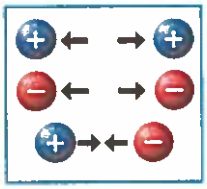
CHAPTER 6

Electricity

Vocabulary



electrical charge one of two kinds of particles, positive or negative, that are in objects

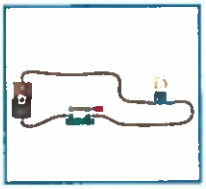
static electricity a build up of electrical charges on an object

discharge a sudden movement of electrical charges from one object to another

conductor a material that lets electric charges flow through it easily

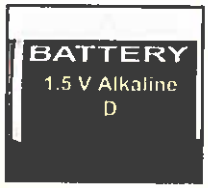
insulator a material that does not let electric charges flow through it easily

electric current a flow of electrical charges through a material, such as a wire



circuit the path of an electric current

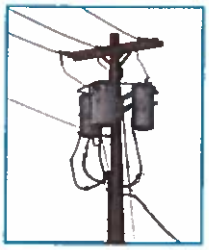
The Big Idea How do we use electricity?



voltage a measure of how strong a battery or any other power source is

series circuit a circuit in which the electrical charges flow through a single path

parallel circuit a circuit in which the electrical charges flow through more than one path



transformer an electrical tool that increases or decreases the voltage in an electric current

circuit breaker an electrical tool that switches off an electric current that gets too high

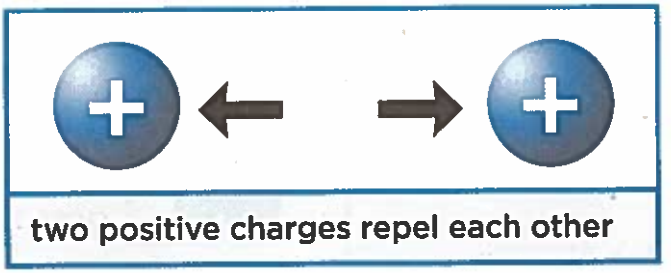
fuse an electrical tool that melts to open a circuit if the electric current gets too high

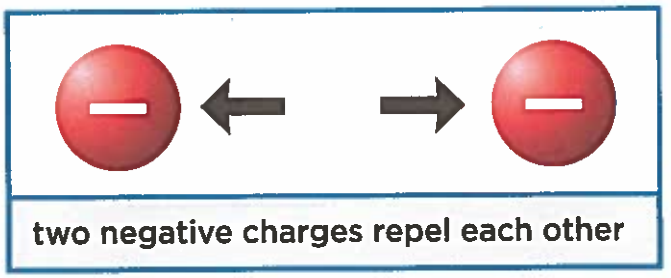
What is electrical charge?

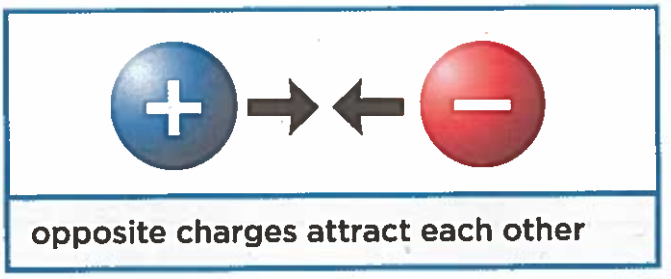
What is electricity? To answer the question, you need to think that everything is made up of tiny particles, too small to be seen.

Each of these tiny particles can have an electrical charge. There are two kinds of **electrical charge**, positive or negative, that can:

- repel (push away) each other—if they are the same kind of charge
- attract (pull toward) each other, if they are opposite charges.







Charges Add Up

Most objects are made up of the same number of positive and negative charges. Objects with the same number of both charges are neutral (NEW•truhl).

When two objects touch or nearly touch, charged particles can move from one object to the other. Negative charges move from object to object more easily than positive charges.

For example, rub a balloon with a wool cloth:

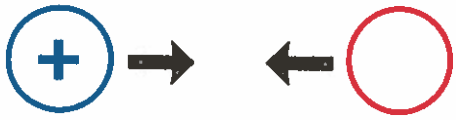
- negative charges move from the wool to the balloon
- the balloon now has more negative charges than positive charges. The balloon is negatively charged.

▲ **Charged particles in the girl's hair are attracted to the charged balloon.**

Quick Check

Fill in each empty particle with a "+" or "-" to show if the two particles attract or repel.

1. 

2. 

Draw arrows in between these particles to show if these two are attracting or repelling.

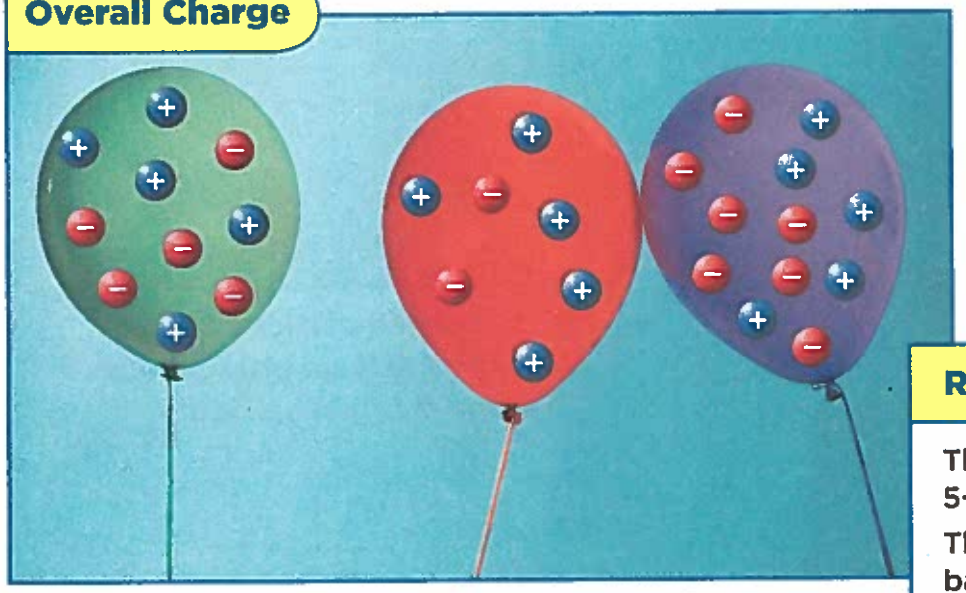
3. 

What is static electricity?

A balloon starts out with the same number of positive charges and negative charges. Remember what happens if you rub the balloon with a wool cloth? Negative charges move from the wool to the balloon.

Rubbing causes a *buildup* of negative charges on the balloon. A buildup means that there are now more negative charges on the balloon than positive charges. The balloon is negatively charged. A buildup of electrical charges on an object is called **static electricity**.

Overall Charge



▲ Neutral ▲ Positively charged ▲ Negatively charged

Reading Diagrams

The neutral balloon has 5+ and 5–.

The positively changed balloon has 5+ and 2–.

The negatively changed balloon has 5+ and 7–.

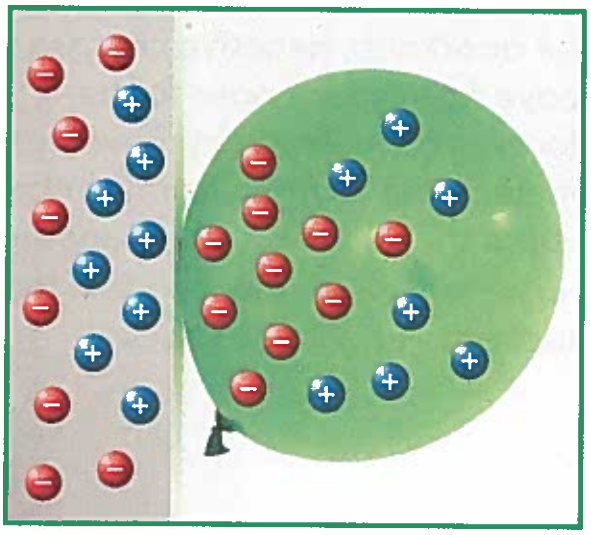
Quick Check

4. Why are the two balloons in the diagram attracting?

As you saw, rubbing can cause negative charges to move from one object (such as wool) to another (a balloon). Charged particles can also move *inside* an object.

Think of what happens when you try this:

- Rub a balloon with wool. Rubbing causes a buildup of negative charges on the balloon.
- Hold the negatively charged balloon near a wall. Positive charges in the wall are attracted to the balloon and move toward it. Negative charges in the wall are repelled from the balloon and move away.
- The wall and the balloon attract each other. The balloon sticks to the wall.

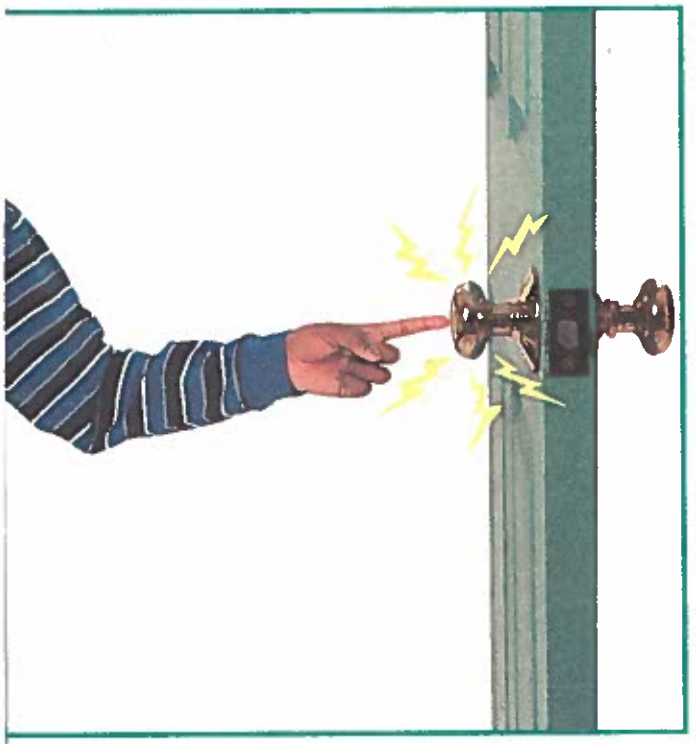


The balloon is negatively charged. The wall is neutral, but the positive charges build up in the wall near the balloon.

Quick Check

Complete the Main Idea diagram. List two details that help explain the main idea.

