

Reflect

Have you ever thought about how much we depend on electricity? Electricity is a form of **energy** that runs computers, appliances, and radios. Electricity lights our homes, schools, and office buildings. Without it, our world would be a much different place. In fact, before electricity was discovered, people mainly used fire to cook and to provide light and heat.



energy: the ability to do work

Electricity has become an important part of our lives. You might know that the use of electricity often involves wires. But, how do you think electricity travels through these wires? How does it produce other kinds of energy like light, heat, and sound?

How does electricity travel?

All matter is made up of particles. *Electrical energy* is energy produced by the movement of certain particles. This flow of particles is called *electric current*.

So, what does this have to do with lights, appliances, and computers? In order to light a light bulb or turn on a computer, we need to produce a continuous electric current. To do this, we need an energy source. Common energy sources include batteries and generators. You'll learn more about these shortly. An electric current also needs a path along which it can travel. An *electric circuit* is a pathway through which electric current flows.



Electric current flows through an electric circuit like this one.

Now you know that electric current flows through a path called a circuit. You also know that a continuous

electric current needs an energy source such as a battery. What else is needed to make a circuit?

What is necessary to have energy flow through a circuit?

You can think of a circuit as a loop. In order for electric current to flow through the loop, the loop must not contain breaks. In other words, the circuit must be closed.

Reflect

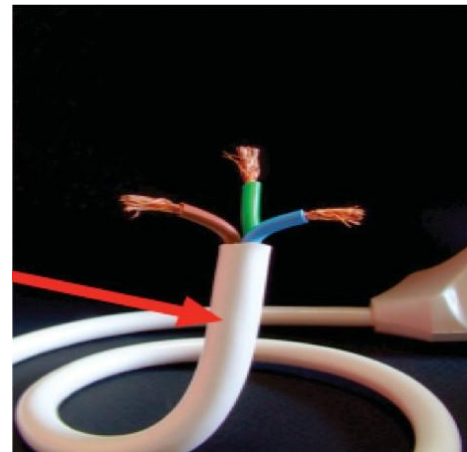
An open circuit has one or more breaks. Most circuits have an energy source, wires, a load, and a switch. As mentioned, energy sources for circuits include generators and batteries. Generators are machines that convert **mechanical energy** into electric energy. In this lesson, we'll focus on batteries. Inside a battery, two kinds of metals build up opposite charges. Negative charges build up on one end of the battery. Positive charges build up on the other end of the battery. This is why batteries are marked with a positive sign (+) and a negative sign (-).

Electrons are attracted from one end of the battery to the other. Connecting these two ends allows an electric current to flow between them.

Wires provide a path through which current can flow from one end of a battery to the other. Wires are made from materials that carry, or *conduct*, electrons more easily than other materials. Materials that conduct electrons easily are called *conductors*. Copper and aluminum are good conductors. Wires are wrapped with a material called an *insulator*. This material does not easily carry electrons. Insulators keep the conductors inside a wire from touching each other and interrupting the flow of electrons. Rubber, plastic, and glass are good insulators.

Circuits deliver electrical energy to a load, or device, that will use that energy. Loads change electrical energy into some other form of energy. Light bulbs, fans, and buzzers are common loads. Think about a light bulb. When current passes through the wires inside the bulb, electrical energy changes into **heat energy** and **light energy**. Similarly, when current passes through a buzzer, electrical energy changes into **sound energy**. And when current passes through a fan, electrical energy changes into mechanical energy.

mechanical energy: energy that an object has because of its motion or position



This electric cord is made from three insulated copper wires. The arrow is pointing to the insulator that protects all three wires.

heat energy: energy of moving particles in a substance; also called thermal energy

light energy: a visible energy source

sound energy: energy produced by vibrations

Reflect



All parts of a circuit must be connected in order for current to flow through the circuit. The picture on the left shows a *switch*, which is a device that closes and opens a circuit. A switch connects or separates two pieces of metal. When the metal pieces are connected, the circuit is closed. Electrons can flow through the circuit. When the metal pieces are separated, the circuit is open. Electrons cannot flow through the circuit. Loads do not function in open circuits because the current does not pass through them. For example, a light bulb will not light up in an open circuit.

Look Out!

Remember that energy is not created in an electric circuit. When electricity produces light in a light bulb or sound in a buzzer, energy is simply changing forms.

