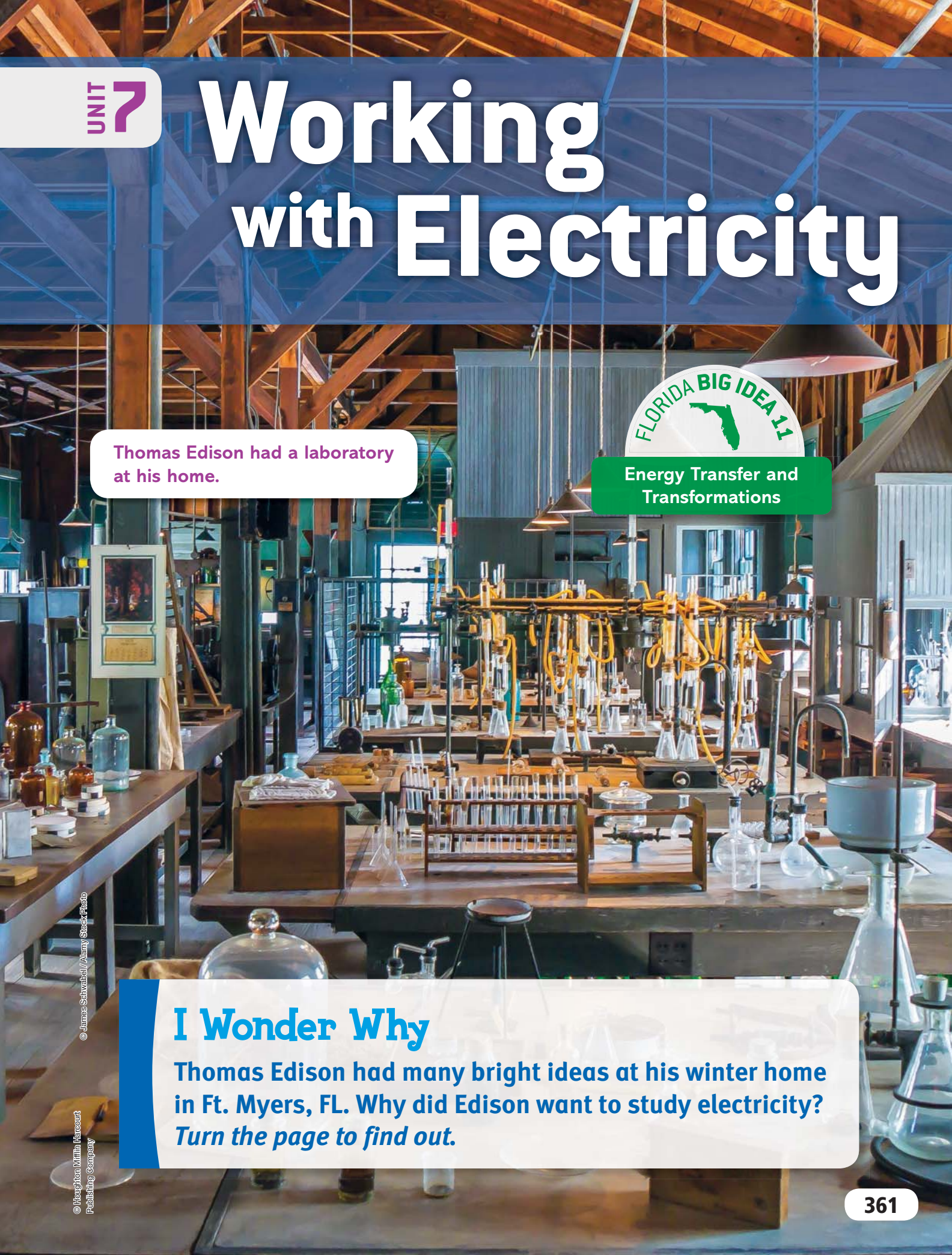
UNIT 7

# Working with Electricity



Thomas Edison had a laboratory at his home.

FLORIDA BIG IDEA 11

Energy Transfer and Transformations

## I Wonder Why

**Thomas Edison had many bright ideas at his winter home in Ft. Myers, FL. Why did Edison want to study electricity?**

***Turn the page to find out.***

# Here's Why

Edison, a great inventor, realized that there were many uses for electricity. He was the first to build an energy station that supplied electricity to homes, schools, and businesses.

## Essential Questions and Florida Benchmarks



### Science Notebook

Before you begin each lesson, write your thoughts about the Essential Question.

Name _____

ESSENTIAL **QUESTION**

# What is an Electric Circuit?

## EXPLORE

You flip a switch and a light bulb goes on. What is there between the switch and the bulb that lets this happen? See if you can figure that out by building an electric circuit.

## Materials

- battery (size D) with holder
- light bulb with holder
- three lengths of wire
- switch
- paper clip
- wooden craft stick
- pencil lead

## Before You Begin—Preview the Steps

1. Lay out the parts in the order you think will make the bulb light up. Show your plan to your teacher before you connect the parts.

2. Connect the parts to test your plan. Does the bulb light up? Keep working until you "see the light!"

3. Draw a picture of your circuit. Show how the parts are connected.

4. The metal inside a wire allows electricity to pass through the wire. What other materials do that? Replace the switch with an unbent paper clip, a craft stick and then a pencil lead. Record your observations.

