Does the Flashlight Work as Designed?

How can you build a working flashlight?

What techniques can you use to make a flashlight that works?

Lab Activity

Building Your Flashlight

1. Review the notes you made in your *Science Notebook* in the previous lesson.
   - Identify the materials you will need. Look around the room. Maybe you will get some new ideas.
   - Organize the steps to build the flashlight in the order that you will follow them (remember the recipe concept).

2. Follow your design. Assemble your flashlight according to the design you wrote down.

3. Activate your flashlight and determine if it meets the criteria:
   - Does the switch turn the flashlight on and off?
   - Is it producing the brightest possible light using just two batteries?
   - Is it easy to carry and use?

4 If your design does not work, revise it and record any changes you may need to make. You must document the entire process, from design to assembly, in your *Science Notebook*. Once it works, determine what makes your design a good one.

5 Remember to turn off your flashlight before putting it away to extend the battery life.

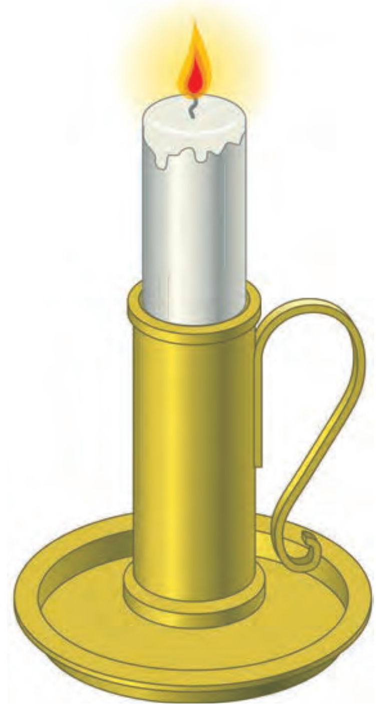
6 Compare your successful design to others in the classroom. What were the different ways this project could be completed? Which design was most efficient? Write your ideas in your *Science Notebook*?

Learn More

History of the Flashlight

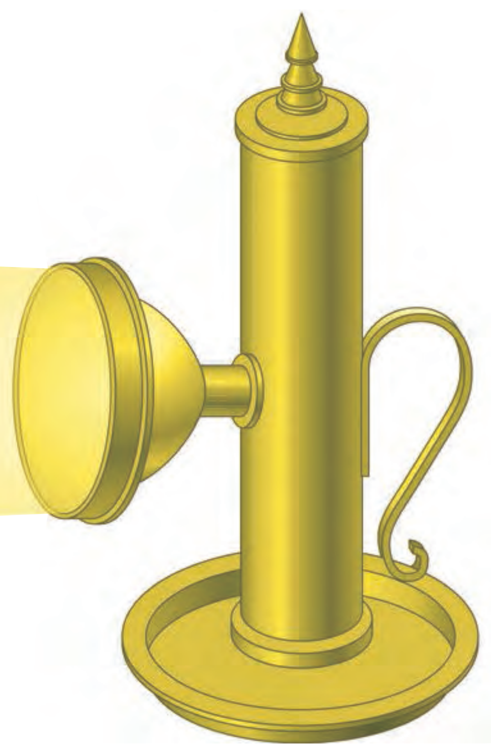
Before battery-operated flashlights were invented, candles and kerosene lights were widely used. However, they did not produce much light, and the wind could blow them out easily. Because fire was used as the source of light, accidental fires happened regularly at that time. This led to a quest for a safer source of light.

In 1866, George Leclanché (1839–1882) developed the dry battery and in 1879, Thomas Edison developed the first practical incandescent lamp (light bulb). The path was open then to developing a different type of portable light. In 1898, Conrad Hubert (1856–1928) invented the first electric flashlight, much more like the ones you know.



The First Flashlights

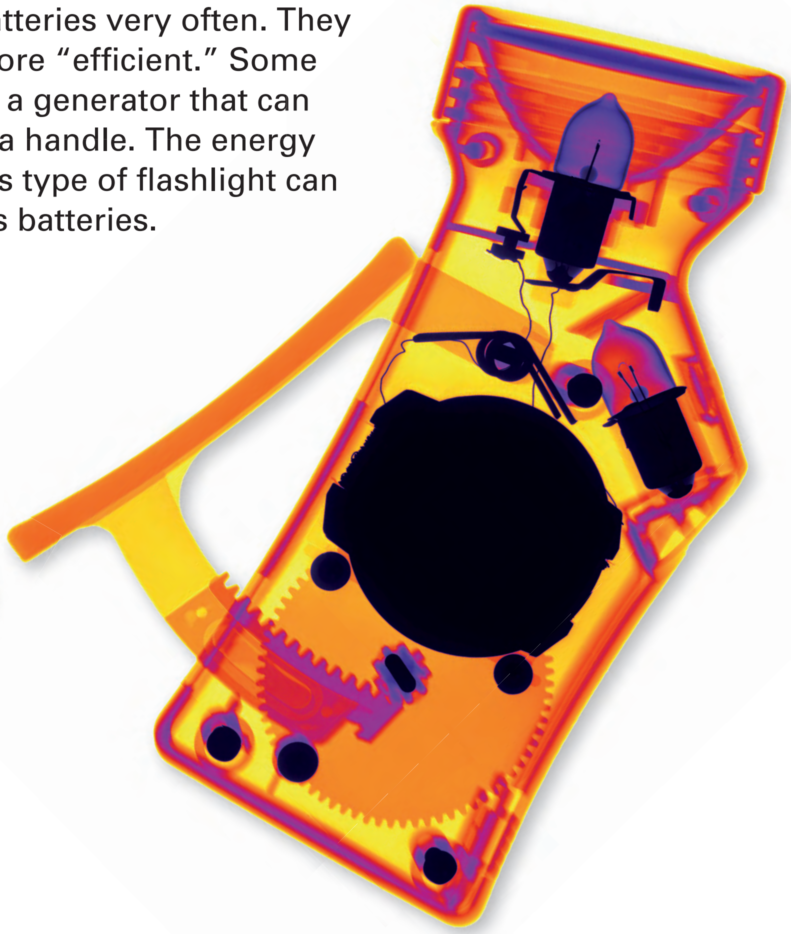
The first batteries that were invented were weak. They could only store a small amount of power, so their energy was used up quite quickly. That meant that the first flashlights did not emit light for very long. Also, the bulbs were not as bright as they are today. Later, bulbs and batteries became more efficient. Then flashlights were produced that could be used in different environments for different purposes.