Main Idea	Details
The balloon sticks to the wall.	**5.** _____
	6. _____



▲ You feel the discharge as a shock. If the room is dark enough, you would see a tiny flash of light.

What is an electrical discharge?

Follow this sequence of events:

1. You walk across a carpet, dragging your feet.
2. Negative charges move from the carpet and build up on your body. You become negatively charged.
3. You reach out to touch a metal doorknob to open a door. OUCH!

When your finger gets close to the doorknob, negative charges move from your finger to the doorknob. The sudden movement of electrical charges from an object where they are built up to another object is a **discharge**. You feel the discharge as a small shock.

Quick Check

Correct each of these false sentences.

7. You become positively charged when you walk across a rug. _____

_____

8. You feel a shock when negative particles move from the doorknob to your hand. _____

_____

What conductors and insulators?

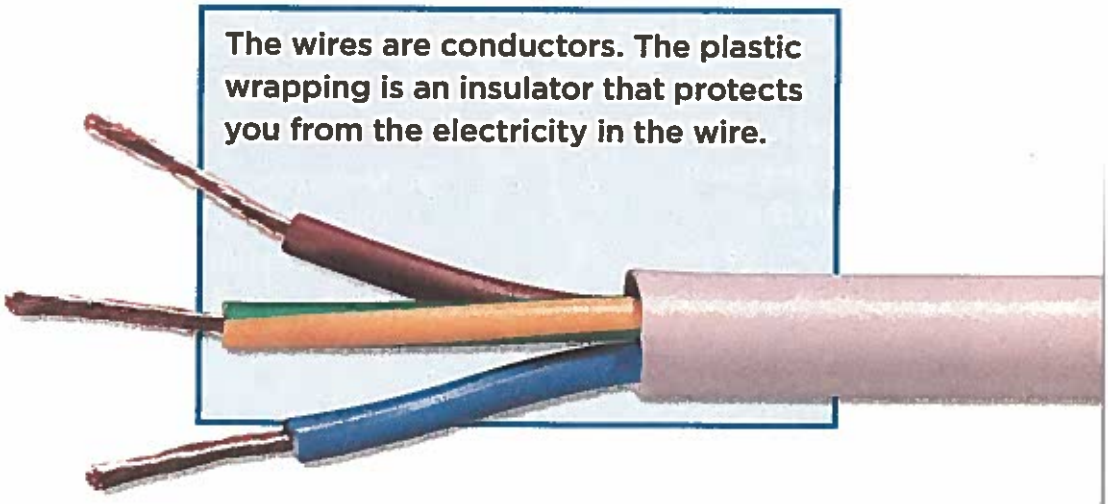
How can you avoid getting a shock from touching a metal doorknob? Touch the wooden door first. Why?

The metal is a conductor. A **conductor** is a material that lets charges flow through it easily. Charges race to the metal doorknob and flow into it. You feel a shock.

Metals such as copper and silver are good conductors. Even a person can be a conductor. That's why you can get a shock when another person touches you.

Wood is an insulator. An **insulator** is a material that does not let charges flow through it easily. When you touch a wooden door, charges move slowly onto the door. You don't feel a shock. Other insulators are:

- glass
- rubber
- plastic



The wires are conductors. The plastic wrapping is an insulator that protects you from the electricity in the wire.

Quick Check

In each row cross out the word or words that do not belong.

9. conductor glass copper silver lets charges flow

10. insulator copper rubber does not let charges flow

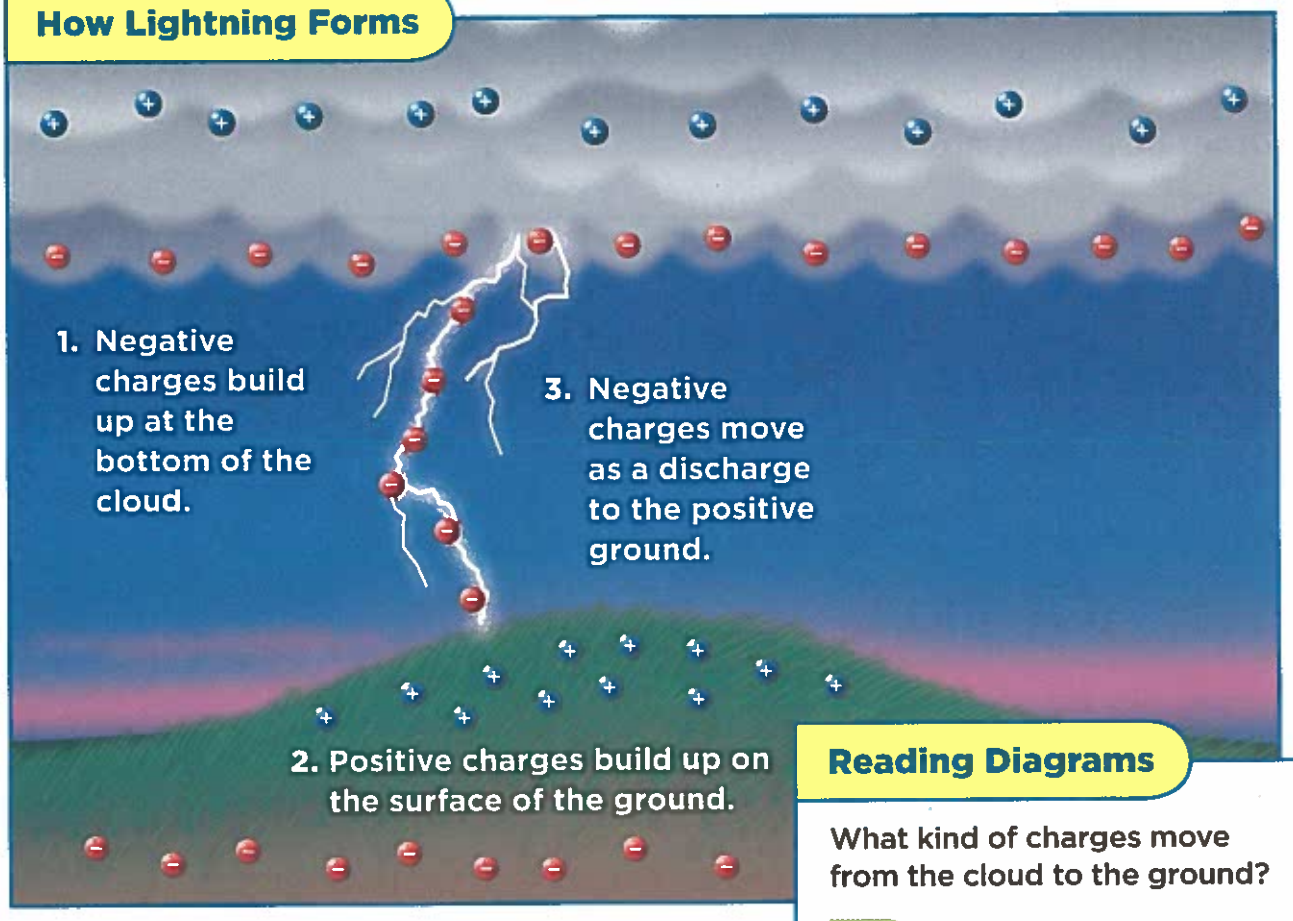
What is lightning?

Lightning is a discharge of static electricity between:

- a cloud and the ground
- two clouds
- two oppositely charged parts of a cloud.

To help you understand how lightning forms, remember that charges can move *inside* something. Charges can move to different parts of a cloud and the ground. Now follow the numbers in the diagram to see how lightning occurs between a cloud and the ground.

How Lightning Forms



Reading Diagrams

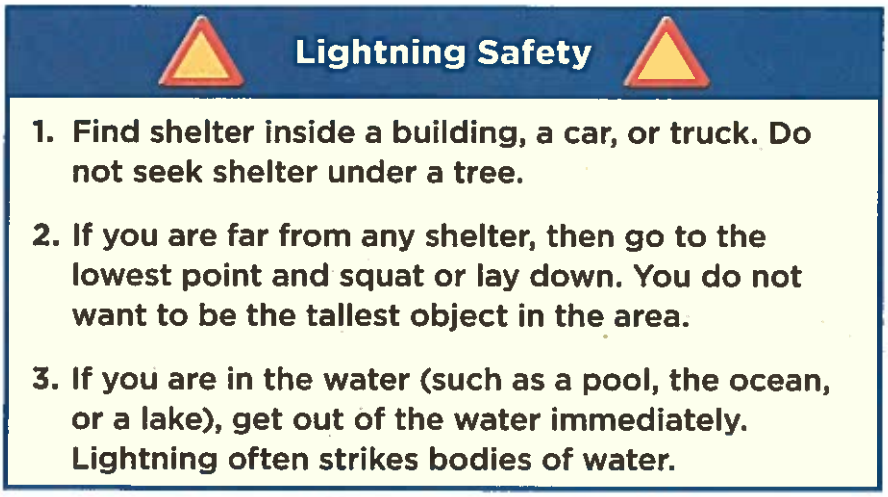
What kind of charges move from the cloud to the ground?

LOG ON *Science in Motion* Watch how lightning forms @ www.macmillanmh.com

Lightning Safety

Lightning takes the shortest path to the ground. It hits the tallest object or best conductor.

If you hear thunder or see lightning, follow these rules to stay safe:



Quick Check

11. What causes lightning to form between the cloud and the ground?

_____

_____

Fill in the Main Idea diagram. List two details that support the main idea.

Main Idea	Details
You can be safe when there is lightning.	**12.** _____
	13. _____

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What is electric current?

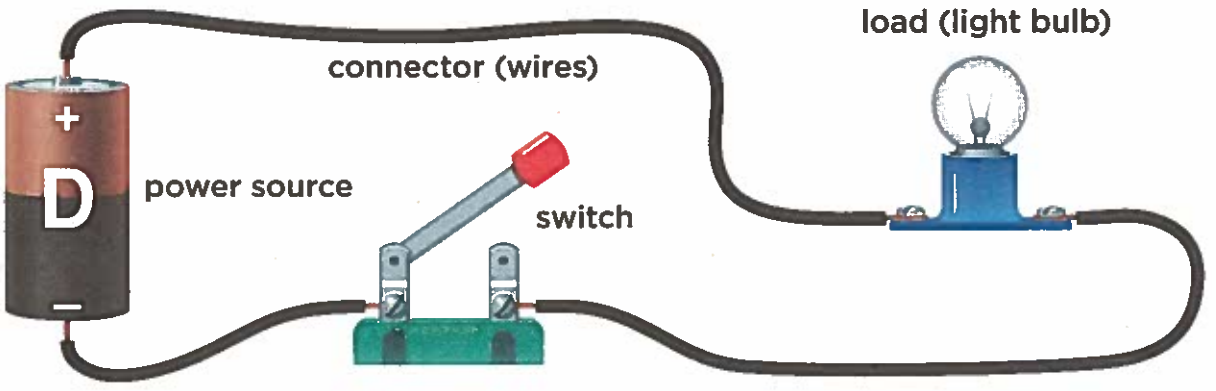
When you plug in a TV set and turn it on, electric charges are flowing through wires. A flow of electric charges is an **electric current**. In an electric current, electric charges keep moving until you turn the current off.