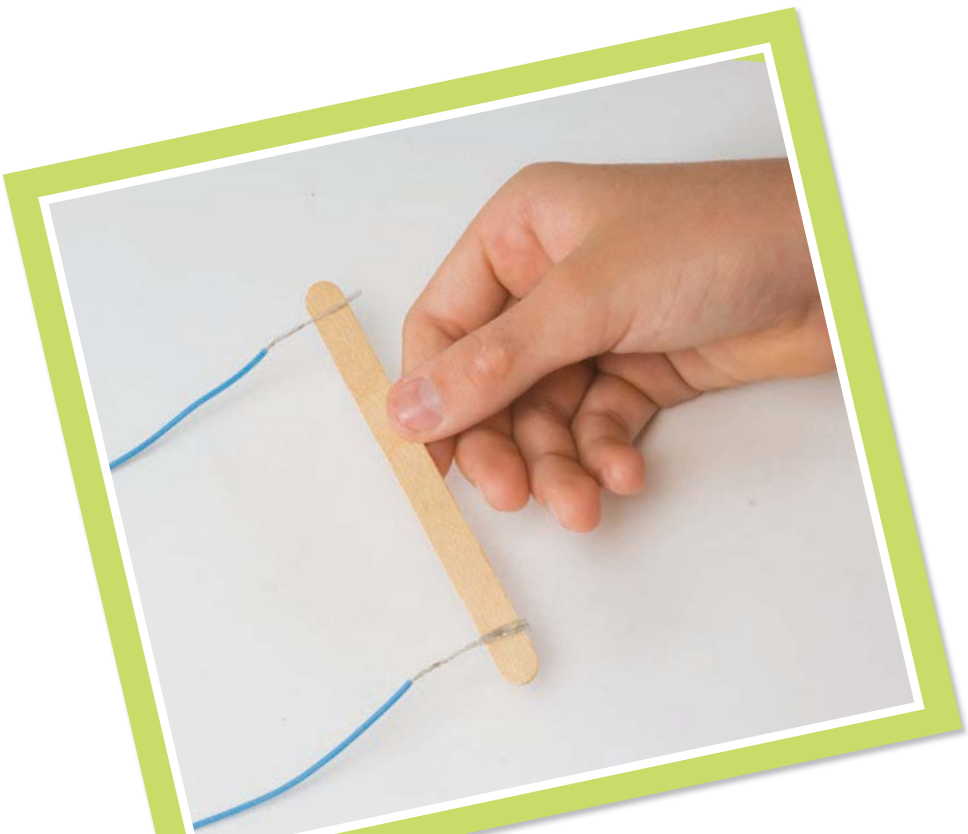
## Set a Purpose

What will you learn from this investigation?

## Think About the Procedure

Did the order in which you arranged the parts make a difference? Explain.

Was the procedure an experiment? Why or why not?



Name _____

## Record Your Data

In the space below, draw your circuit that worked. Label each part, and describe how the parts were connected.

Place a check mark next to the materials that enabled the bulb to light up.

## Draw Conclusions

How can you build a circuit?

_____

_____

_____

_____

## Claims • Evidence • Reasoning

1. Make a claim about why it is helpful to have a switch in a circuit. Explain your reasoning.

_____

_____

_____

2. Make a claim about why a circuit would not work when a wire is replaced with a cotton string. Use evidence to support your claim and explain your reasoning.

_____

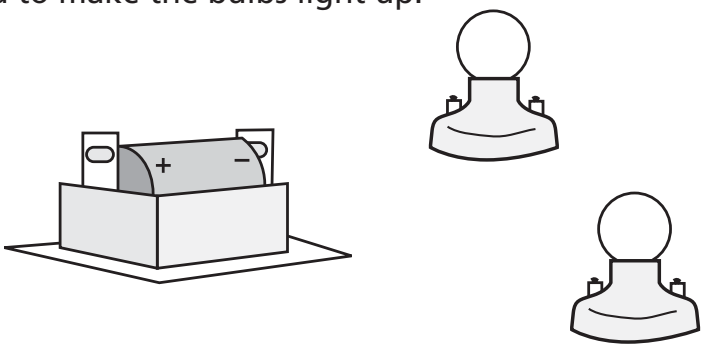
_____

3. Look at the first part of the word *circuit*. Why do you think what you built is called a circuit? Explain your reasoning.

_____

_____

4. Look at the picture below. Draw lines to show how three wires could be connected to make the bulbs light up.

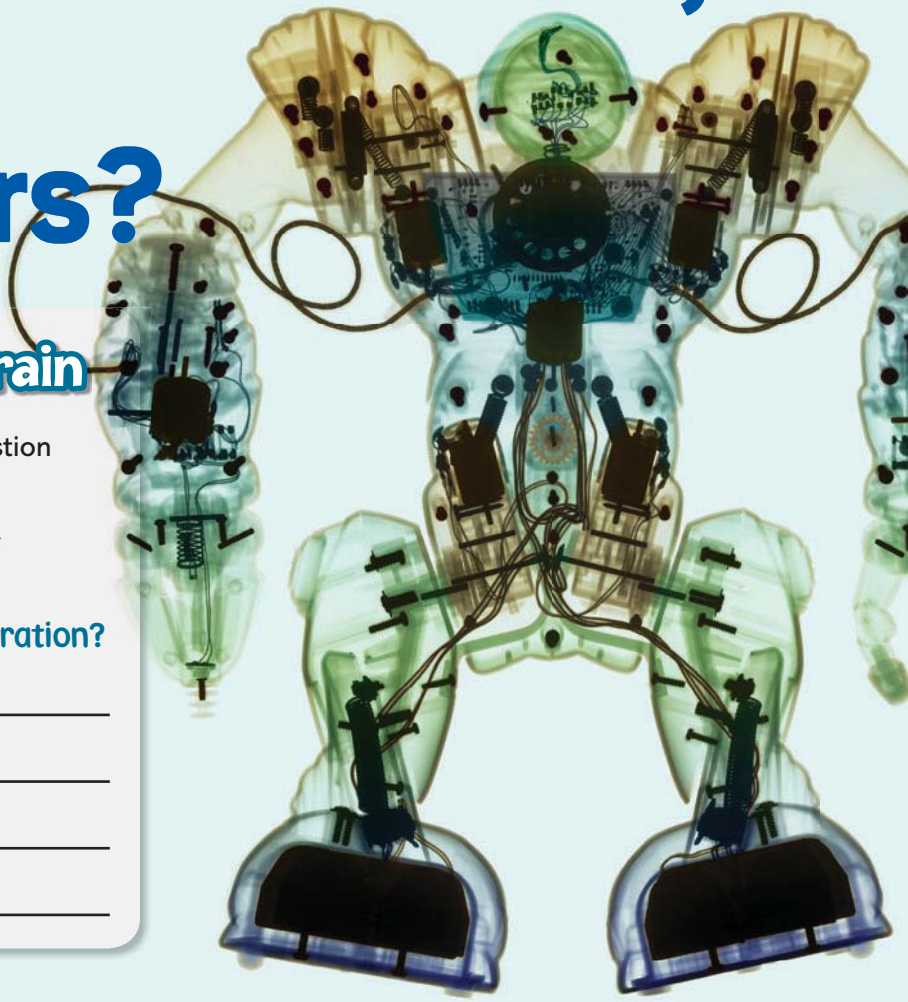



5. Identify the part that performs each of the jobs listed below.

- Source of current _____
- Carries current _____
- Turns circuit on and off _____
- Changes electrical energy to light _____

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?