The elbow type flashlight can be used vertically or attached to a backpack.

Modern Flashlights

With the use of LEDs that consume less energy than filament light bulbs, batteries last much longer. You are used to flashlights that do not require replacing the batteries very often. They can be called more "efficient." Some flashlights have a generator that can be activated by a handle. The energy produced by this type of flashlight can also recharge its batteries.

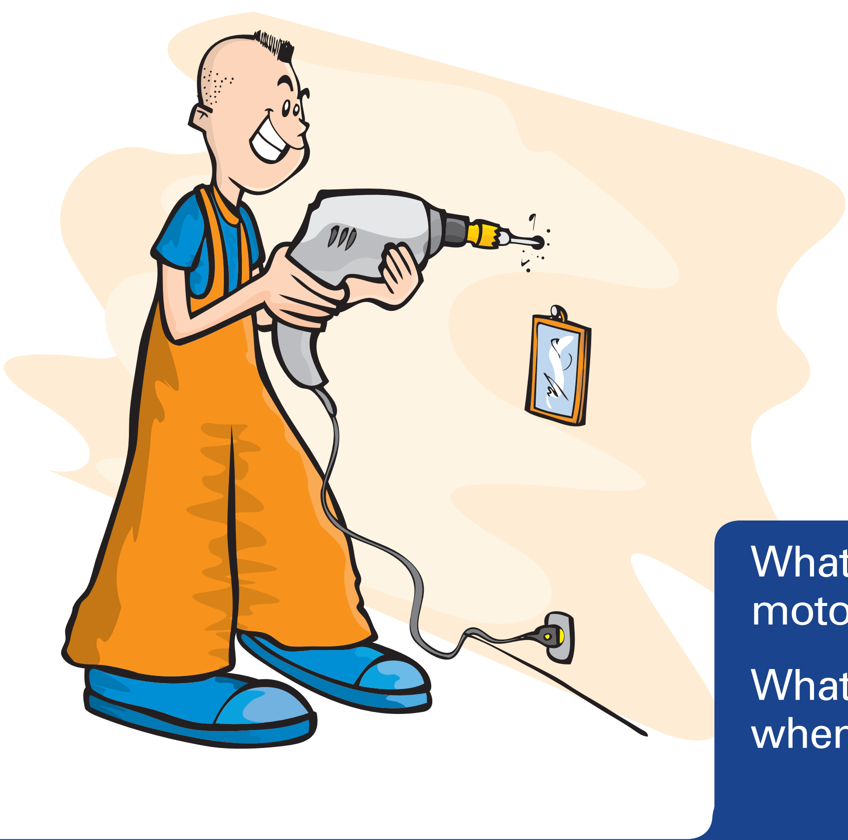


Some types of flashlights use 12V batteries, allowing a higher consumption of energy and a brighter light.

The energy obtained from some flashlight generators can be used to make light or recharge batteries.

LESSON 6

What Is an Electric Motor?



What parts are needed to make a motor?

What happens inside a motor when it is working?

Lab Activity

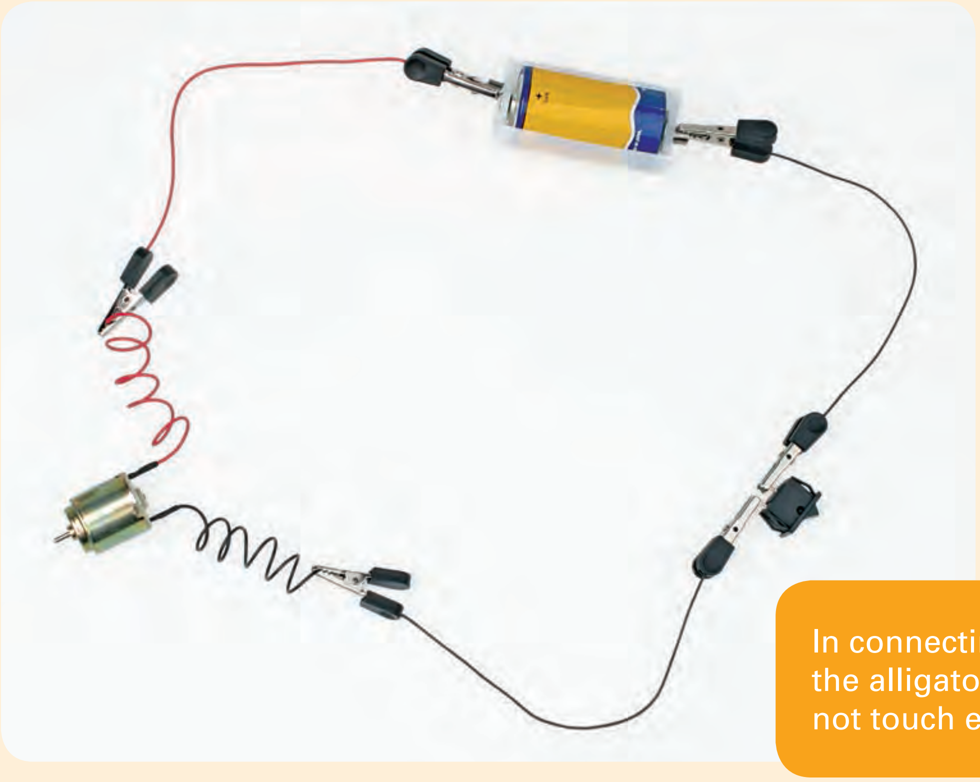
Electric Motors

1. Assemble the electric circuit with the motor using the wires with alligator clips prepared in the previous lesson.

2. Check if the motor will work. If the motor will not run, look for bad contacts on the battery holder or the alligator clips.