Circuits

An electric current needs a path to carry the charges. The path an electric current follows is a **circuit**. A circuit has several parts:

- a power source—such as a battery
- a load—something that uses electricity to work such as a lamp, a TV, or a computer
- wires and other things that connect the parts

Many circuits also have a switch. A switch is used to turn the electric current on or off. The circuit shown here has all the parts, So why do you think the bulb is not lit up? The switch is up.



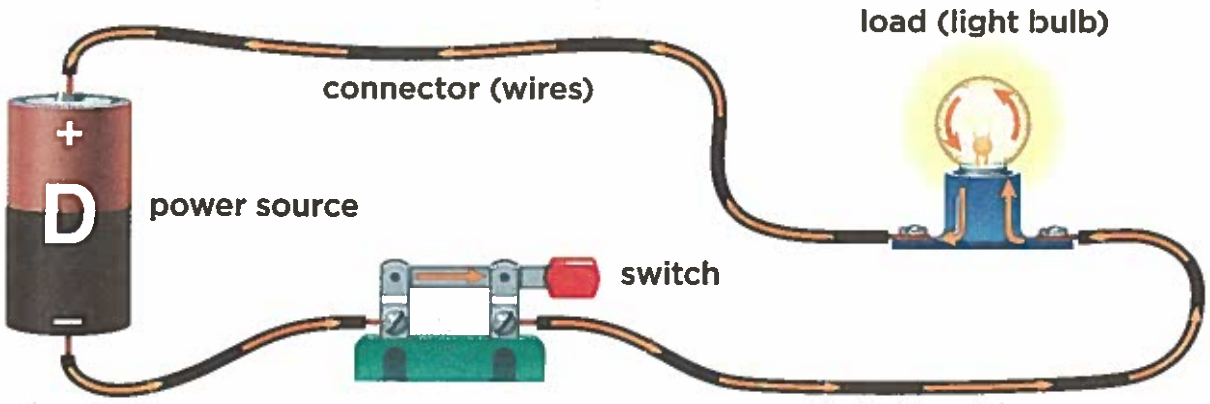
▲ The switch in this circuit is up, so that the circuit has a break in it. Electric current cannot flow.

Open and Closed Circuit

When the switch is up, the circuit is open. An *open circuit* has a break or opening. Electric current cannot flow in an open circuit. Circuits are open if a bulb burns out or if wires are loose.

The switch is closed in the circuit below. Current flows because there are no breaks in the circuit. A complete, unbroken circuit is a *closed circuit*.

Every circuit needs a power source, something that moves the electrical current. The power source shown here is a battery. Any power source has a certain amount of voltage (VOHL•tij). **Voltage** is the strength of a power source with greater voltage, more electric current can flow.



▲ When the switch is closed, the bulb lights up.

Quick Check

Match the description with the word.

14. _____ something that uses electricity

15. _____ a flow of electric charges

16. _____ a path for the electric charges

17. _____ the strength of a battery

a. circuit

b. voltage

c. load

d. electric current

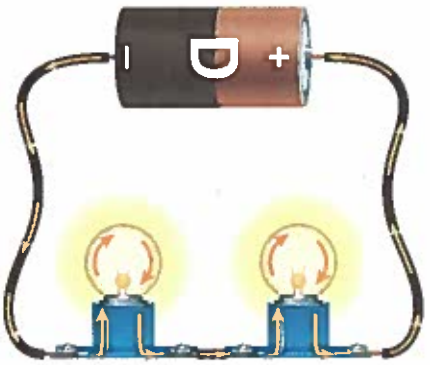
What is a series circuit?

What are the parts of the circuit shown in the diagram and the photograph? Start with a battery. There are two bulbs. A wire is used to connect the battery and the bulbs.

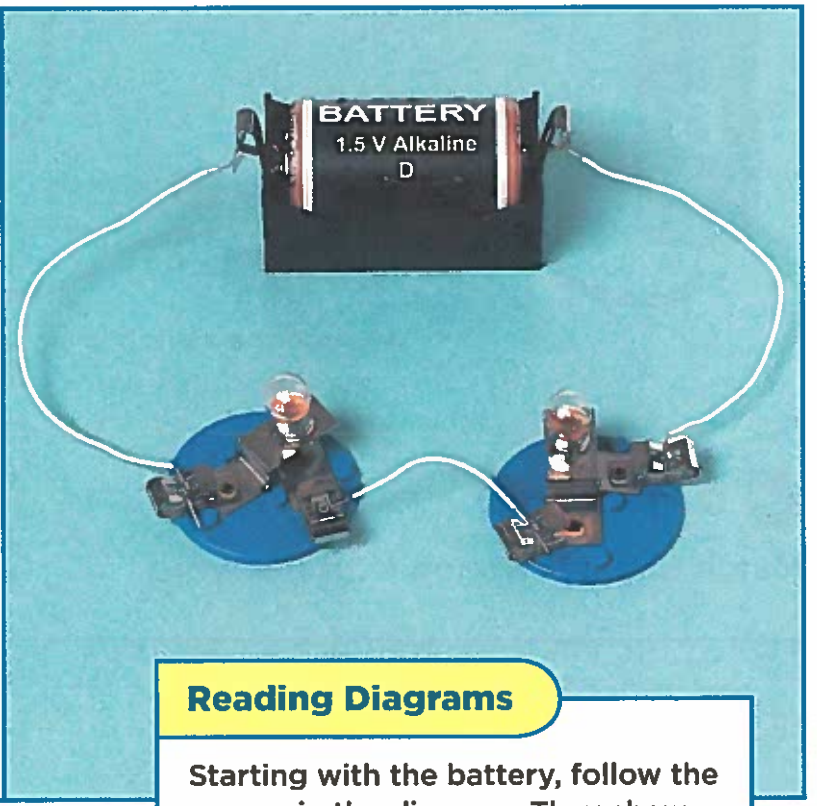
This simple circuit does not need a switch. As soon as all the parts are connected, the circuit is closed. Electric current flows and both bulbs light up.

This is a series (SEER•eez) circuit. In a **series circuit**, all the electrical charges flow in one direction along a single path. There is only one way for the electric current to go.

Series Circuit



In a series circuit, the parts are connected all in one path. All the electric current passes through each part.

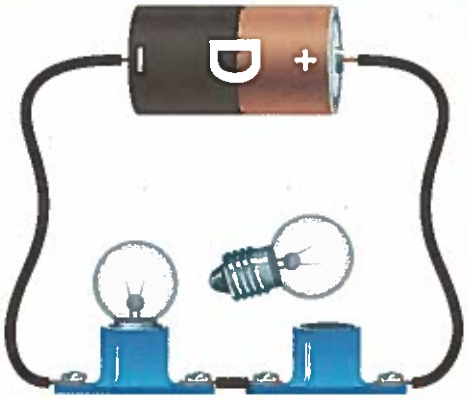


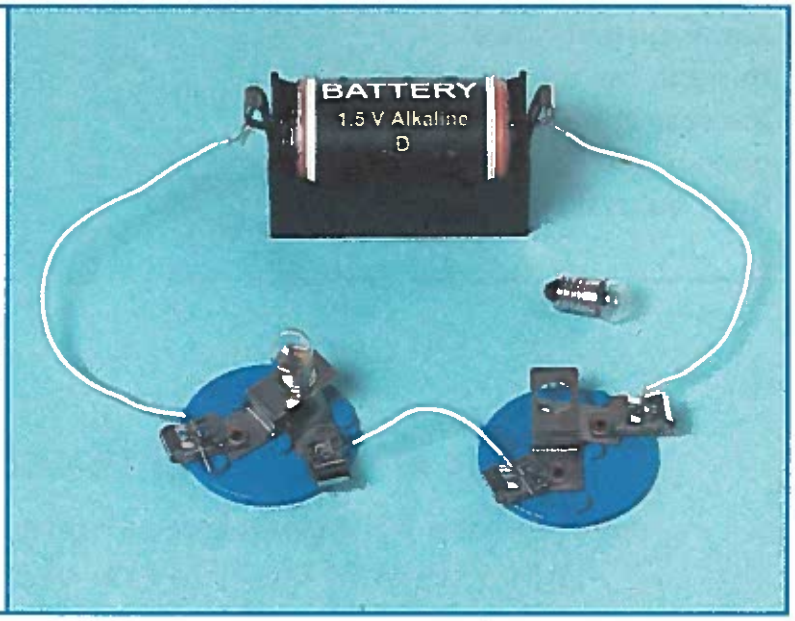
Reading Diagrams

Starting with the battery, follow the arrows in the diagram. They show how the electric current is flowing.

If any part of a series circuit is removed, the circuit is open. None of the parts will work because the electric current stops flowing.

For example, the electric current stops if one bulb burns out or is removed from the circuit. Because the electric current stops, the other bulb no longer lights up.





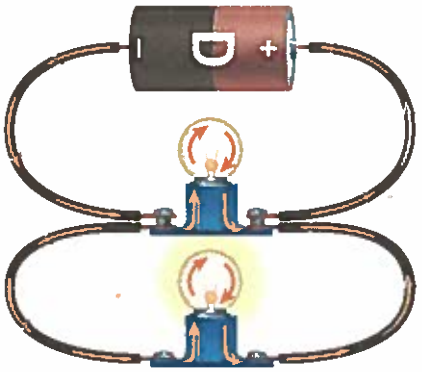
If one part of a series circuit is broken or removed, electric current cannot flow in the circuit.