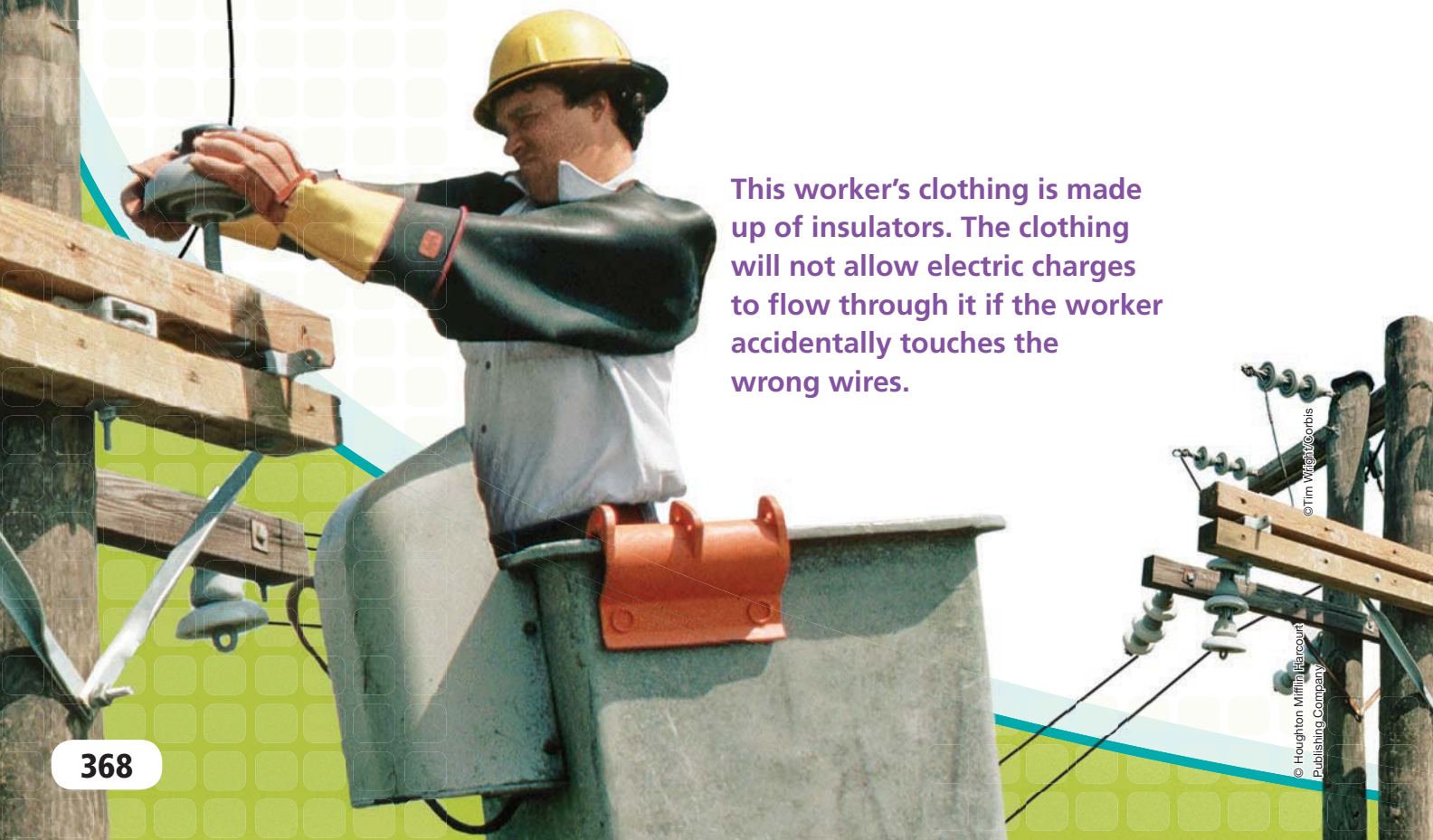
# It's Shocking!

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!

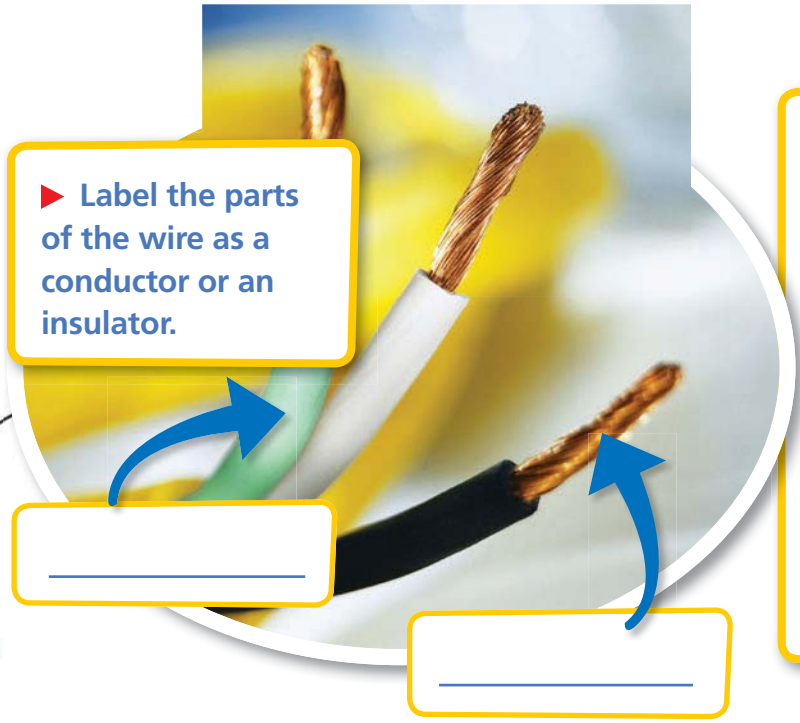
The rubber and plastic used in the protective clothing do not allow electric charges to flow through them. A material that resists the flow of electric charges is called an **insulator**. Electric charges flow easily through metals and some liquids. A material that readily allows electric charges to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