3. Explain how you think the motor works. Record your ideas in your *Science Notebook*.

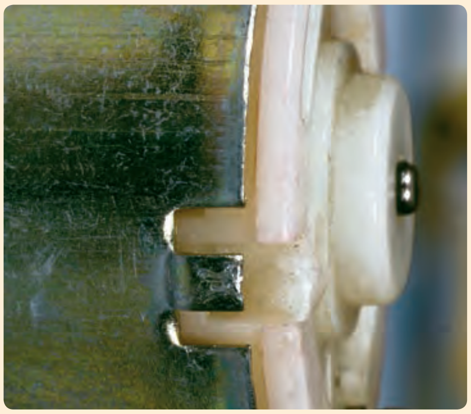
4. Carefully open the electric motor and remove the rotor without undoing the other connections.



In connecting the switch, the alligator clips must not touch each other.

Assembling the Motor on the Stand

ATTENTION!
Separate the cover very carefully! Pay attention. You will have to put it back together later.



A. With a nail, lift the motor's flaps.

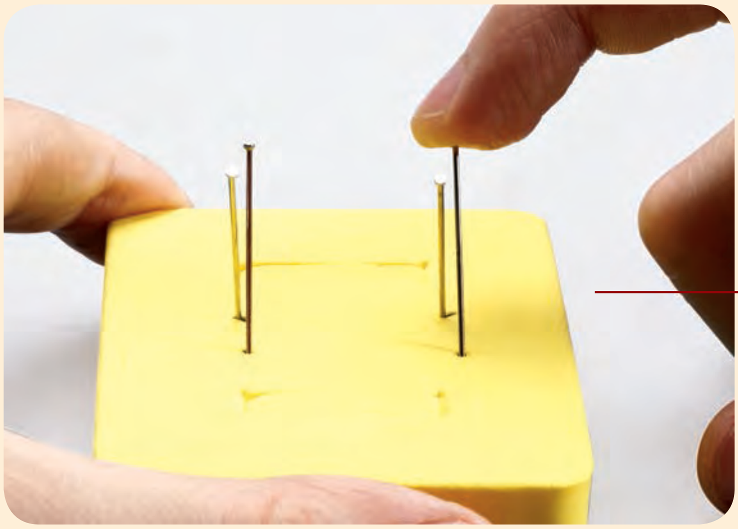
B. Place the end of the motor's axle vertically on the table and push down the motor's body so that the cover is released.

C. Remove the rotor by pulling it with the axle.

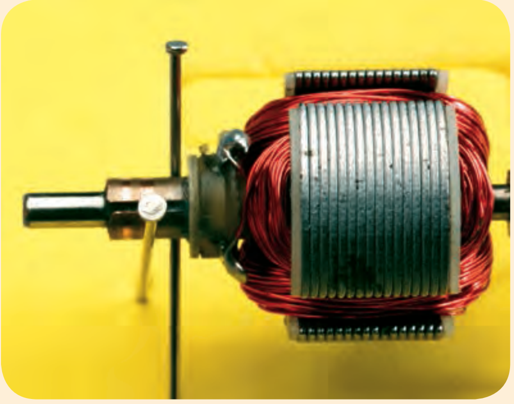
Lab Activity

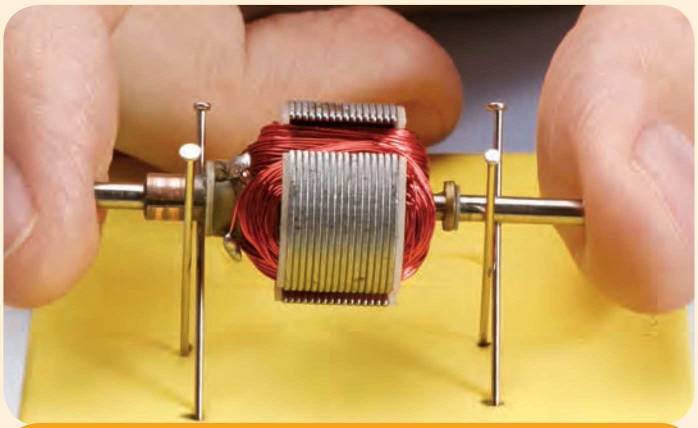
Electric Motors Continued

D. To get the motor working while open, set up a stand with the pins, as shown in the figure below.



Use the rotor to determine the distance between the pins. The motor must not touch the yellow foam base.

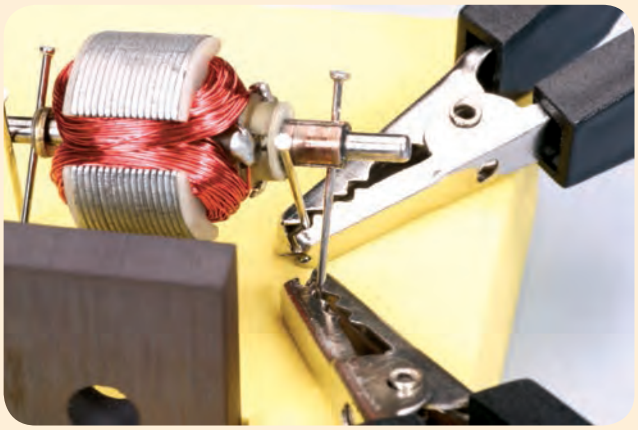




The pins that are in contact with the commutator must not touch each other as this would cause a short circuit.