Quick Check

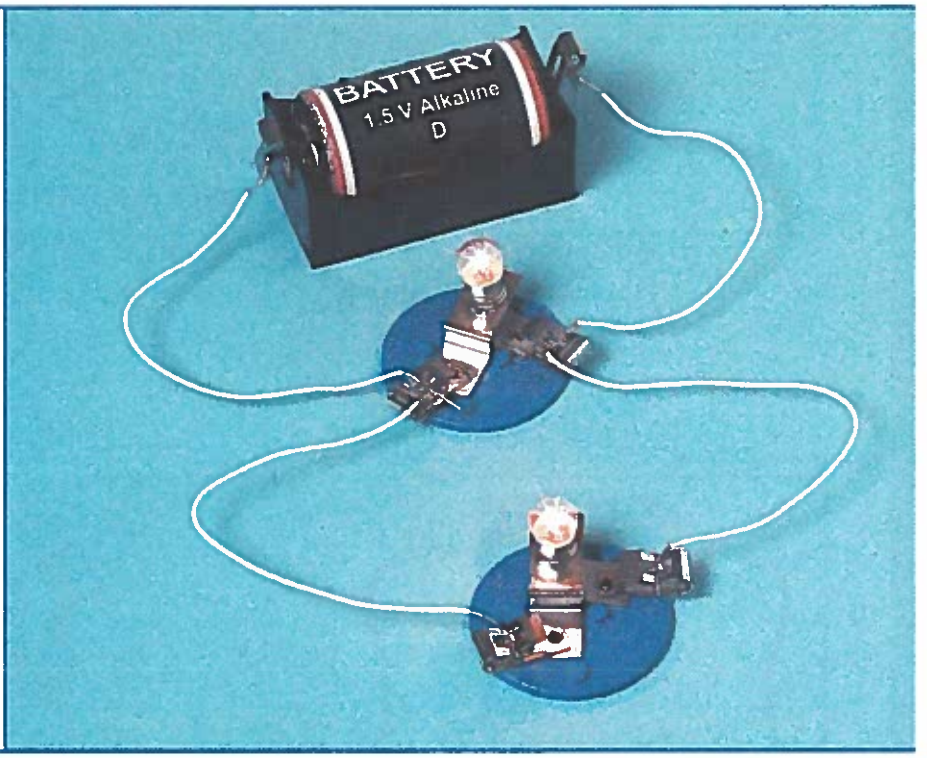
Complete the diagram below.

Cause →	Effect
Connect all the parts of this series circuit. →	**18.** _____
Remove one bulb from the circuit. →	**19.** _____

Parallel Circuit



Some current flows through the top path and the rest of the current goes to the bottom path. Both bulbs light up.

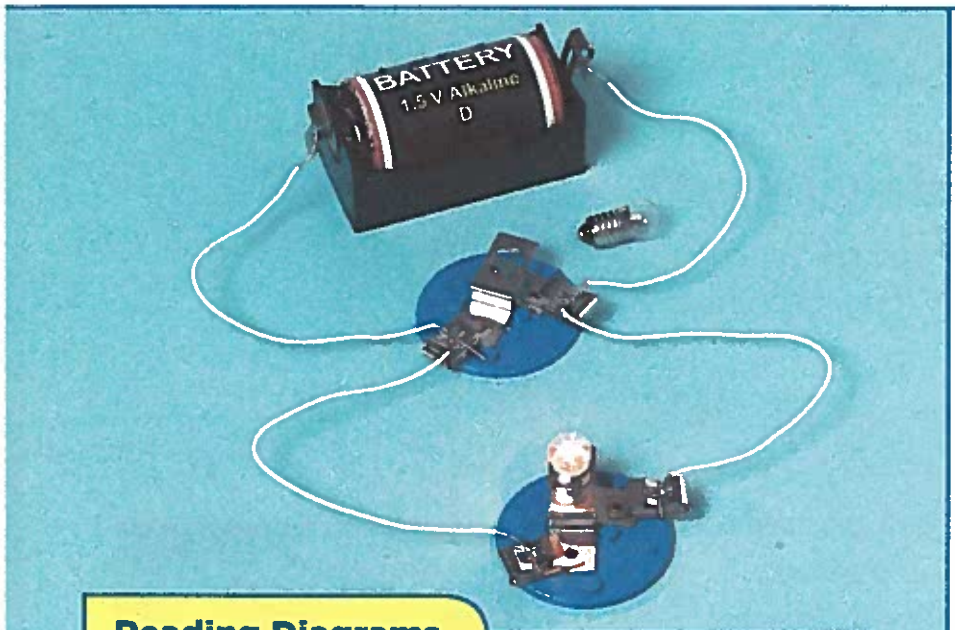


What is a parallel circuit?

If one light goes out at home, the rest of the lights stay on. They stay on because parallel (PA•ruh•lel) circuits are used. In a **parallel circuit**, electric current flows through more than one path.

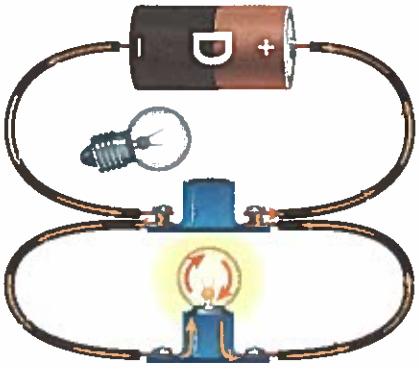
The pictures here show how a parallel circuit works. The parts are the same as the parts in a series circuit. However, the parts are connected so that there are two paths for the electric current

In a parallel circuit, some of the electric current flows through one path. Some flows through another path. In bigger circuits, there may be many more than just two paths.



Reading Diagrams

Follow the arrows from the "-" side of the battery. The arrows show how the current can pass by the break in the top path and flow to the bottom path.



If the bulb from the top path is removed, the electric current can pass by the break in the circuit. It can light up the bottom bulb.

If any path of a parallel circuit is opened, the current still flows through the other paths. So if a light bulb in one path is removed or burns out, other bulbs in other paths can still stay lit.

One danger is that all the electric current may flow through one very short path, a *short circuit*. The result can be overheated wires and a fire.

Quick Check

20. How can you tell a parallel circuit from a series circuit? _____

_____

21. Why is a parallel circuit helpful at home? _____

_____

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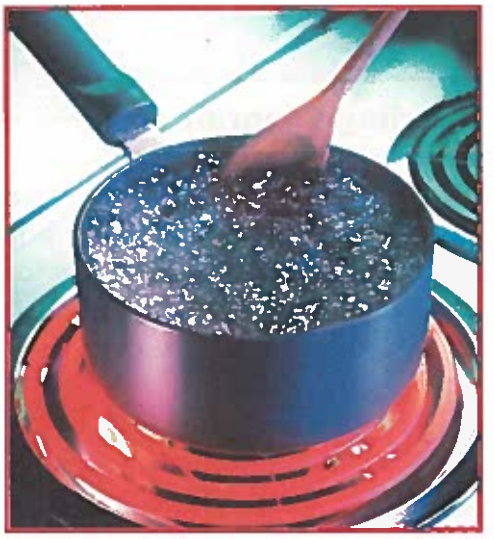
How is electrical energy used?

Energy comes in many forms. Electrical energy is one form. Other forms are heat, light, and motion.

Electrical energy can be changed into other forms all the time in useful ways.

- **heat** When electric current passes through very thin wires, it slows down—much like cars slowing down when a road gets narrow. When electric current slows down, the wires get hot. Burners, heaters, hair dryers, and toasters produce heat by using certain wires that cause electric current to slow down.
- **light** When electric current flows through thin wires, the wires can get hot enough to glow. That is how some light bulbs work.
- **motion** Electric motors change electric current to motion. Motors run trains, washing machines, and cars.



▲ **The wires in a burner slow down electric current so much that the burner gets hot and glows.**

Quick Check

For each device, tell what change of energy takes place.

22. car _____

23. hair dryer _____

23. bulb _____

How can we use electricity safely?

Here are two tips for using electricity safely:

- **bared wires** Be sure the coating around a wire is unbroken. The coating is an insulator. If the coating tears and the wire is bared, the wire can touch another wire. A short circuit can heat the wire and start a fire.
- **overloaded outlets** Never plug too many devices into one outlet. They can overheat circuits in the wall and start a fire.

Homes and buildings are protected against overheating wires. Circuits are protected by:

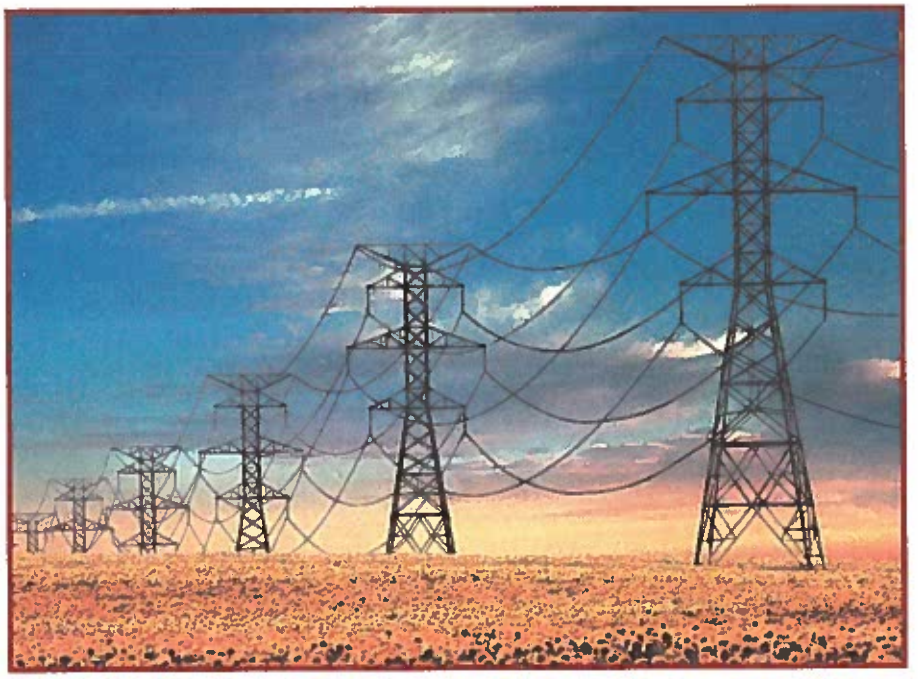
- **circuit breakers**, which switch open a circuit if the current gets too high.
- **fuses**, which melt, causing a circuit to open if the current gets too high.

