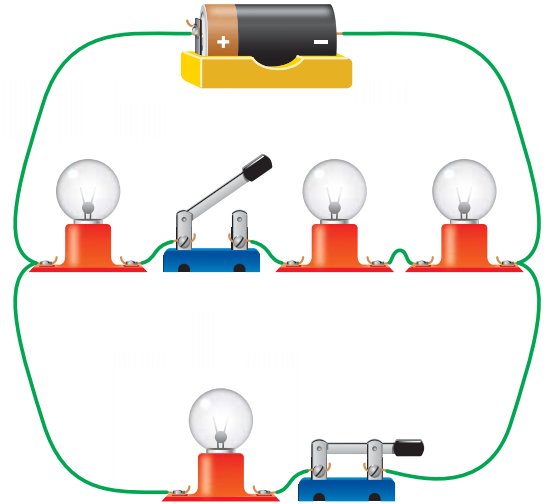
Suppose that the television and all the lights in a room are part of the same circuit. What would happen if one of the light bulbs burned out? It would depend on how the circuit is wired.

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!

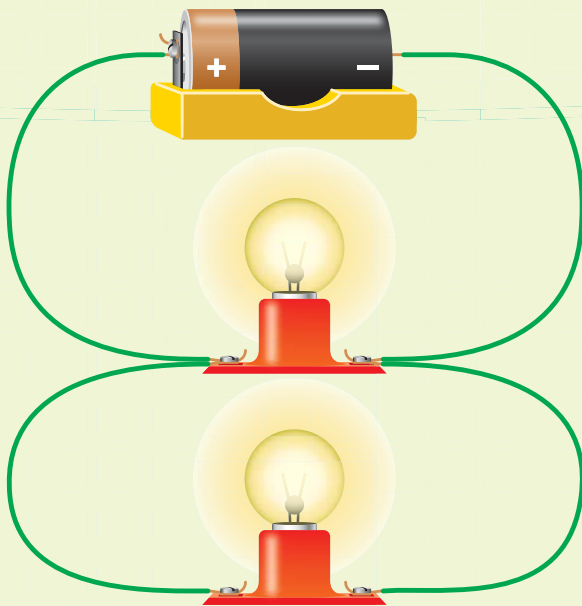
A circuit with several different paths for the charges to follow is called a **parallel circuit**. If one part of the circuit breaks, the charges can still flow along the other parts.

## 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.



# Circuit Overload!

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

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.

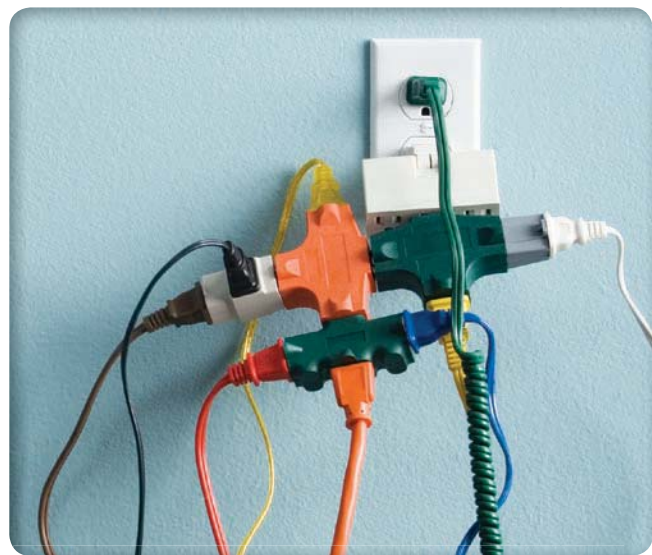
To protect against fires, a fuse or a circuit breaker is added to each circuit. Fuses and circuit breakers are switches that work automatically. They open if charge flows too quickly through a circuit. The flow stops and the wires cool, which prevents a fire.

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!



television  
3 amps



hair dryer  
12.5 amps



## 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!**



clothes dryer  
42 amps

lava lamp  
0.5 amp



laptop computer  
1.5 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?  
\_\_\_\_\_

# Sum It Up »

On each numbered line, fill in the vocabulary term that matches the description.

1

\_\_\_\_\_

a material that *cannot* carry electric charges

2

\_\_\_\_\_

a material that *can* carry electric charges

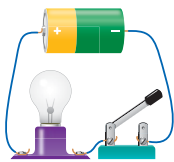
An electric circuit is a path through which electric charges can flow.

can be

can be a type called a

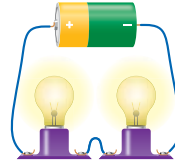
3

\_\_\_\_\_



5

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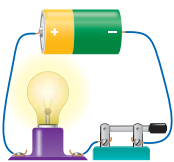


or

or a type called a

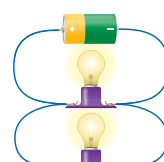
4

\_\_\_\_\_



6

\_\_\_\_\_





Name \_\_\_\_\_

### Vocabulary Review

1

Unscramble the scrambled word in each sentence. Write the unscrambled word after the sentence. The first one is done for you.