What Do You Think?

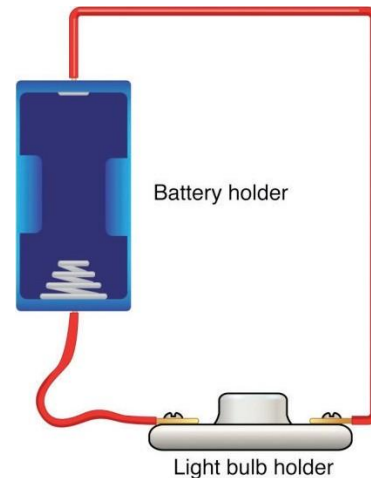


Look at the photographs above. The photograph on the left shows a radio speaker. The center photograph shows a roll of aluminum foil. The photograph on the right shows a rubber band. Think about how each object could be used in a circuit. Then decide whether each one would best be used as a conductor, an insulator, or a load.

Try Now

With a few different materials, you can explore the parts of a circuit. Flowing electrons can cause a shock if you come into contact with them, so it's always good practice to handle electricity with care. Be sure to use caution when handling the exposed parts of the wires.

1. You will need a battery holder and a battery. You will also need two pieces of insulated wire with exposed ends, a light bulb holder, and a light bulb.
2. Connect the battery holder, wires, and bulb holder as shown in the diagram on the right. Describe your observations.
3. Now insert the light bulb into its holder. Describe your observations.
4. Insert the battery into its holder. Make sure the positive (+) and negative (-) ends of the battery match the positive (+) and negative (-) markings on the holder. Describe your observations.
5. Disconnect an end of one of the wires from the light bulb holder. What happened and why?
6. If you placed a piece of aluminum somewhere within the circuit and the circuit remained closed, would the light bulb still light? What would happen if you placed a piece of rubber within the circuit? Explain.



Getting Technical: Electromagnets

Electricity and **magnetism** are closely related because both involve negative and positive charges in matter. In fact, when electric current flows through a conductor, it generates a **magnetic field** around the conductor. The magnetism resulting from flowing electric charges is called **electromagnetism**.

You can increase the strength of a magnetic field in a current-carrying wire by wrapping the wire to form

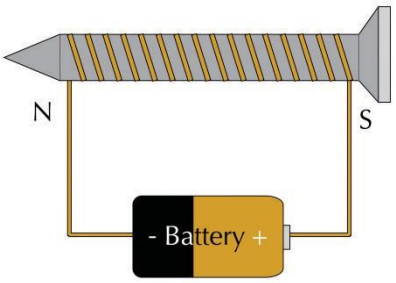
coils, or loops. The more coils you have, the stronger the magnetic field. To make an even stronger magnetic field, you can wrap the coils around an iron rod (or other iron object).