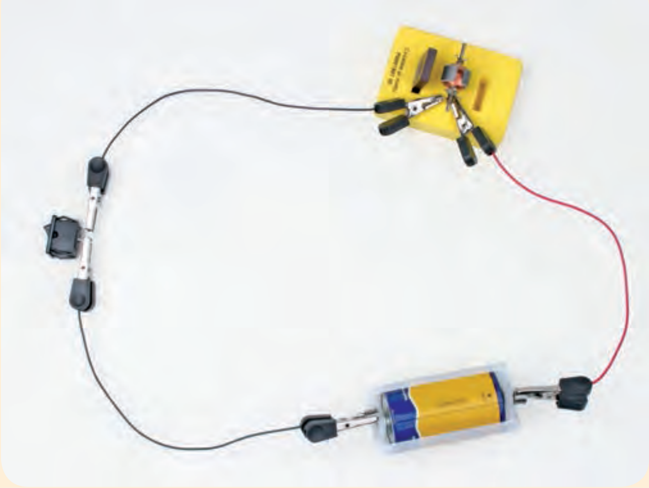
E. Place a flexible magnet in one of the cavities.

F. Now use the circuit with the battery and the switch that you assembled at the beginning of the lesson. Attach an alligator clip to the pins that are in contact with the rotor's commutator.



G. Turn on the switch. If the **rotor** does not turn, give an initial spin with your fingers.

H. Turn off the motor, using the switch.

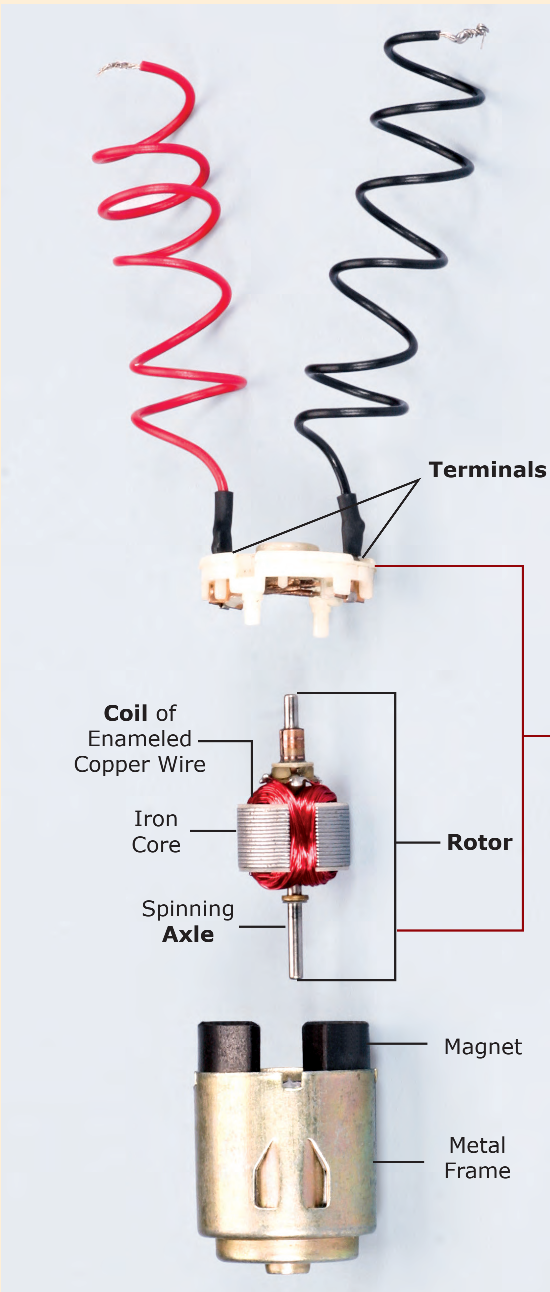


Lab Activity

Electric Motors Continued

5. Identify the motor's components.

6. Identify the function of each part of the operating motor.



7 Describe the role each of the following has in an electric motor in the *Vocabulary* section of your *Science Notebook.*

- commutator
- contacts
- iron core
- magnets
- terminals

8 Use the electric motor pages in the *Science Notebook* to help you record what you observed in operating electric motors in different situations. Record in which direction the rotor spins and to which battery poles the alligator clips are connected. What can you do to make it spin in the opposite direction?

9 Explain how the motor works. Which part acts as an electromagnet? Describe the energy change that takes place in the circuit that powers the motor. Respond in your *Science Notebook*.