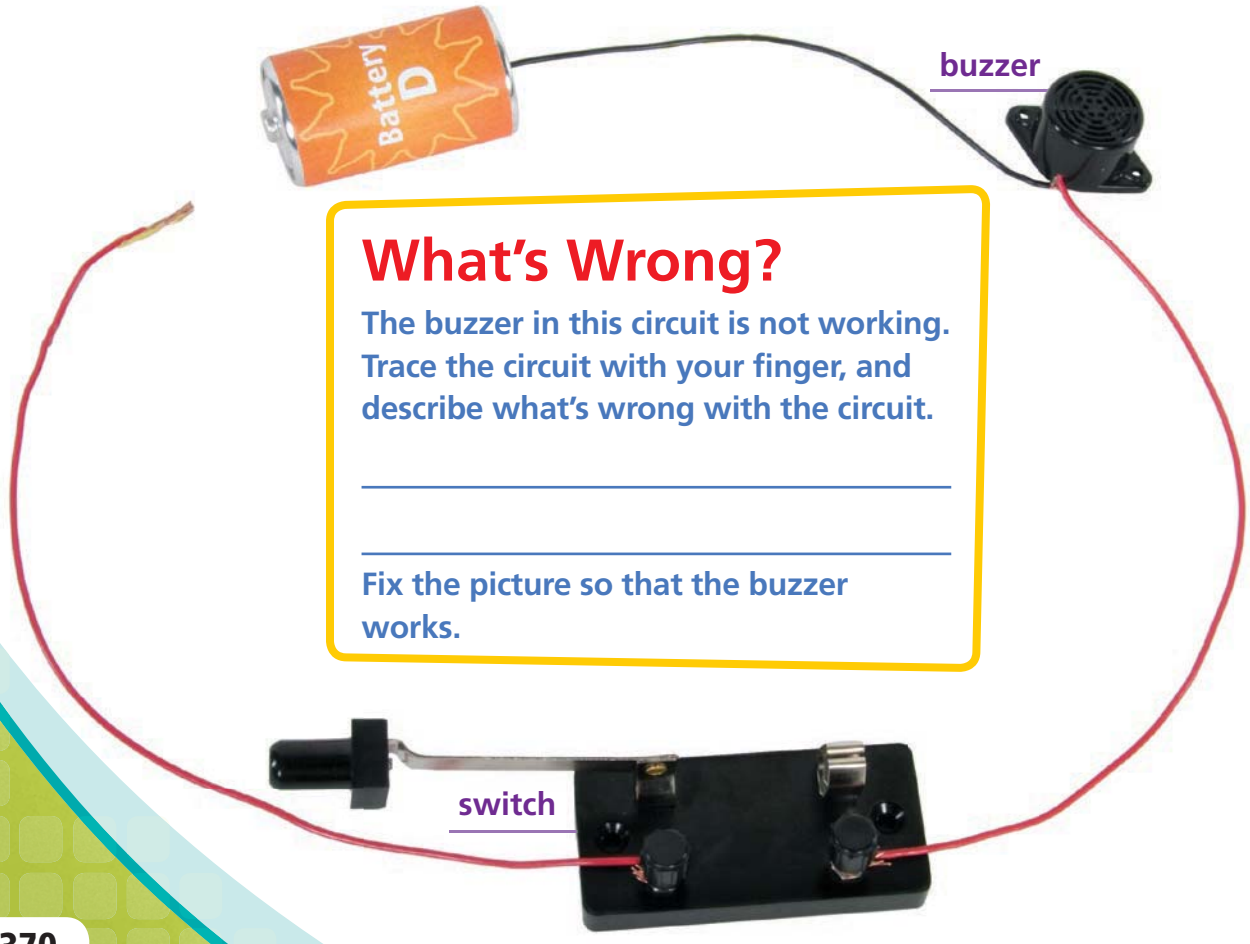
# A Path to Follow

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?

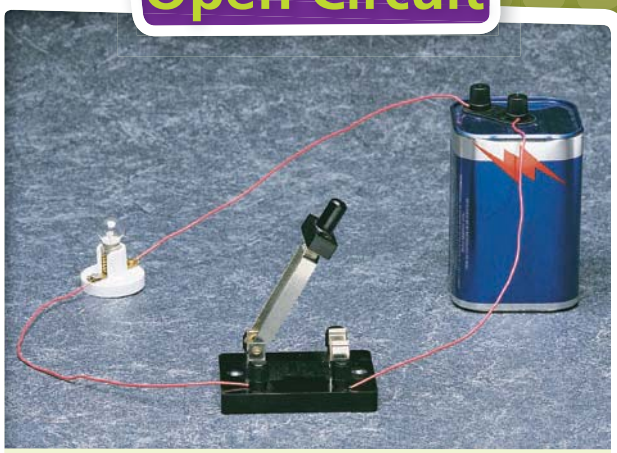
**The buzzer in this circuit is not working. Trace the circuit with your finger, and describe what's wrong with the circuit.**

_____

_____

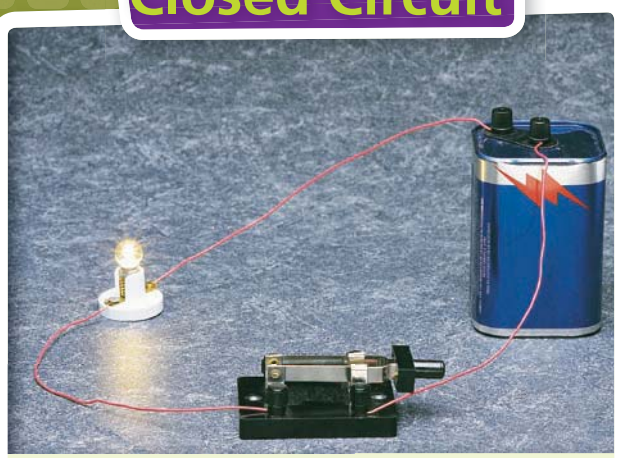
**Fix the picture so that the buzzer works.**

## 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.

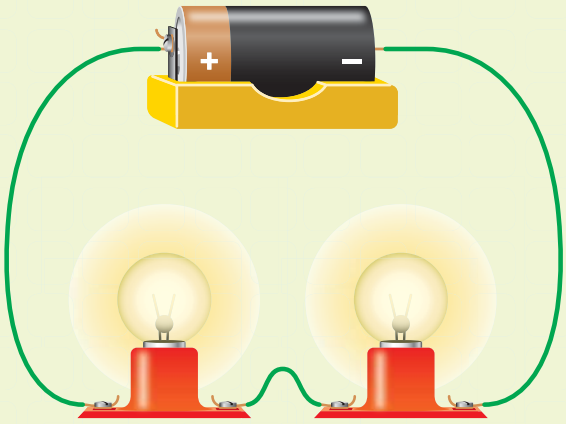
▶ The filament in a light bulb is a tiny wire. It is part of the circuit. If the filament breaks, the circuit will be _____.

# 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.**

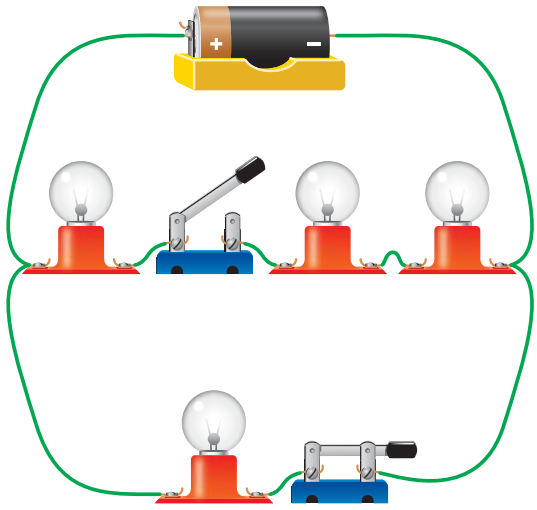
Suppose that the television and all the lights in a room are part of the same circuit. What would happen if one of the light bulbs burned out? It would depend on how the circuit is wired.

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!