magnetism: the force of pulling or pushing between poles, or ends, of a magnet

magnetic field: the area around a magnet that is affected by magnetic forces

Try Now

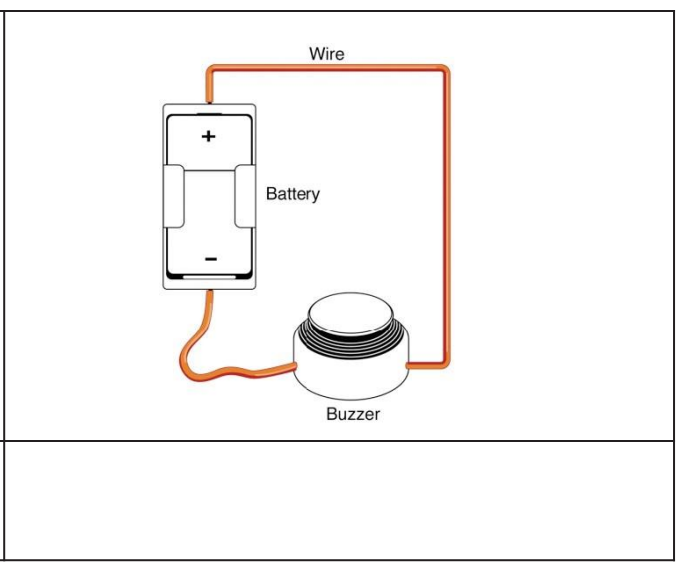
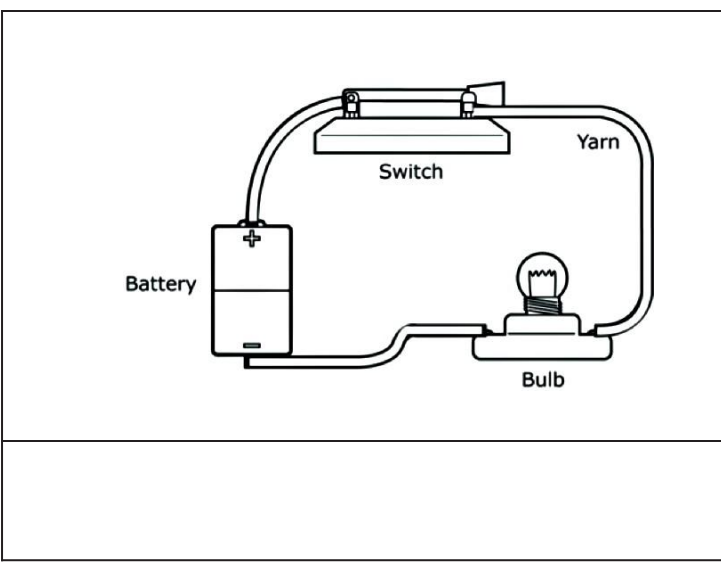
The current passes through the wire coils and magnetizes the rod. This produces a strong magnet called an electromagnet. Many everyday devices use electromagnets, including doorbells and electric motors.



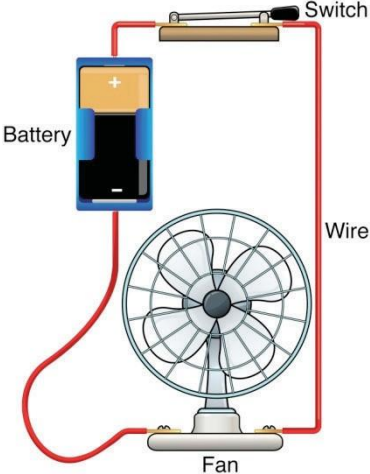
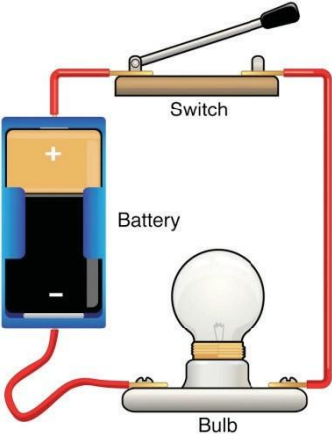
A copper wire is wrapped around an iron nail in this electromagnet. The letters "N" and "S" indicate the north and south poles of the magnetic field.

What do you know?

The flow of electricity depends on an energy source and a path, or circuit, through which it can travel. Study the images below. Decide whether or not electricity will completely flow through each circuit. Write "yes" or "no" in the space below each image, and explain your reasoning. Then, for each image that includes the answer "yes," describe the form of energy produced by the electricity.



Try Now



Circuits and Electricity at Home

To help students learn more about circuits and electricity, go through each room of your living space and have students make a list of all the devices that use electrical energy. Discuss the different forms of energy that are produced, and have students find the switches on each device if applicable. For example, a computer uses electricity to produce light (through the monitor) and sound (through the speakers). If you touch the monitor or outside of the hard drive, you will probably also feel thermal energy. Many computers have three switches: one for the monitor, one for the speakers, and one for the hard drive, which controls the computer as a whole.

If possible, take students to the area of your living space that houses the fuse box or circuit breaker panel. A fuse box or circuit breaker panel is basically the distribution center for all of the electric circuits in your home. A utility company provides the main source of electricity, which flows through an electric meter that tracks usage. Then the electricity eventually flows through the fuse box or circuit panel. The breakers or switches control the electricity. If too many devices on the same circuit are used at the same time, an overload may occur. If there is an overload of electricity in any of the circuits of the home, the breaker will open the circuit to stop the flow of electricity. Explain to students that this is a safety feature to help prevent electrical fires.

Here are some questions to discuss with students:

- Where do you think the circuits are located in each device you listed?
- What would happen to a device if part of the circuit were missing or broken?
- If you have problems with electrical circuits in your home, you might call an electrician. What kind of information do you think an electrician needs to know in order to do his or her job?