Lab Activity

Electric Motors Continued

10 Reassemble the motors.

Mounting the Motor into the Body Frame

A. Put the rotor into the frame with the commutator facing up.

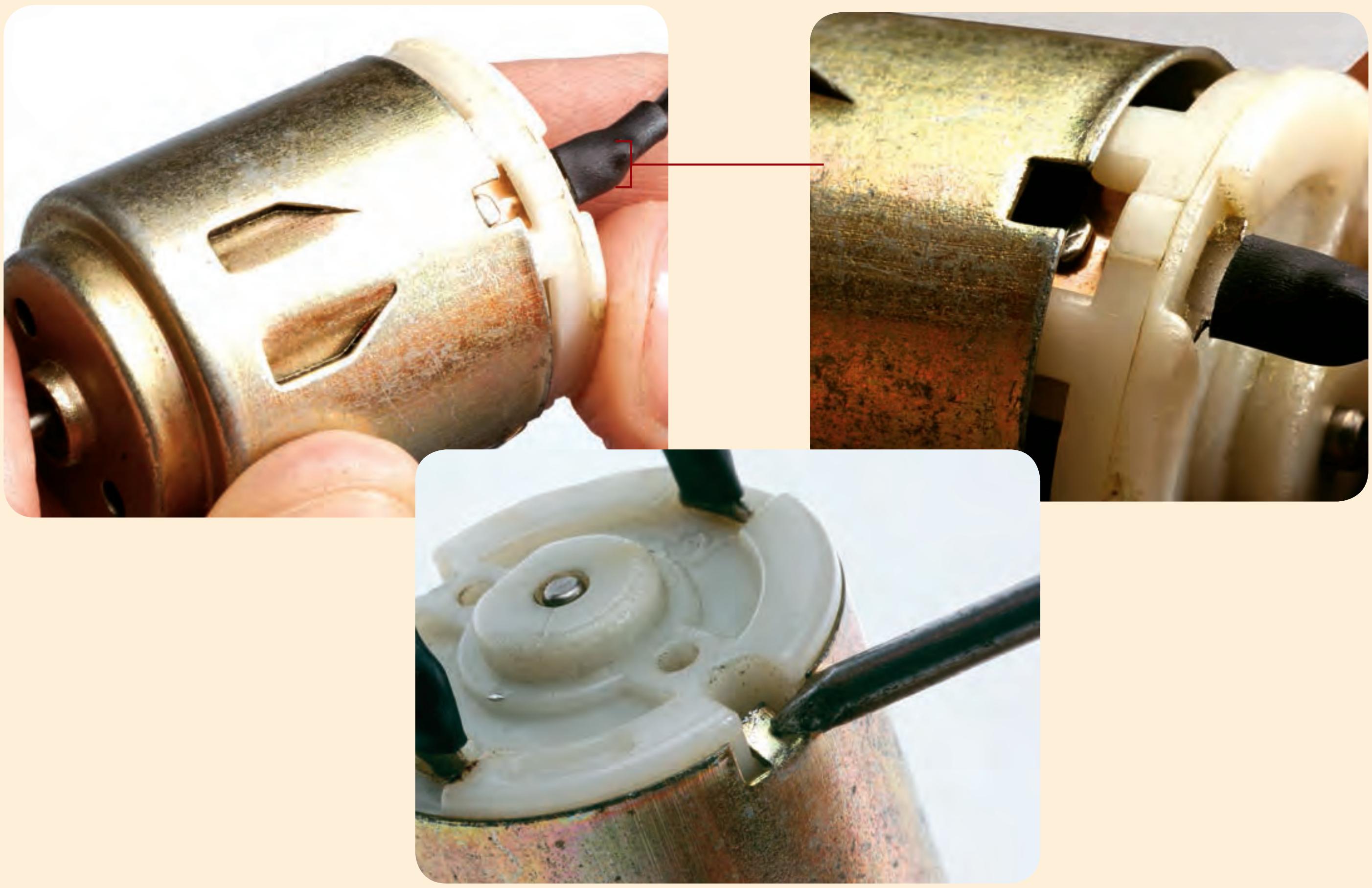
B. Hold the axle with one finger so that the commutator is kept out of the frame.

C. Fit the rotor's cover, taking care to keep the contacts separated from the commutator.

D. On the cover there is a small guiding "dent" that helps you to correctly fit it into the frame. Locate it and twist the cover until it fits the opening on the frame.

E. Check whether the motor will spin easily. If it does not, reopen the motor and repeat the procedures, starting with *Step 3.* Now, try the battery and see if the motor works.

F. If the motor works, close the flaps with the nail.



11 Assemble the circuit used at the beginning of the lesson to check if the motor is working. Connect the motor's wires to the alligator clips. If the motor does not work, give it an initial turn with your fingers. If it still does not work, disconnect the circuit and reopen the motor to repeat the procedures.

Learn More

Transformations of Energy in Motors

Even though energy changes form, it is always conserved. That means energy is never used up. It never disappears. The total amount of energy in a system is always the same, even though it transforms to other types. For example, in a motor, electrical energy is transformed into mechanical and thermal energy. That energy makes a motor "run." In a battery, the chemical energy stored in the materials can be changed to light energy, thermal energy, or mechanical energy. The total amount of energy, however, does not change.

The wires of an electrical circuit are what transmit the electrical energy. Where there is electric current, electrical energy is also there. In an electric motor, electrical energy is transformed into kinetic energy. Kinetic energy is the energy of movement. It is a form of mechanical energy that causes a motor to spin. The word *kinetic* comes from the Greek word *kínesis*, which means movement. In a circuit made up of a battery and a running electric motor, the battery's chemical energy is transformed into electrical energy, which is transmitted by the electric current to the motor. The motor transforms the electrical energy it receives through the wires into mechanical and heat energy.

Antoine Laurent de Lavoisier

"In nature nothing is created and nothing is lost, everything is transformed."