The coating on an electrical cord is an insulator. If the coating tears, do not use the cord. Have an electrician replace the cord.

Quick Check

25. To use electricity safely at home, look out for _____

_____



▲ **Power lines carry electric current at a very high voltage. They are covered with an insulator, but you must still keep away to be safe.**

How does electrical energy get to your home?

Power plants produce electricity. From the power plant electric current travels along long power lines to homes and businesses.

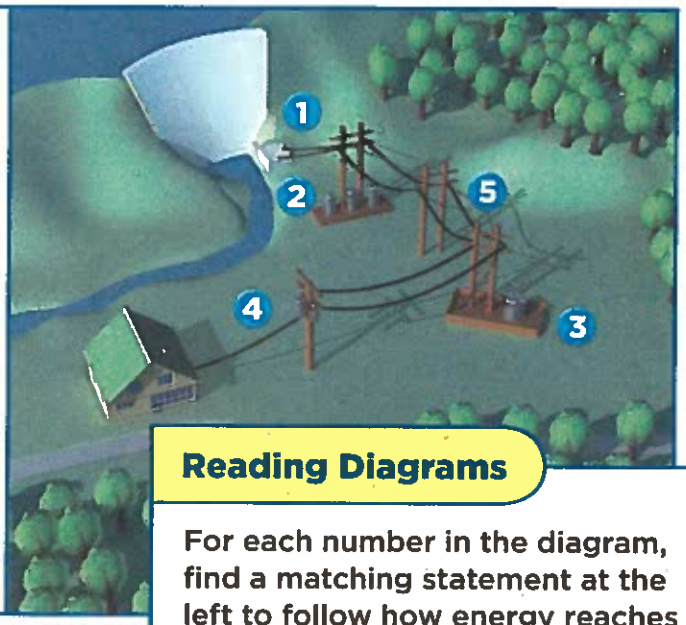
Electric current leaves a power plant with a voltage of about 25,000 volts. That is high voltage, very dangerous to be near. However, it is not enough voltage for power lines to carry the electric current to towns and cities.

An electric tool called a **transformer** can change the voltage. Electric current from the power plant enters a transformer. The transformer increases the voltage to about 400,000 volts!

Before reaching your home, electric current goes through a transformer like this one. This transformer decreases voltage.

The Path of Energy

1. Electrical energy is produced at a power plant.
2. A transformer increases voltage of the electric current.
3. A transformer lowers the voltage of current.
4. Another transformer lowers the voltage so it is safe enough to enter a home.
5. Electrical cables carry the electric current back to the power plant.



Reading Diagrams

For each number in the diagram, find a matching statement at the left to follow how energy reaches your home.

Before electric current reaches your home, it goes through other transformers. These transformers lower the voltage to safe levels. Most homes run on 120 volts or 240 volts.

Then current travels through different power lines back to the power plant. Transformers increase the voltage for the "trip."

Quick Check

Tell how electric current gets to your home.

First Electricity is produced by a power plant.

↓

Next **26.** Transformers _____

↓

Last **27.** Transformers _____

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Vocabulary Review

Electricity

Match the words in the first column to the best answer in the second column.

1. electrical charge _____

2. static electricity _____

3. electric current _____

4. series _____

5. parallel _____

6. circuit breaker _____

a. an electrical tool that switches off an electrical current that gets too high

b. a circuit in which the electrical charges flow through more than one path

c. one of two kinds of particles in objects, positive or negative, that can cause objects to pull toward each other or push away from each other

d. a flow of electrical charges through a material, such as a wire

e. a buildup of electrical charges on an object

f. a circuit in which the electrical charges flow through a single path

Answer the following questions. Use one or more words from the first column above in each answer.

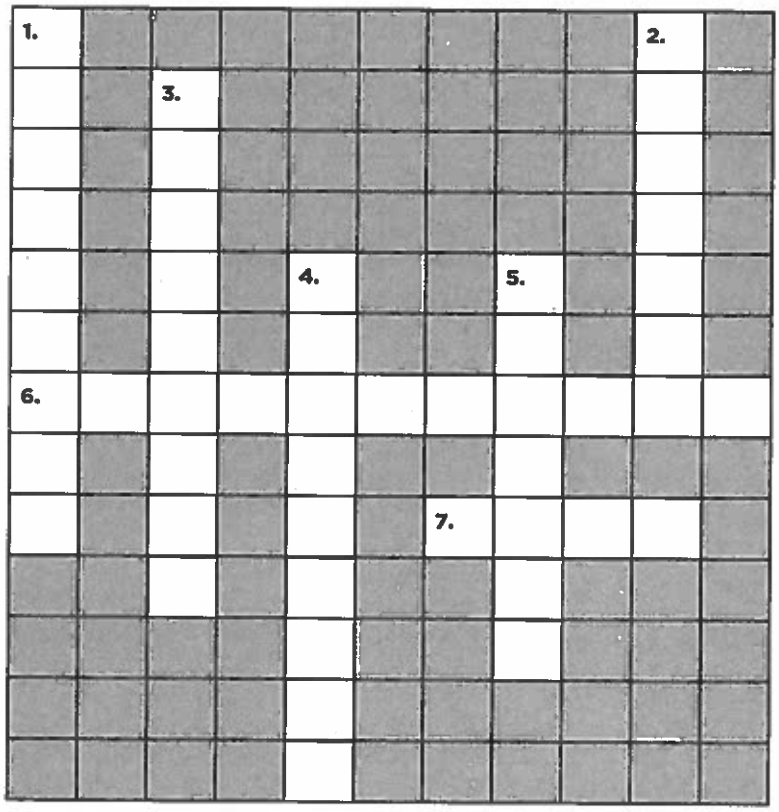
7. What happens when you rub a balloon with a wool cloth? _____

_____

8. Each of two circuits has two bulbs. You remove a bulb from each circuit. In one circuit the remaining bulb goes out, but in the other circuit it stays lit. What's the difference? _____

_____

Use the clues to fill in the crossword puzzle below.



ACROSS

6. An electrical tool that increases or decreases the voltage in an electrical current

7. An electrical tool that melts to open a circuit if the electrical current gets too high

DOWN

1. A material that lets electric charges flow through it easily

2. A measure of how strong a battery or any other power source is

3. A material that does not let electric charges flow through it easily

4. A sudden movement of electrical charges from one object to another

5. The path of an electric current

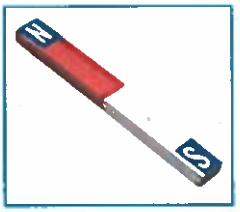
CHAPTER 7

Magnetism

Vocabulary

magnet any object that attracts certain metal objects

compass a tool that shows directions by letting a needle line up with Earth's magnetic field



pole the part of a magnet where the ability to push or pull is the strongest

electromagnet a magnet that is made when an electric current flows through a coiled wire around an iron rod

magnetic field the area around a magnet where it can push or pull another magnet

loudspeaker a tool that changes electrical energy into sound

The Big Idea: How do we use magnets?

microphone a tool that changes sound into electric signals

motor a tool that changes electrical energy into energy of motion

generator a tool that changes energy of motion into electrical energy

alternating current electrical current that flows in one direction and then in the opposite direction, back and forth

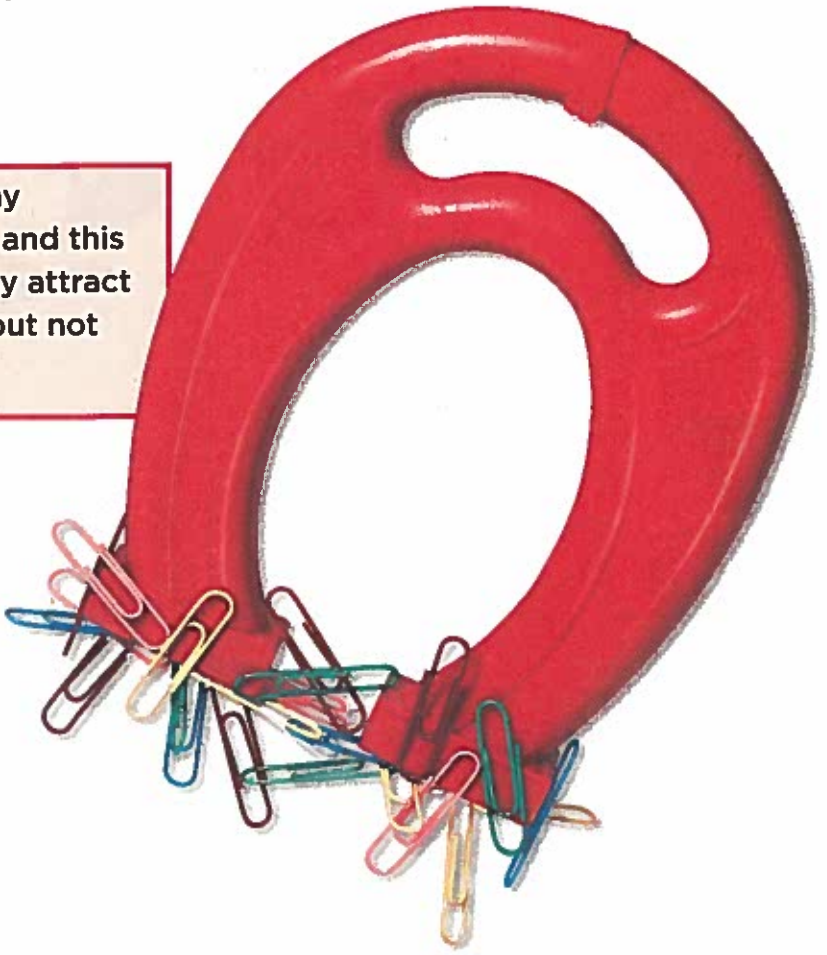
direct current electrical current that flows in just one direction

What is a magnet?

You may have used magnets to pull (or attract) things made of metal, like steel paper clips. A **magnet** is any object that attracts certain metal objects. A magnet also can attract or can push away (repel) another magnet.

Refrigerator Magnets

Refrigerator magnets are made up of very tiny strips of magnets placed next to each other. The way they are arranged causes the ability to attract to be very strong on one side of the magnet. That is why one side of the magnet attracts (or sticks to) the metal in a refrigerator.