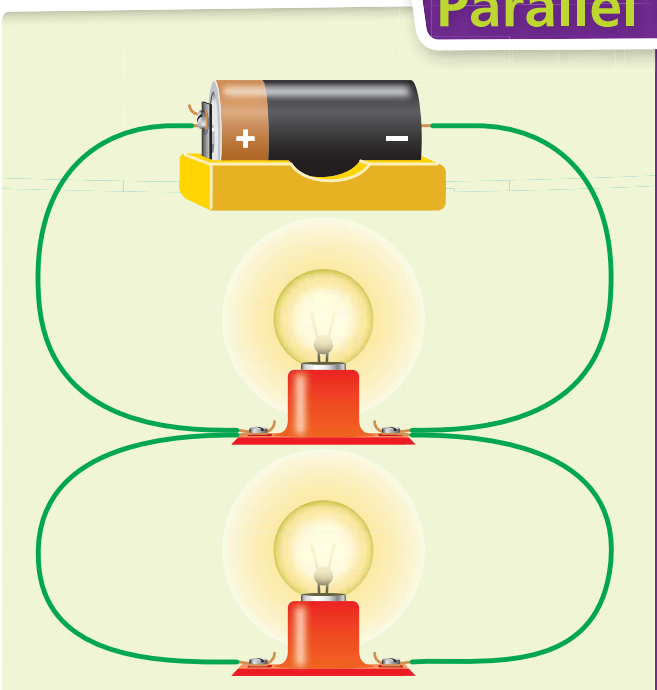
A circuit with several different paths for the charges to follow is called a **parallel circuit**. If one part of the circuit breaks, the charges can still flow along the other parts.

## 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

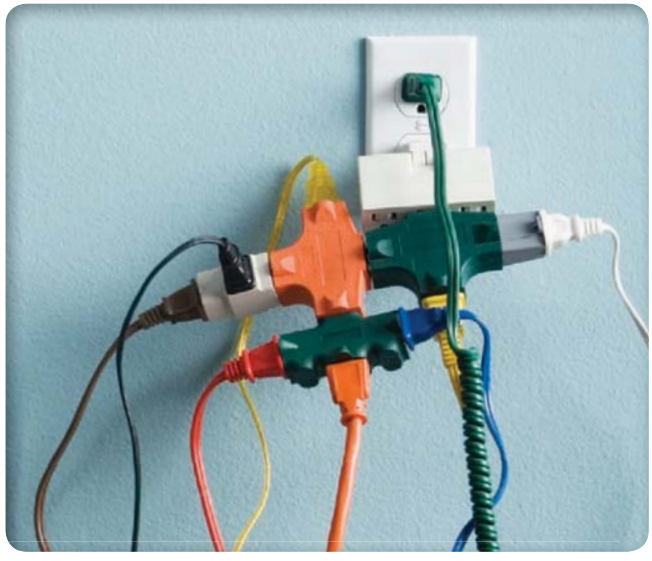
As electric charges flow through conductors, they produce heat. Insulation protects the materials around these conductors from the heat—up to a point! If the conductor gets too hot, the insulation can melt.

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.



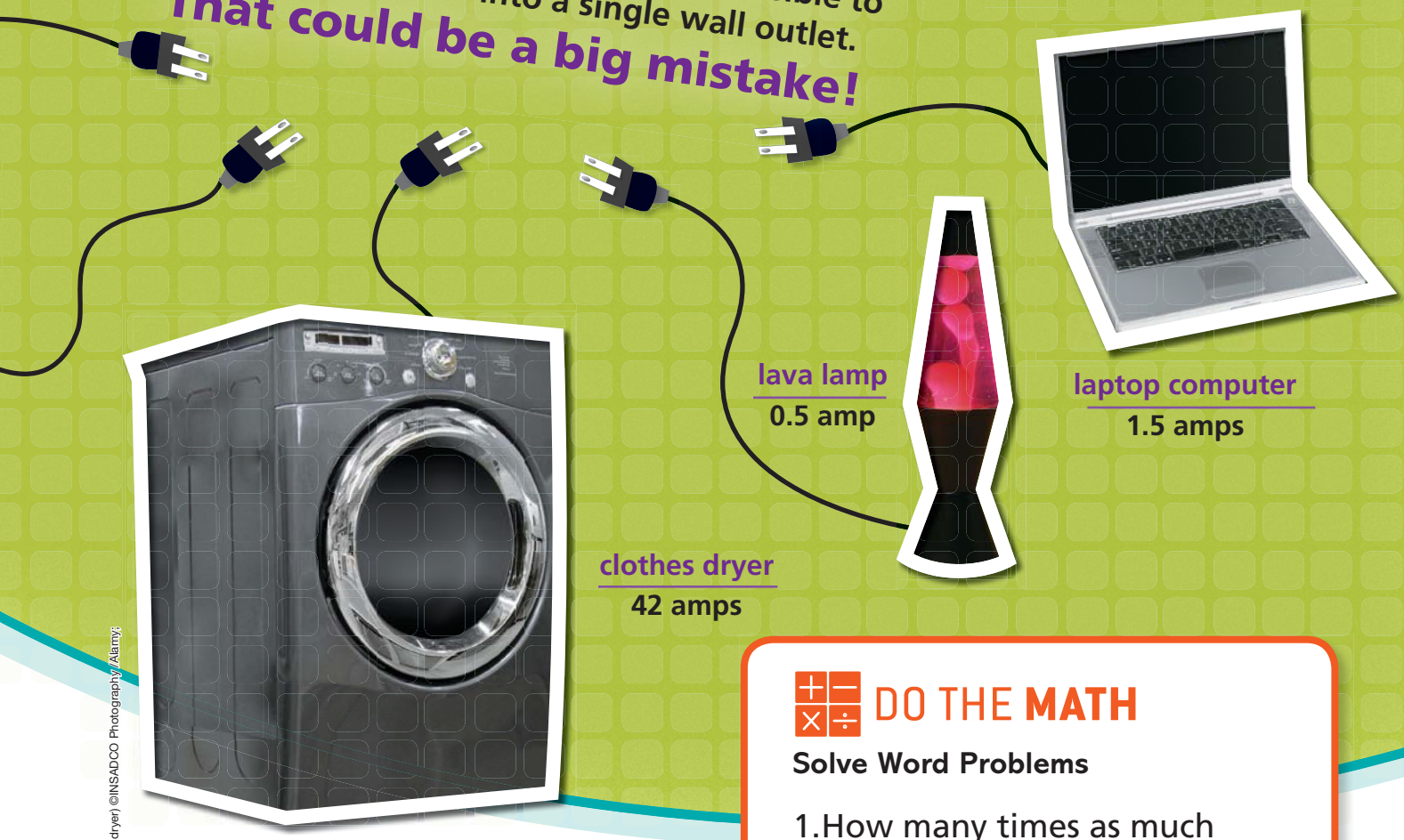
Never plug more appliances into a circuit than it is designed to handle!