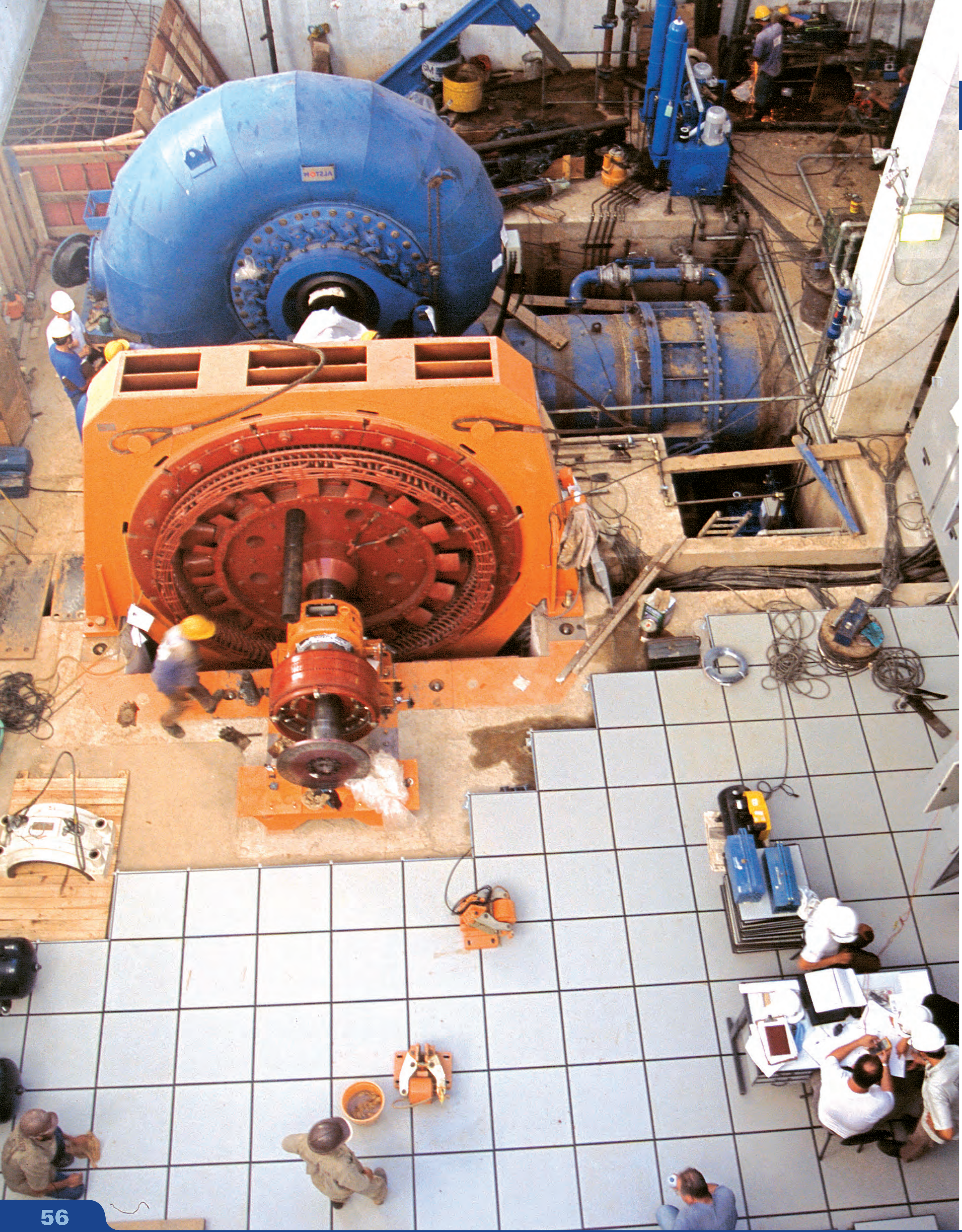
A quote attributed to the French chemist Antoine Laurent de Lavoisier (1743-1794)

Water Is also Conserved

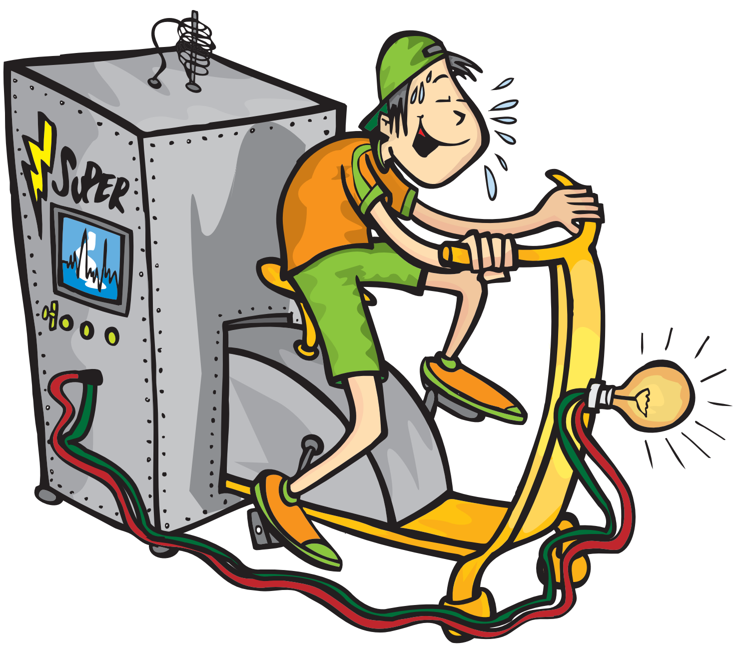
Think about all the water on Earth. Is the volume of water (the amount) increasing or decreasing? Make a prediction before you keep reading. What do you know about the water cycle? Liquid water on the surface of the earth evaporates and becomes water vapor in the air. This water vapor returns to Earth's surface as rain, snow, or ice. Some of the water you drink goes back to the environment in the form of sweat and urine.

In some parts of the world, water can be stored during winter as snow or ice. When summer comes, the snow melts, returning the water to its liquid state. On Earth, liquid water (oceans, lakes, rivers), gaseous water (vapor in air), and solid water (snow or ice) can be transformed from one state to another. Ice can melt to become liquid water, and water can evaporate and become water vapor. But the amount of water is always the same. Scientists say that the total amount of water on Earth is conserved. That means the number of water molecules is the same even though the water may be in different forms.

Water in Different Physical States



What Is an Electric Generator?



Where does an electric generator get its energy?

How are generators and motors similar?