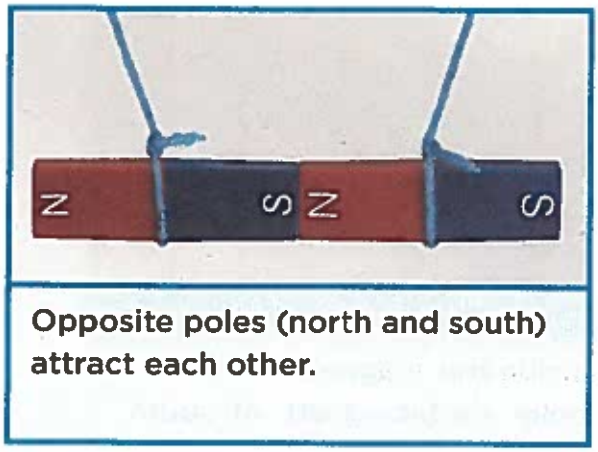


Magnets come in many shapes—bars, circles, and this horseshoe shape. They attract metallic paper clips, but not plastic paper clips.

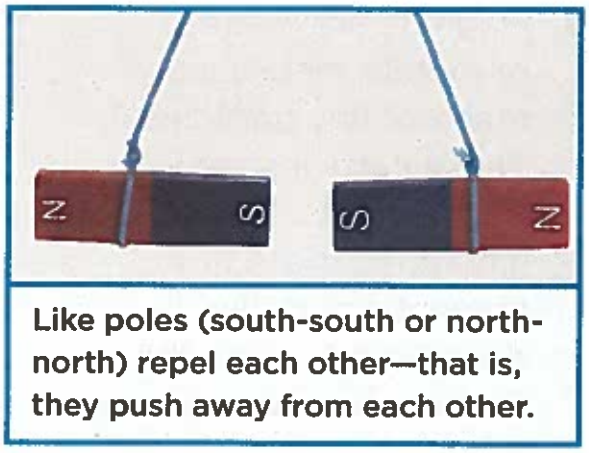
Magnetic Poles

Hold two bar magnets by strings. Point the ends toward each other. The ends will push or pull each other. The ends of a bar magnet are its poles. A **pole** is the part of a magnet where the ability to push or pull is the strongest.

Magnets have two poles—north (N) and south (S). When the poles are brought together:



Opposite poles (north and south) attract each other.



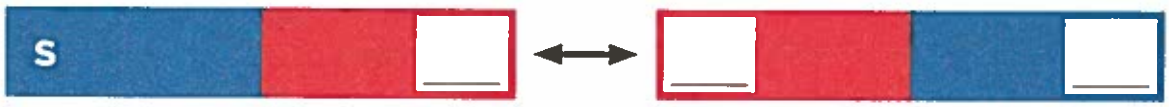
Like poles (south-south or north-north) repel each other—that is, they push away from each other.

The ability to attract or repel depends on how far apart two magnets are. The farther apart two magnets are, the weaker their ability to attract or repel each other becomes. Far enough apart, the magnets do not attract or repel at all.

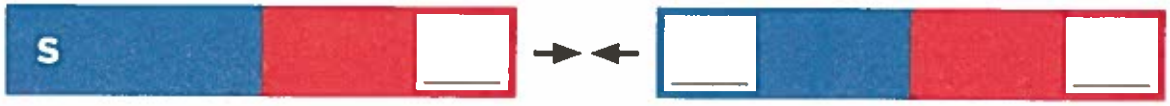
Quick Check

Fill in each space with an N or S to show that the two bar magnets attract or repel.

1. repel



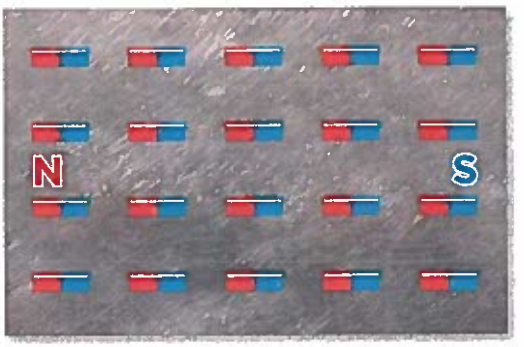
2. attract



How do magnets attract?

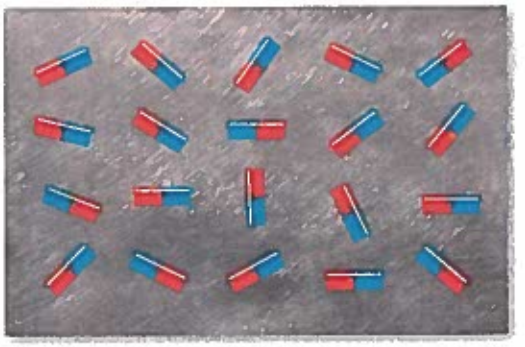
Magnets attract some metal objects, like metal paper clips. How do magnets attract metals? When you bring a magnet near some metal objects, the metal objects actually become magnets. Here's how:

1. Magnets are made of metals. Metals are made of tiny particles. These particles are like tiny magnets. Inside a magnet, these tiny magnetic particles are all lined up. All the north poles face one direction. All the south poles face the other.



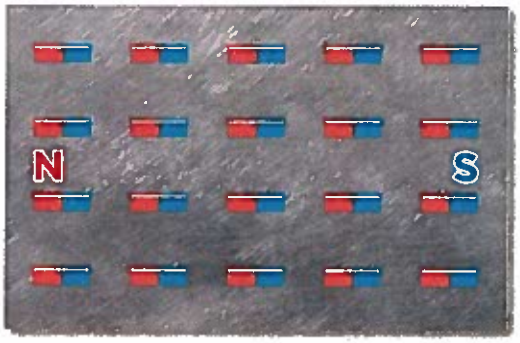
Inside this magnet, all north poles are facing left. All south poles are facing right.

2. Magnets attract certain metals, such as iron, nickel, and cobalt. If a metal is not a magnet, the metal still has tiny magnetic particles inside. However, they are not lined up. North poles and south poles are facing many different directions.



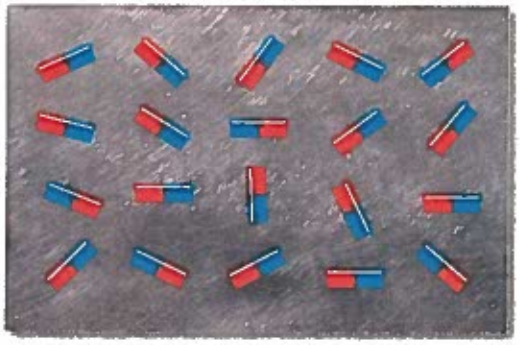
This piece of metal is NOT a magnet. The tiny particles inside are facing many directions.

3. Bring a bar magnet or any other permanent magnet near a piece of iron, nickel, or cobalt. The tiny magnetic particles turn around and line up. The metal becomes a temporary magnet. This temporary magnet attracts the bar magnet.



This piece of metal becomes a temporary magnet when you bring a permanent magnet near to it. All particles become lined up.

4. Take the permanent magnet away from the piece of metal. Usually, the tiny particles move around and face many directions again.



When it is not near a permanent magnet, the piece of metal no longer has particles all lined up.

Quick Check

Fill in this diagram to show what happens when you bring a bar magnet next to a piece of iron.

3. First In a piece of iron, the tiny particles are

_____

↓

Next Bring a bar magnet near the piece of iron.

↓

4. Last Now the tiny particles inside the piece of iron are

_____

What is a magnetic field?

When you pull or push something, you have to touch it. A magnet can pull or push without touching. How?

Every magnet has a magnetic field around it. A **magnetic field** is the area around a magnet where it can push or pull another magnet.

Look at the magnetic field traced by iron filings. If you move another magnet into this magnetic field, the two magnets will:

- attract if opposite poles are facing each other
- repel if like poles are facing each other.

The magnetic field is strongest at the poles. Farther away from the poles, the ability to attract or repel becomes weaker and weaker.

These tiny pieces of iron are on a glass plate held over a magnet. When the plate is shaken, the iron pieces trace the magnetic field around the magnet.

Quick Check

Correct each of these *false* sentences.

5. Two magnets will repel if opposite poles are facing each other. _____

_____

_____

6. A magnetic field is weakest at the poles. _____

_____

_____

What is a compass?

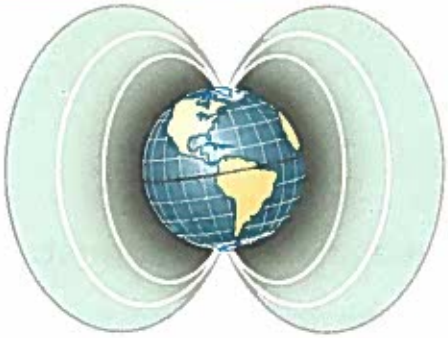
Earth is a giant magnet. Part of the inside of Earth is made up of melted iron. This iron sets up a magnetic field around Earth.

The north pole of Earth's magnetic field is located near the geographic North Pole. Earth's magnetic south pole is located near the geographic South Pole.

A **compass** is a tool that gives directions. It is made up of a free-spinning magnetic needle that lines up with Earth's magnetic field. It points to the magnetic north pole.

Because a compass needle points north, the compass can be used to find all the other directions as well.

Earth's Magnetic Field



Reading Diagrams

Earth's magnetic field is strongest at the point where the field lines come together, at the north and south magnetic poles.

Quick Check

In each row cross out the word (or words) that does (do) not belong.

7. magnetic field Earth poles land

8. north equator compass south

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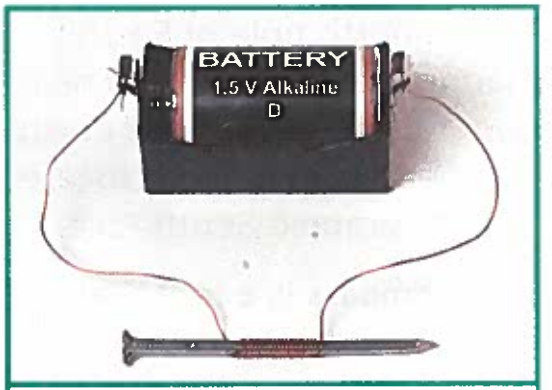
What is an electromagnet?

When an electric current flows through a wire, it sets up a magnetic field around the wire. The field is stronger if you wind the wire into a coil.

Just add one more item, an iron rod (or nail), and you can make an electromagnet. An **electromagnet** is a magnet made when an electric current flows through a coil of wire wrapped around an iron rod. When current flows, the iron rod acts like a magnet. Its two ends become north and south poles.