## 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?

# Sum It Up »

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

1 _____

a material that *cannot* carry electric charges

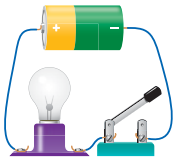
2 _____

a material that *can* carry electric charges

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

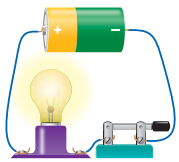
can be

3 _____



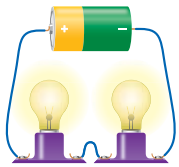
or

4 _____



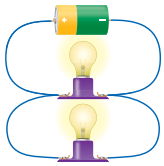
can be a type called a

5 _____



or a type called a

6 _____



# Brain Check



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 lubb. | (B) U L B<br>6 |
| B. The wires in a circuit are made of a material that is a doortuccn. | _ _ _ _ _ _ _ _ (_)<br>10 |
| C. A path that an electric current can follow is an electric icurict. | _ _ _ _ (_) _ (_)<br>4 5 |
| D. A circuit in which electric charges can follow several different paths is called a rallpale circuit. | _ (_) _ _ _ _ _ _<br>8 |
| E. If a wire is disconnected, the circuit is an enop circuit. | _ _ (_) _<br>9 |
| F. The covering on electric plugs and around wires is made of an rainulost. | (_) _ _ _ _ _ _ _ (_)<br>2 7 |
| G. A circuit in which all the devices are connected in a single path is a ressie circuit. | _ _ (_) _ _ _<br>3 |
| H. When a light is on, it is part of a scolde circuit. | (_) _ _ _ _ _<br>1 |

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

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

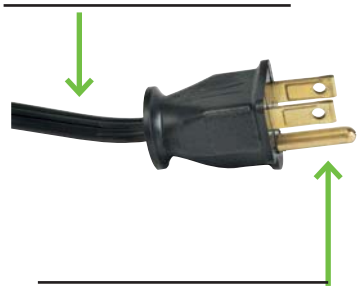
A _ _ _ C _ I _ B _ E _ K _ _
1 2 3 4 5 6 7 8 9 10

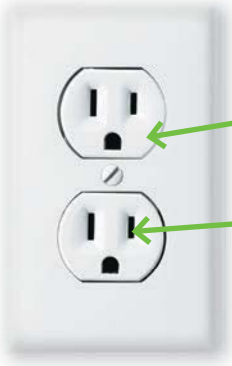
# Apply Concepts

**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?

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

**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.





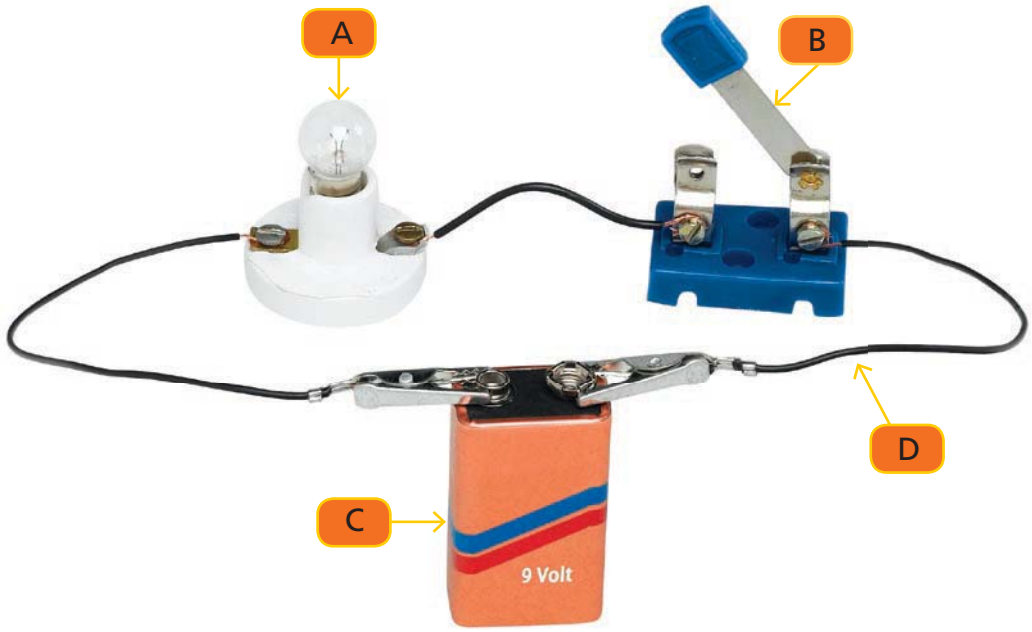
**5** Suppose you are building a series circuit using a small battery and a small light bulb, and you run out of wire. What everyday objects could you use to connect the battery to the light bulb? Explain.

_____

_____

_____

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




A _____

B _____

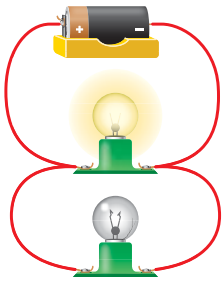
C _____

D _____

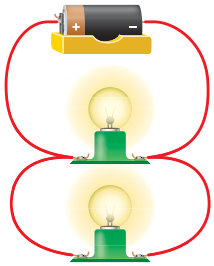
**7** Study each of the following circuits.

- 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.

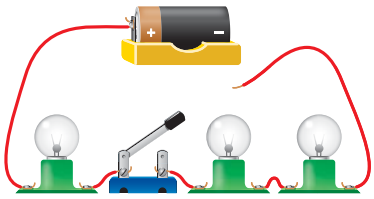
☐ open
☐ closed



☐ open
☐ closed

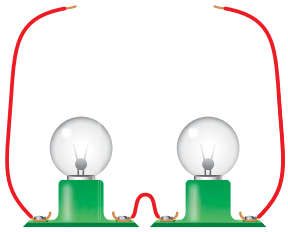


☐ open
☐ closed



_____

☐ 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.

**SC.5.N.1.2** Explain the difference between an experiment and other types of scientific investigation.

S.T.E.M.

ENGINEERING & TECHNOLOGY

# How It Works:

## The Electric Grid

At home, you flip a switch and a light comes on. The electricity to power the light comes from generating stations. Generating stations are a part of a larger system know as the *electric grid*. Generators, high voltage steel towers, conductors, insulators, and your home appliances are all parts of this system.

At generating stations, generators transform kinetic energy into electrical energy.

From the generating stations, electrical energy travels over electrical lines on tall steel towers. These lines are made up of a conductor and an insulator.

Coal is a fossil fuel. There is plenty of it in the United States. Most of our electricity comes from burning coal.