Lab Activity

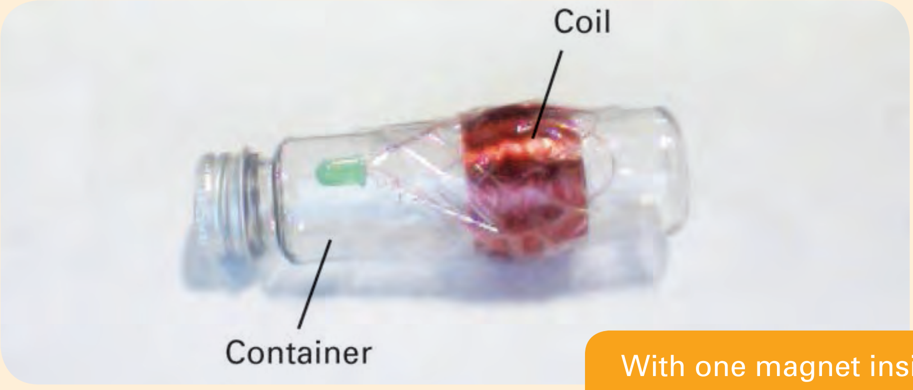
Generating Electricity

1. Obtain the container with the coiled wire and one magnet. Be careful, the magnet is very strong. Examine the components.

2. Look at the small lightbulb. How is it different from the incandescent bulbs you have used before? This is a LED bulb. LED stands for **L**ight **E**mitting **D**iode. Instead of a filament that heats and glows, LEDs produce light when electricity passes through a special type of circuit, called a *diode*. Make sure the LED bulb is connected to the coil. Try to make it emit light.

3. Experiment with the generator. What is the simplest way to light the LED bulb? Try moving a second magnet back and forth near the coil.

4. In your *Science Notebook*, record the energy transformation demonstrated in the circuit. Fill in the type of energy—thermal, mechanical, light, or electrical—in the appropriate blanks.



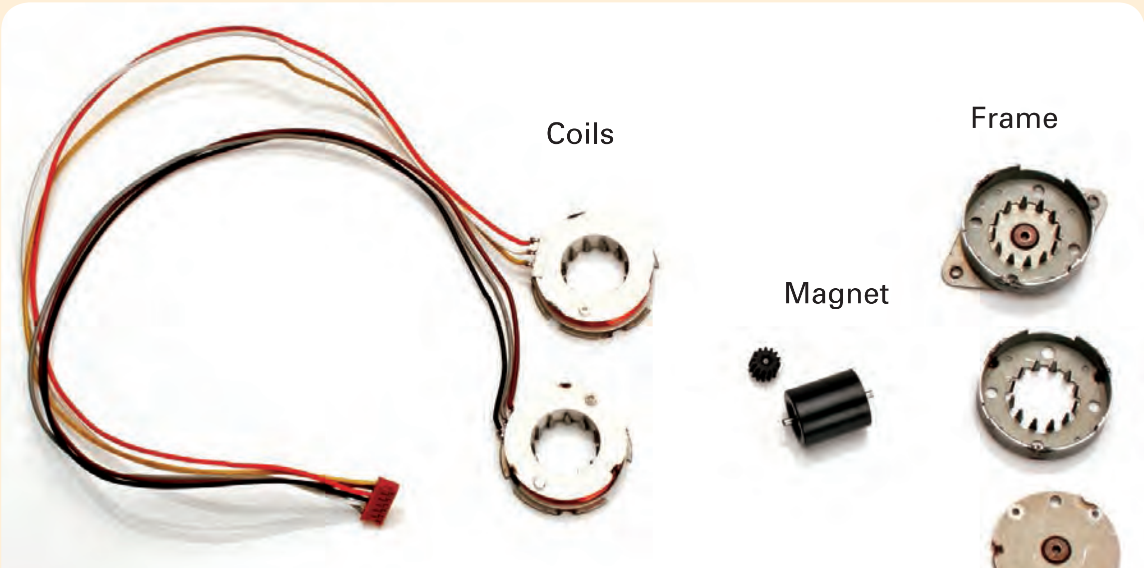
With one magnet inside the container, you'll move another magnet along the length of the magnetic coil.

5 Experiment with lighting the LED bulb. Record your experiments in your *Science Notebook*.

6 Complete the *Energy Transformations* table in your *Science Notebook*.

Transformations of Energy

7 Explain what you have learned about electric motors and generators in your *Science Notebook*.



Step Motor

Ordinary Electric Motor

Learn More

Daylight Saving Time

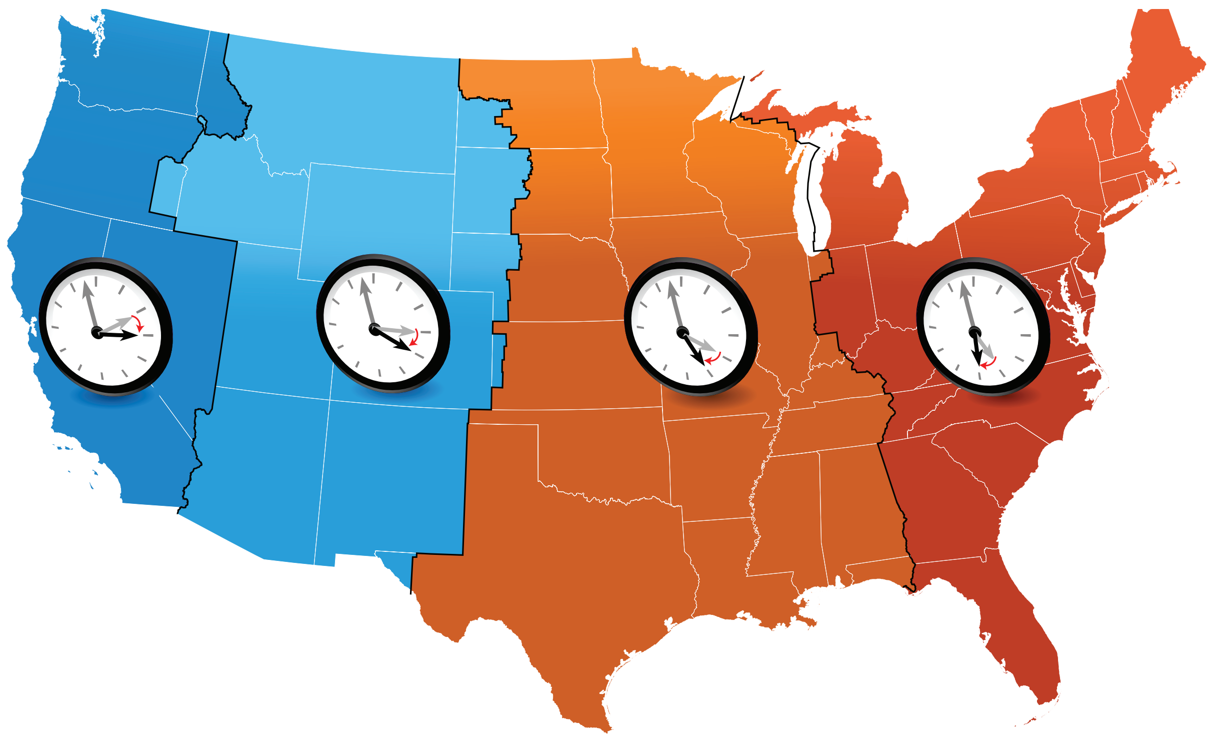
Daylight Saving Time became a law in the United States in 1918. Almost 100 years later, most states continue to observe Daylight Saving Time in order to conserve energy. What does this mean? By changing the time on their clocks, people increase their ability to use natural light from the sun. The longer people can use light from the sun, the less need they have to turn on lights and use electrical energy. The daylight hours in the summer become especially long, with the sun rising before 7:00 AM and setting after 8:00 PM. During summer, with Daylight Saving Time, many people can leave work and get home while the sun is still shining. They can turn on lights later in the evening than they need to in the winter. This means that the electrical energy consumption of the whole country is reduced. When people reduce how much electrical energy they consume, it also reduces the fuel consumption at electrical generating plants.