A. In some circuits, electrical energy is transformed into light energy by a light <b>lubb</b> .	<b>B U L B</b> 6
B. The wires in a circuit are made of a material that is a <b>doortuccn</b> .	_____ 10
C. A path that an electric current can follow is an electric <b>icuriect</b> .	_____ 4 5
D. A circuit in which electric charges can follow several different paths is called a <b>rallpale</b> circuit.	_____ 8
E. If a wire is disconnected, the circuit is an <b>enop</b> circuit.	_____ 9
F. The covering on electric plugs and around wires is made of an <b>rainulost</b> .	_____ 2 7
G. A circuit in which all the devices are connected in a single path is a <b>ressie</b> circuit.	_____ 3
H. When a light is on, it is part of a <b>scolde</b> circuit.	_____ 1

Solve the riddle by writing the circled letters above in the correct spaces below.

**Riddle:** What is another name for a clumsy electrician?

A                   C                   B                   E           K               

      1  2  3        4  5        6  7  8        9  10



# Apply Concepts

- 2 Draw a closed series circuit with two light bulbs, a battery, and a switch. What would happen if one of the light bulbs blows out?

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- 3 Explain what causes an overloaded circuit. How can you prevent an overloaded circuit?

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- 4 Write the word *conductor* or *insulator* on each of the lines. Then infer which type of material is inside the holes in the outlet. Explain your answer.

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\_\_\_\_\_

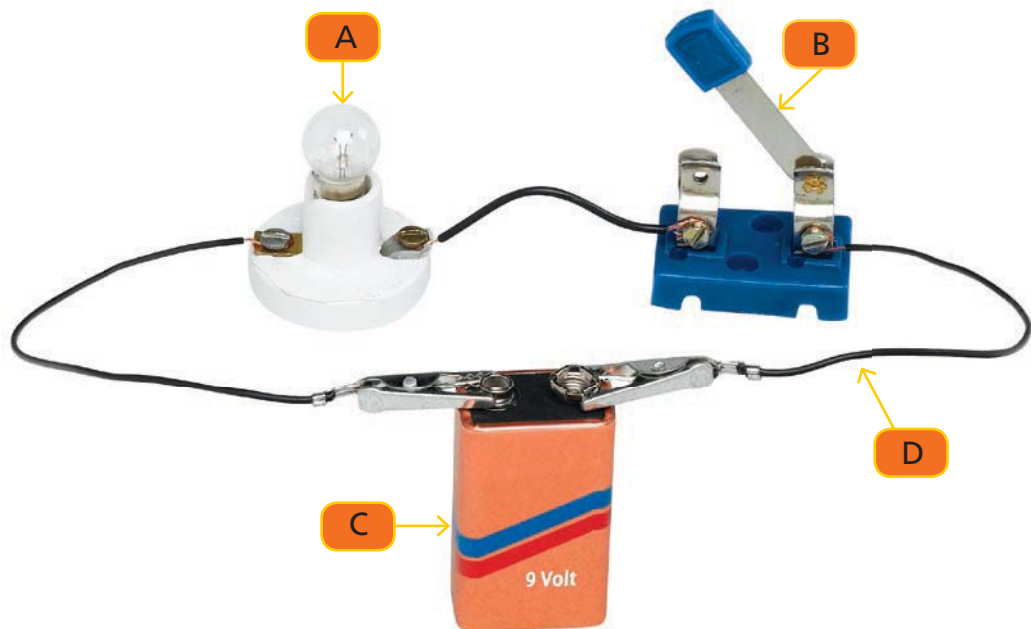
- 5** Suppose you are building a series circuit using a small battery and a small light bulb, and you run out of wire. What everyday objects could you use to connect the battery to the light bulb? Explain.

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- 6** Identify each lettered part of the circuit, and explain what each part does.



A \_\_\_\_\_

B \_\_\_\_\_

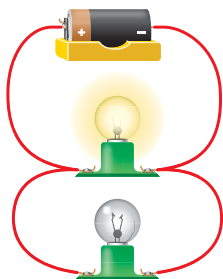
C \_\_\_\_\_

D \_\_\_\_\_

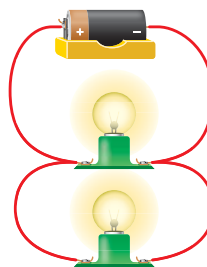
**7** Study each of the following circuits.

- Make a check mark to show whether the circuit is open or closed.
- Draw the missing parts needed to make the open circuits work.
- Label each circuit as a series circuit or a parallel circuit.

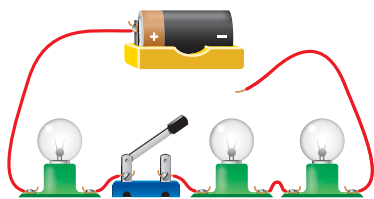
- open  
 closed



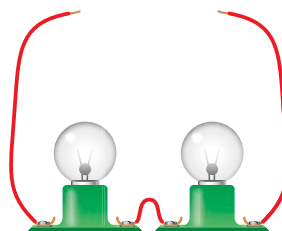
- open  
 closed



- open  
 closed



- open  
 closed



**Take It Home!**

Discuss with your family what you have learned about circuits. Gather some electrical devices and explain how they use electricity. Try flipping some switches in your home, and explain whether they are series circuits or parallel circuits.