Wind turbines are large generators. Turbines use energy from wind to generate electricity.

## TROUBLESHOOTING

During prolonged hot weather, many people use air conditioning units to remain cool. How could this affect the electric grid and the environment?

## S.T.E.M. continued

Water falling through a turbine can generate electricity. Most hydroelectric generating stations have a dam that blocks a river. A lake forms behind the dam and provides a constant source of falling water. The dam also floods areas that were once dry land. Draw a picture that shows what you think the area behind the dam looked like before the dam was built.

A hydroelectric dam uses energy from moving water to generate electricity.

Research the benefits and risks for each of the first three sources of electrical energy listed below. Fill out the chart. Then identify the energy source described in the last entry.

| Electrical energy source | Benefits | Risks |
|---|---|---|
| Wind turbines | do not pollute air, land, or water | |
| Coal-burning generating stations | | Coal mines change the landscape; they can cause land, air, and water pollution. |
| Hydroelectric dams | use water, a renewable resource | |
| | do not pollute air, land, or water | These produce toxic wastes that must be stored for a very long time. |

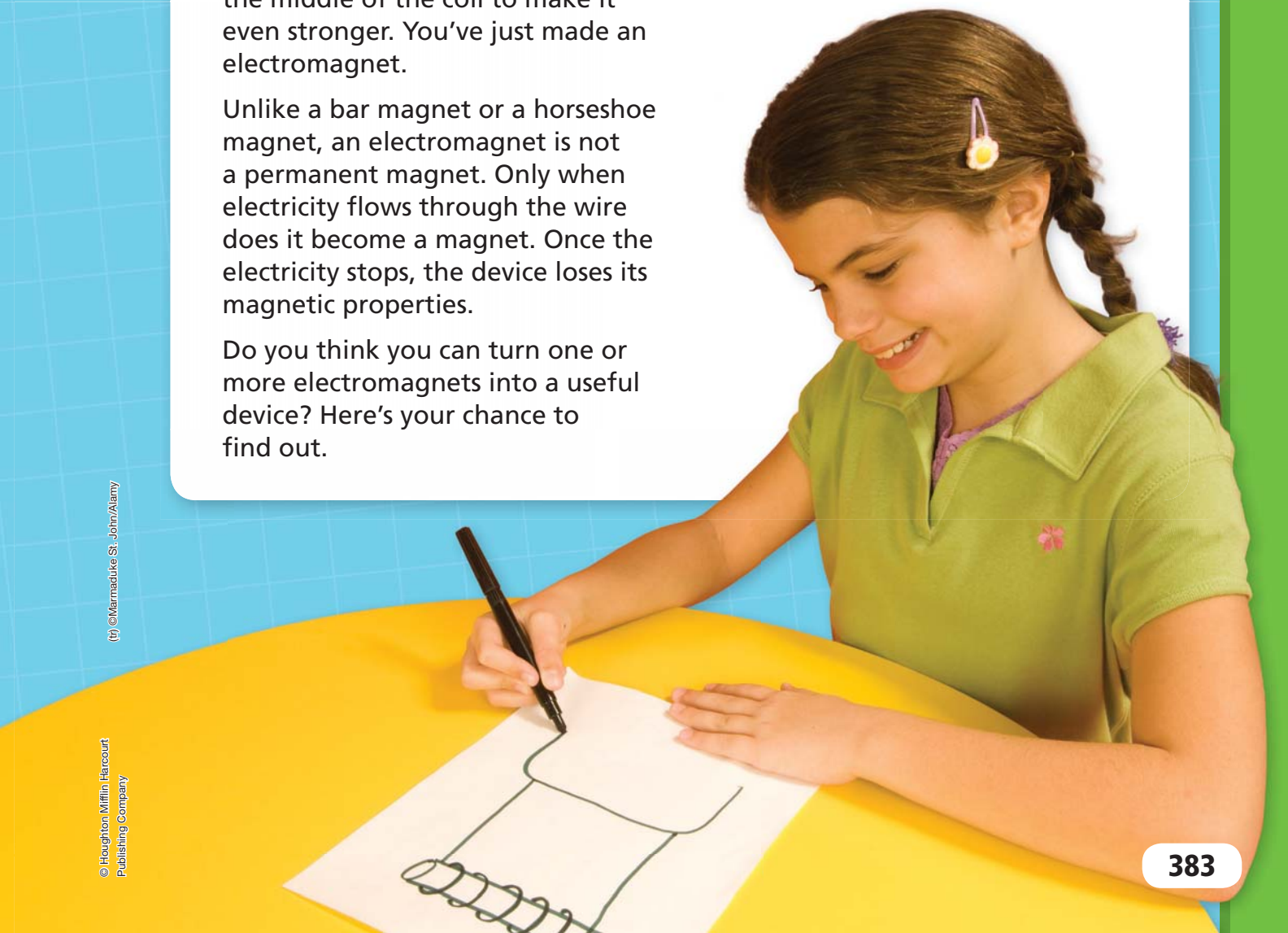

# Build in Some Science: An Attractive Option

Did you know the flow of electric charges through a wire produces magnetism? You can focus this magnetic effect by coiling the wire. Then you can place an iron rod in the middle of the coil to make it even stronger. You've just made an electromagnet.

Unlike a bar magnet or a horseshoe magnet, an electromagnet is not a permanent magnet. Only when electricity flows through the wire does it become a magnet. Once the electricity stops, the device loses its magnetic properties.

Do you think you can turn one or more electromagnets into a useful device? Here's your chance to find out.

Both of these electromagnets work based on the same principles. What makes one magnet stronger than the other? The amount of electricity flowing through its wires! Which electromagnet do you think uses the most electricity?




# What to Do:

1. Research electricity and learn about its connection to magnetism.
2. Find out more about electromagnets and their uses. List two uses you learned about.
3. Make an electromagnet from wire, an iron nail, a battery, and a switch. Use paper clips to explore how your electromagnet works.
4. Think about how one or more electromagnets might help make a useful product. What is the use of the product?
5. Draw your design.
6. Discuss your design with others. Improve or redesign it based upon feedback. Explain any improvements you made.
7. Keep a record of your work in your Science Notebook.

# Ask an Electrician

**Q.** Do electricians make electricity?

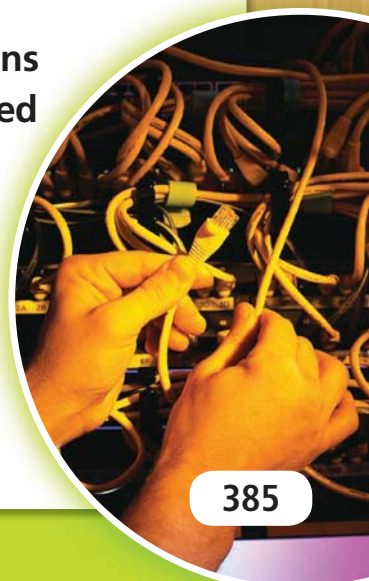
**A.** No. Electricity is produced in energy stations and carried to buildings through wires. Electricians work with wires to make sure the electricity moves safely.