To make current flow through the coiled wire, attach the ends of the wire to a battery.

Quick Check

Complete the diagram to tell how to make an electromagnet.

9. First Wind a wire into a _____ .

↓

10. Next Wrap the _____ .

↓

11. Last Attach the ends of _____ .

How are electromagnets used?

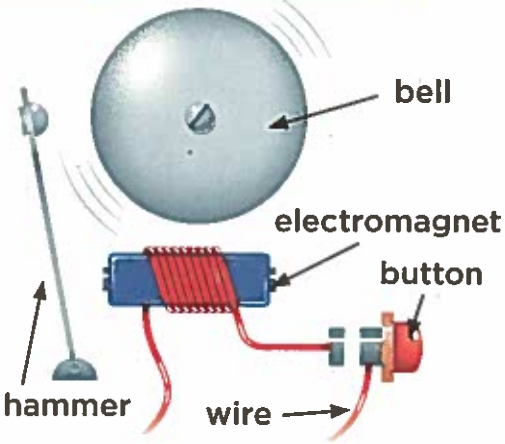
Electromagnets are often more useful than permanent magnets because:

- you can turn them on and off by switching the current on and off
- you can make them stronger by increasing the current and/or the coils of wire.

Electromagnets are used in many things people use everyday, including:

- doorbells
- motors that run hobby trains and cars
- electric guitars.

How a Doorbell Works



When you push the button, you switch the current on. The electromagnet pulls a hammer to strike a bell.

Quick Check

12. To turn on an electromagnet, all you have to do is _____

_____

13. One way to make an electromagnet stronger is to _____

_____

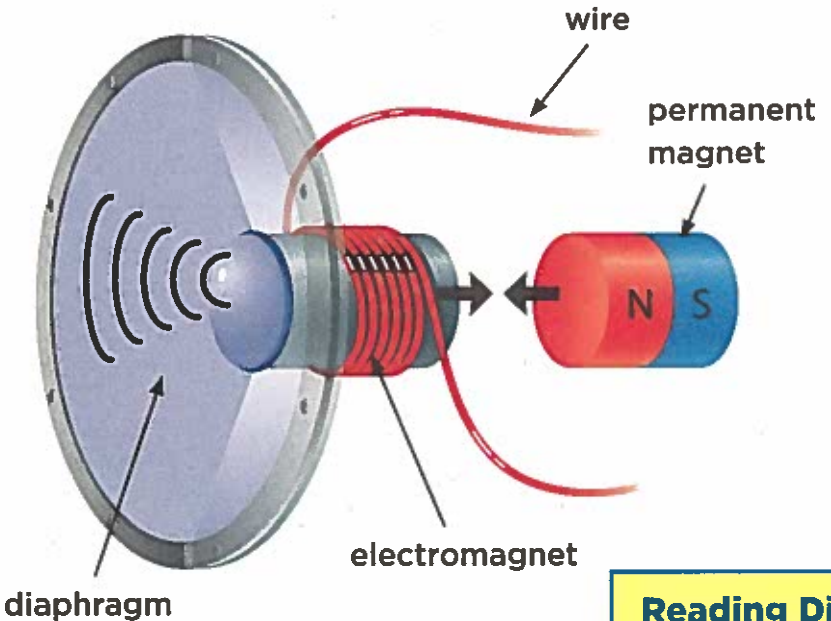
How does a loudspeaker work?

Electromagnets are used in loudspeakers. A **loudspeaker** is a device that changes electrical energy into sound. Loudspeakers produce sound in radios, stereos, televisions, and headphones.

Inside the loudspeaker, an electromagnet is attached to a diaphragm (DIGH•uh•fram). The *diaphragm* is a cup-like surface that can make sound when:

- a current flows through an electromagnet inside the loudspeaker
- the electromagnet is pushed and pulled by a permanent magnet
- at the same time, the diaphragm also moves back and forth (vibrates) and makes sound.

How a Loudspeaker Works



Reading Diagrams

When current flows, an electromagnet is attracted and repelled by a permanent magnet over and over again.

Telephones

Telephones use electromagnets. A telephone receiver is a tiny loudspeaker. When someone calls you:

- the person speaks into a mouthpiece. The mouthpiece is often a microphone (MIGH•kruh•fohn). A **microphone** uses a magnet to change sound into electric signals
- the signals travel to your receiver
- your receiver uses an electromagnet just as any loudspeaker does—to change the signals into sound.

The Parts of a Receiver

Reading Diagrams

The labels identify the two parts of a telephone used for peaking and listening.

Quick Check

Match the object with its description.

14. ___ loudspeaker

15. ___ microphone

16. ___ diaphragm

a. changes sound into electric signals

b. vibrating part of microphones and loudspeakers

c. changes electric signals into sound

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What is an electric motor?

Just about any electrical device that has moving parts inside uses an electric motor. An electric **motor** changes electrical energy into motion.

Electric motors operate:

- air conditioners
- refrigerators
- electric toys, such as trains and cars
- power tools.

A simple electric motor has several parts:

- a source of power—such as a battery or a plug
- a permanent magnet
- a loop of wire that can spin
- a motor shaft—a rod that can spin and move

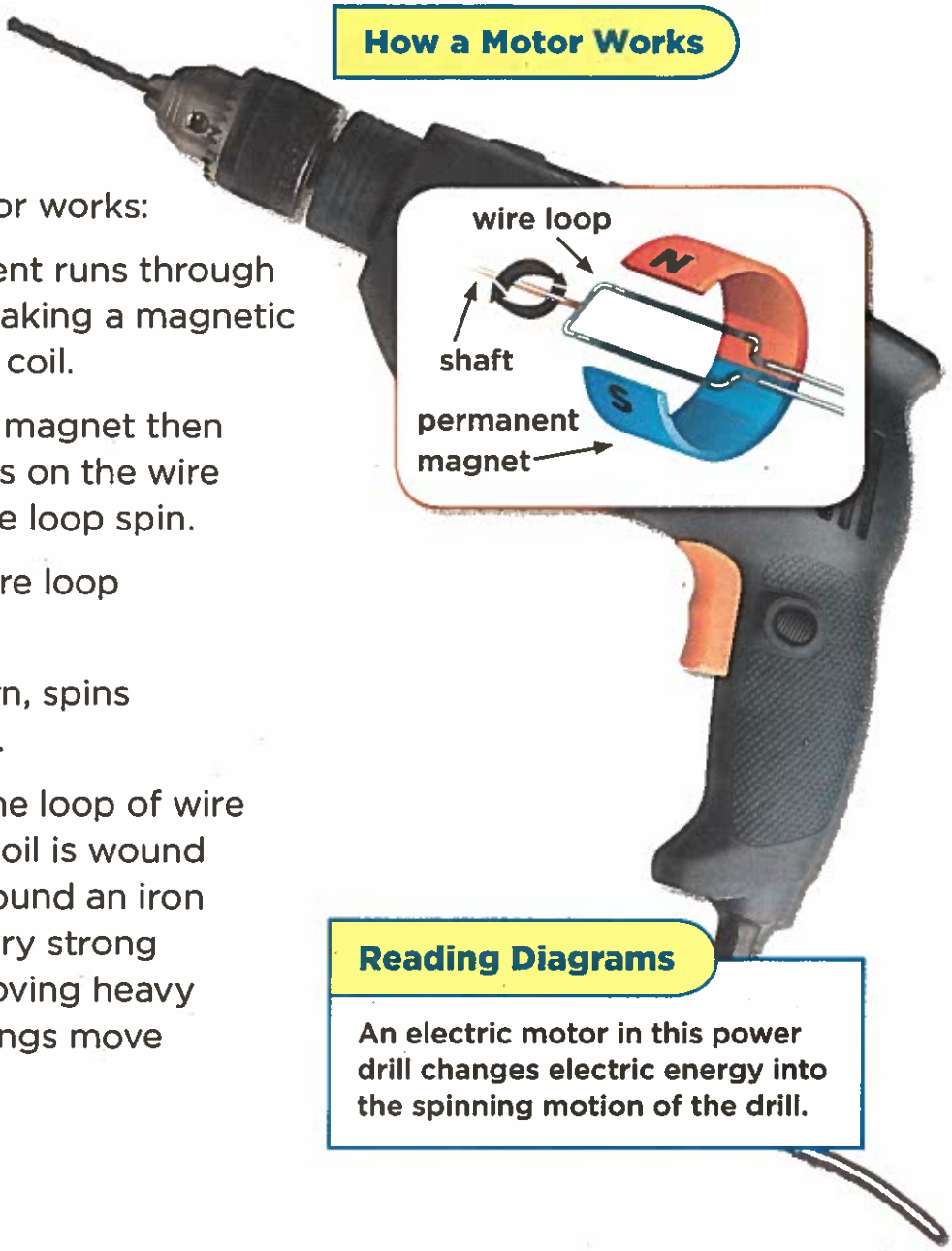
An electric motor in this toy car changes electric energy into the spinning motion of the wheels. ▶

How a Motor Works

Here is how a motor works:

1. An electric current runs through the wire loop, making a magnetic field around the coil.
2. The permanent magnet then pushes and pulls on the wire loop, making the loop spin.
3. The spinning wire loop spins the shaft.
4. The shaft, in turn, spins a wheel or gear.

In larger motors, the loop of wire is a coil of wire. The coil is wound hundreds of times around an iron tube. This makes a very strong electromagnet for moving heavy objects or making things move very fast.



Reading Diagrams

An electric motor in this power drill changes electric energy into the spinning motion of the drill.