**Q.** Don't electricians worry about electric shocks when they work?

**A.** Electricians must always turn off electricity to the wires they are working on. Electricity can be dangerous and safety is an important part of the job.

**Q.** What kind of training do you need to be an electrician?

**A.** Most electricians learn from experienced electricians while they are attending classes. During this period, they are called an apprentice.



## Now It's Your Turn!

What question would you ask an electrician?

_____

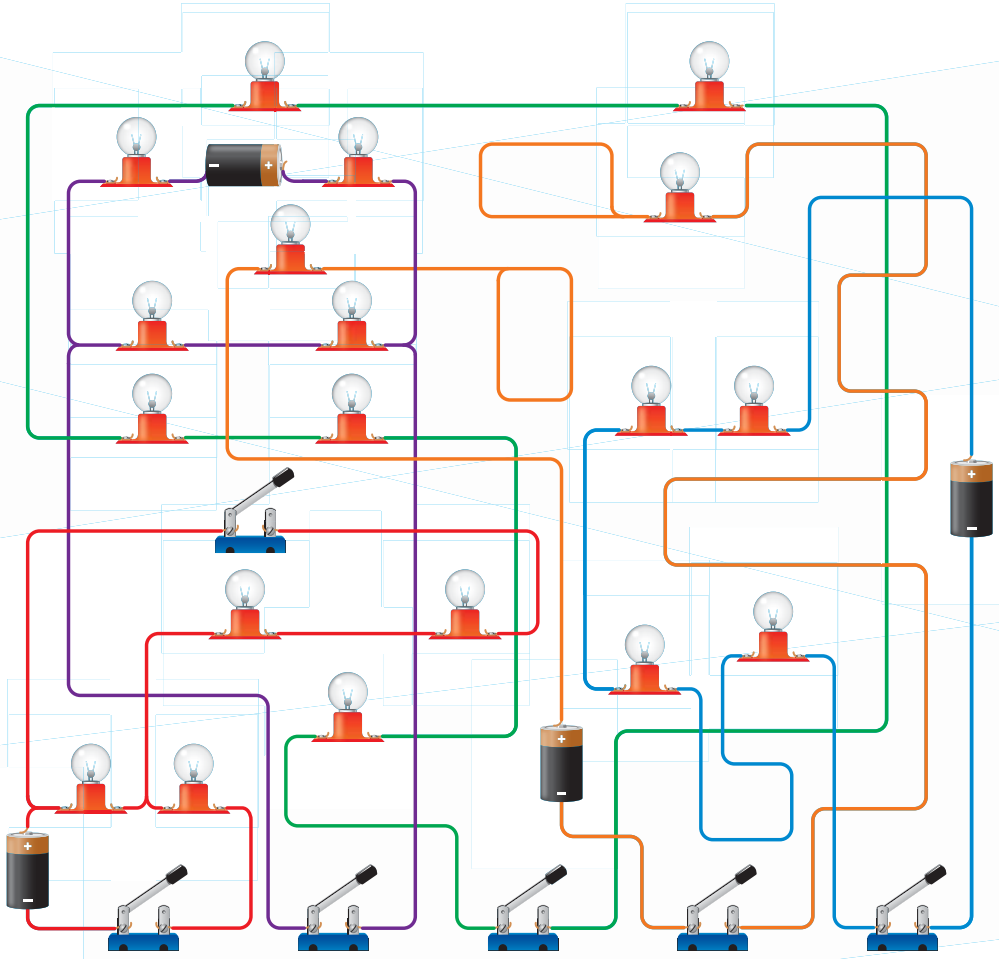
_____

_____

_____

# Untangle the Wires!

**For each circuit, explain what would happen when the switch at the bottom is closed.**



**Red:** _____

**Purple:** _____

**Green:** _____

**Orange:** _____

**Blue:** _____

# Benchmark Review

Name _____

## Vocabulary Review

Use the terms in the box to complete the sentences.

circuit
insulator
conductor

1. An electrical wire is made of a(n) _____ so that it can carry electricity.

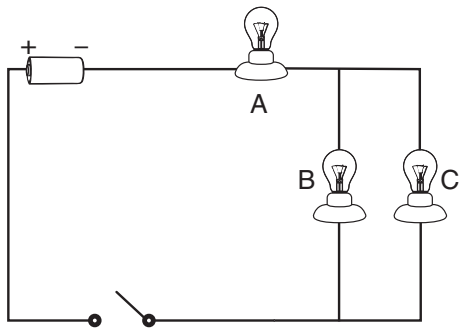
2. A(n) _____ must make a continuous loop or the electricity will not flow.

3. Plastic is a(n) _____ because it does not carry electricity.

## Science Concepts

Fill in the letter of the choice that best answers the question.

4. Study the circuit below. When the switch is closed, all three light bulbs are lit.




What will happen if Bulb A burns out?

(A) Bulbs B and C will continue to shine.
(B) Bulbs B and C will stop shining.
(C) Bulbs B and C will shine more brightly.
(D) Bulbs B and C will shine less brightly.

5. Jayden uses various objects to complete a circuit. He compares how bright a bulb glows using each object. His results are shown below.

| Object | Glow |
|---|---|
| nail | very bright |
| crayon | dim |
| eraser | very dim |
| pencil lead | bright |

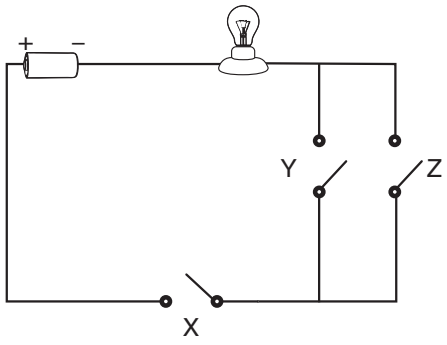
Which object is the **best** electrical conductor?

(F) nail
(G) eraser
(H) crayon
(I) pencil lead

## Apply Inquiry and Review the Big Idea

Write the answers to these questions.

6. The circuit below consists of a battery, a light bulb, and three switches. All of the switches are open, and the light bulb is off.




Make a claim about the combination of switches that could be closed and cause the light bulb to remain off. Explain your reasoning.

7. Study the materials in the table below.

| Insulators | Conductors |
|---|---|
| air | gold |
| cloth | iron |
| silver | copper |
| bronze | glass |
| rubber | aluminum |

Which are placed in the wrong column? Explain your reasoning.