Quick Check

Tell if each sentence is ***true*** **or** ***false*****. If** ***false*****, correct the sentence.**

17. Electric motors use motion to produce electrical energy.

18. In a motor, a magnetic field is made around the wire coil.

19. In a motor, the spinning wire loop spins the permanent magnet.

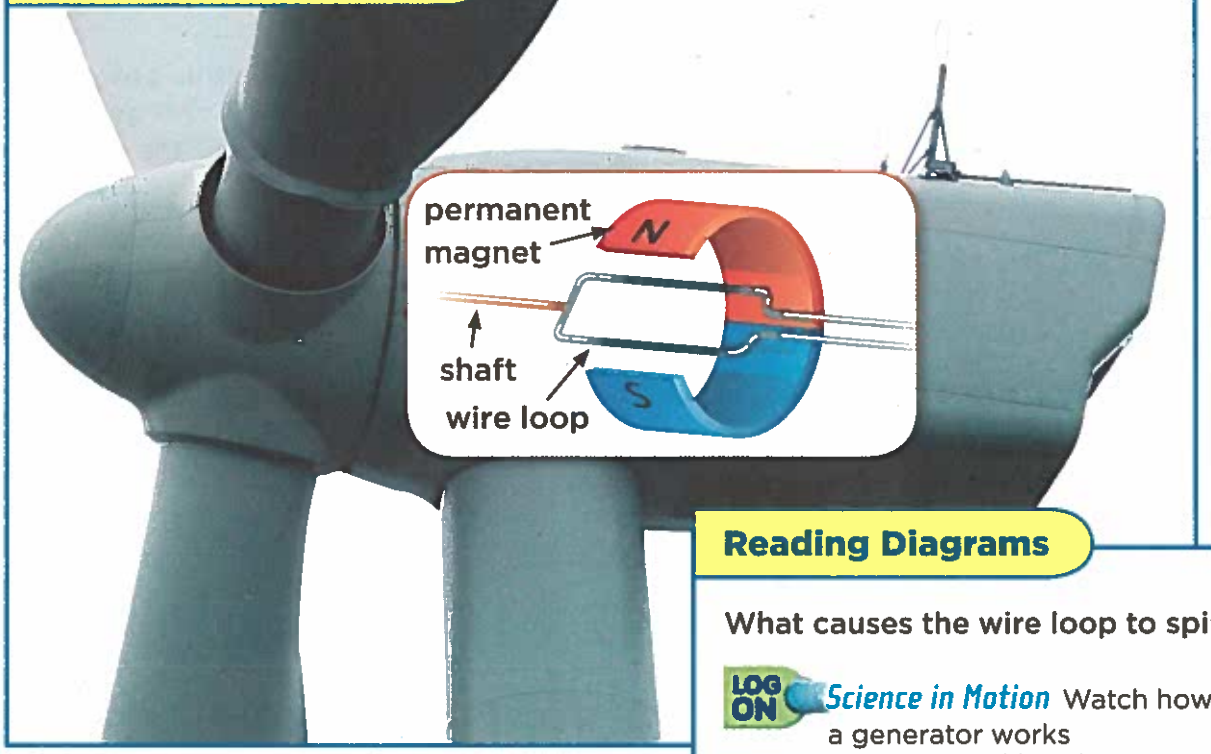
What is a generator?

Almost all of our electrical energy is produced by generators (JEH•nuh•ray•turz). A **generator** changes motion into electrical energy. That is exactly the opposite of what a motor does.

Here's how a generator works:

1. Wind, flowing water, or steam is used to spin a *turbine* (TER•bin). A turbine is a part that looks like a pinwheel or an electric fan.
2. The turbine is connected to a wire loop. The spinning turbine turns the wire loop between the poles of a permanent magnet.
3. The magnet is surrounded by a magnetic field. Current flows through the wire loop as the loop moves through the magnetic field.

How a Generator Works



Reading Diagrams

What causes the wire loop to spin?

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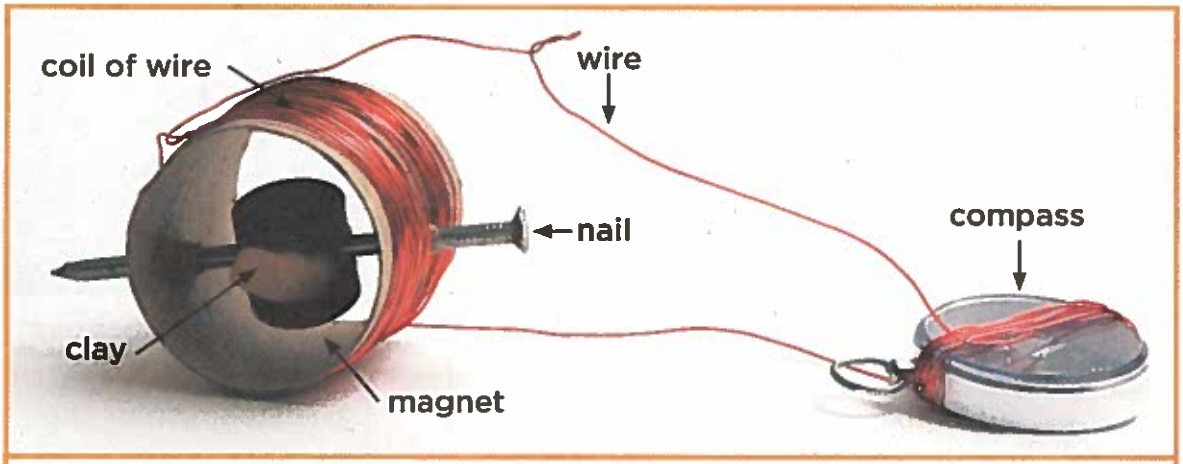
One way generators can work is by making a coil of wire spin inside a magnetic field. Another way generators can work is just the opposite. Make a magnetic spin inside of a coil of wire.

For example, to make this hand-made model work:

1. Spin the nail. The magnets stuck to the clay spin inside the coil of wire.
2. Current will flow through the coil of wire.
3. The current sets up a magnetic field around the compass. The magnetic field causes the compass needle to move. When you see the needle move, you know current is flowing.



The motion in this generator comes from your hand when you spin the nail.

Quick Check

Tell which of these steps happens first, second, and third. Label them *1*, *2*, and *3*.

20. _____ As the wire loop spins inside a magnetic field, current flows through the wire.

21. _____ The spinning turbine, in turn, causes a wire loop to spin.

22. _____ Wind or flowing water make a turbine spin.

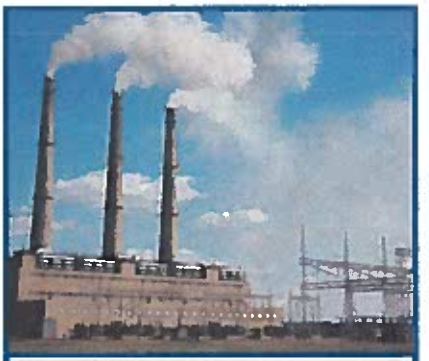
What are sources of electrical energy?

A generator works because energy of motion is needed to make the turbine spin. Where does that energy of motion come from?

The word *source* (SAWRS) is used to describe where something comes from. Generators have several sources of energy.

Wind can spin a turbine without the need for heating water and producing steam.

Source of Energy	How It Is Used in a Generator
fossil fuels	Oil, coal, and natural gas are burned to heat water. Steam from hot water turns turbines.
nuclear energy	Energy is released from inside atoms. This energy heats water and produces steam.
geothermal energy	Heat from under the ground is used to produce steam.
hydropower	Flowing water (a river or waterfall) can spin turbines.
wind	Wind can spin turbines.



Many generators use heat to produce steam. The steam spins the turbines.

Quick Check

23. Which sources of energy can spin a turbine without making steam?

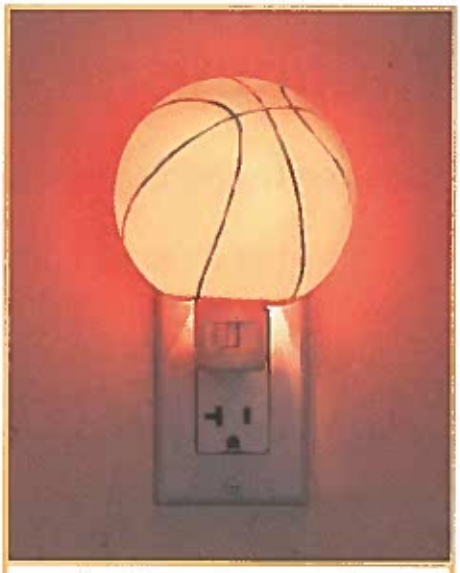
What kinds of electric current are there?

The electric current that most generators make is an alternating current (AC). An **alternating current** flows in one direction and then in the opposite direction. Electrical charges flow back and forth, over and over again.

Alternating current is available in electrical wall outlets. You use alternating current when you plug in an electric device and turn it on.

When you use a battery, you are using direct current (DC). A **direct current** is an electric current that flows in just one direction.

Many computers need direct current. Yet you plug them into an outlet. These computers have a part inside that changes alternating current from the outlet into direct current.



The electric current from a wall outlet in your home is alternating current.

Quick Check

Summarize what you learned on this page by filling the diagram.

24. _____ **25.** _____

Summary

There are two kinds of electric current

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Vocabulary Review

Magnetism

Choose the letter of the best answer.

1. The area around a magnet where it can push or pull another magnet is a(n)

- **a.** magnetic field
- **b.** compass
- **c.** pole
- **d.** electric current

2. A magnet that is made when an electric current flows through a coiled wire around an iron rod is a(n)

- **a.** permanent magnet
- **b.** alternating magnet
- **c.** pole
- **d.** electromagnet

3. Electrical energy is changed into sound by a(n)

- **a.** generator
- **b.** microphone
- **c.** loudspeaker
- **d.** motor

4. Electrical current that flows in one direction and then in the opposite direction, back and forth, is a(n)

- **a.** direct current
- **b.** alternating current
- **c.** parallel
- **d.** closed

5. Electrical current that flows in just one direction is a(n)

- **a.** direct current
- **b.** alternating current
- **c.** parallel
- **d.** closed

6. Loudspeakers, microphones, and doorbells all work by using a(n)

- **a.** motor
- **b.** generator
- **c.** electromagnet
- **d.** turbine

Fill in each blank with a letter to spell out the answer.

1. Any object that pulls (or attracts) certain metal objects is a(n) ___ ___ ___ ___ ___ ___.
10 11

2. The part of a magnet where the ability to push or pull is the strongest is a(n) ___ ___ ___ ___.
2 1

3. A tool that shows directions by letting a needle line up with Earth's magnetic field is a(n) ___ ___ ___ ___ ___ ___ ___.
8 9

4. Electrical energy is changed into energy of motion by a(n) ___ ___ ___ ___ ___.
5 7

5. Sound is changed into electric signals by a(n)

___ ___ ___ ___ ___ ___ ___ ___ ___ ___.
4 3

6. Energy of motion is changed into electrical energy by a(n)

___ ___ ___ ___ ___ ___ ___ ___ ___.
12 13 6

Use the letters in the numbered blanks to answer a question.

What do you get when you use a battery, a coil of wire, and an iron bar?

___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
1 2 3 4 5 6 7 8 9 10 11 12 13