As the graphic below illustrates, the greater the number of electrical appliances operating in a house, the more difficult it is to turn the generator. This means that when more electrical equipment is operating, more fuel, water, or wind is needed to turn the generators at electric power plants. Since it costs money to make electricity, the less electricity people use, the more money they save. Saving energy is good for the environment, too.

The Origin of Daylight Saving Time

Benjamin Franklin first suggested Daylight Saving Time in the United States in 1784. He realized that during some months, the sun rose before people woke up. Thinking about this, he realized that if people set their clocks forward one hour, they could make better use of sunlight and save on candles in the morning. At the same time, they would have more natural sun light in the evening, when they were still awake and active. At the time of Franklin's ideas, there was no electricity! But light was still a need. Not enough people were interested in putting his idea into practice.

In 1916, during the First World War, Germany adopted Franklin's idea. During the war, the need for electrical energy was greater to keep industry making things like guns and ammunition. By adopting Daylight Saving Time, Germany could save energy used by the arms industry. Today, the United States, most European countries, and much of Latin America also adopt Daylight Saving Time, but at different periods. In North America—the USA, Canada, and Mexico—Daylight Saving Time is April to October. In Europe, it is March to October. Since the seasons in some countries are opposite those in North America, when you set your clocks ahead (spring forward), they set their clocks back!



Each spring, time zones in the United States are moved ahead an hour to make the daylight hours more useful to use and to save energy. In the fall, we set our clocks back an hour.

How Does a Hydroelectric Plant Work?

Where does energy come from in a hydroelectric plant?

What is the benefit of using renewable resources as energy sources?

Lab Activity

Static Charges

Did you ever walk across a carpet and then touch a light switch or doorknob and feel a shock? That is electricity—static electricity. In this activity, you will create static electricity and experiment with static charges.

1. Arrange six strands of mylar film tinsel together and tie them in a knot at one end.

2. About 15-cm from the first knot, tie the strands together again. Just past each knot, cut off the loose ends from both sides.

3. “Charge” the PVC pipe by rubbing it back and forth in your hair for about 10 seconds.

4. Hold the PVC pipe in one hand. With your other hand, grasp the tinsel by its end, and hold it above the charged PVC pipe.

5. Let the tinsel drop and touch the pipe. What happens? Try this several times and record in your *Science Notebook* what takes place with each try.

6. Give each team member the opportunity to experiment with the tinsel, “recharging” the PVC pipe by rubbing it in the hair before each attempt.

7 Discuss the answers to the following questions:

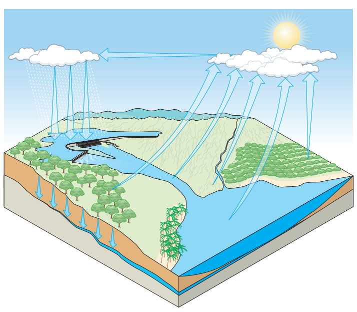
- What kind of charge did you give to the pipe when you rubbed it into your hair?
- Why did the tinsel react the way it did when it touched the pipe?
- What happened to the tinsel's charge when it touched the pipe?
- What effect did this have?
- Did you notice the tinsel cling to you at any time? What causes the tinsel to be attracted or repelled by you?

Learn More

Production and Preservation of Energy

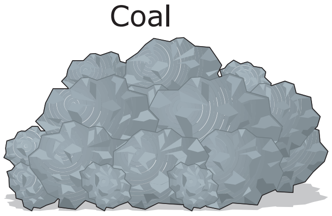
An important characteristic of energy is that it is conserved. Energy cannot be created or destroyed. It can be transformed from one type of energy to another. When you turn on a lamp, or a microwave oven, the electrical energy that comes to where you live changes from one type of energy to other types of energy. Most of the appliances you use at home need electrical energy to operate. Where does this energy come from? To get useful electrical energy, other types of energy that exist in nature—like wind, water, or sun must be transformed to electric power.

Water



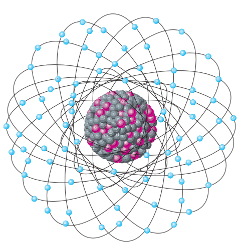
Hydroelectric Plant

Coal



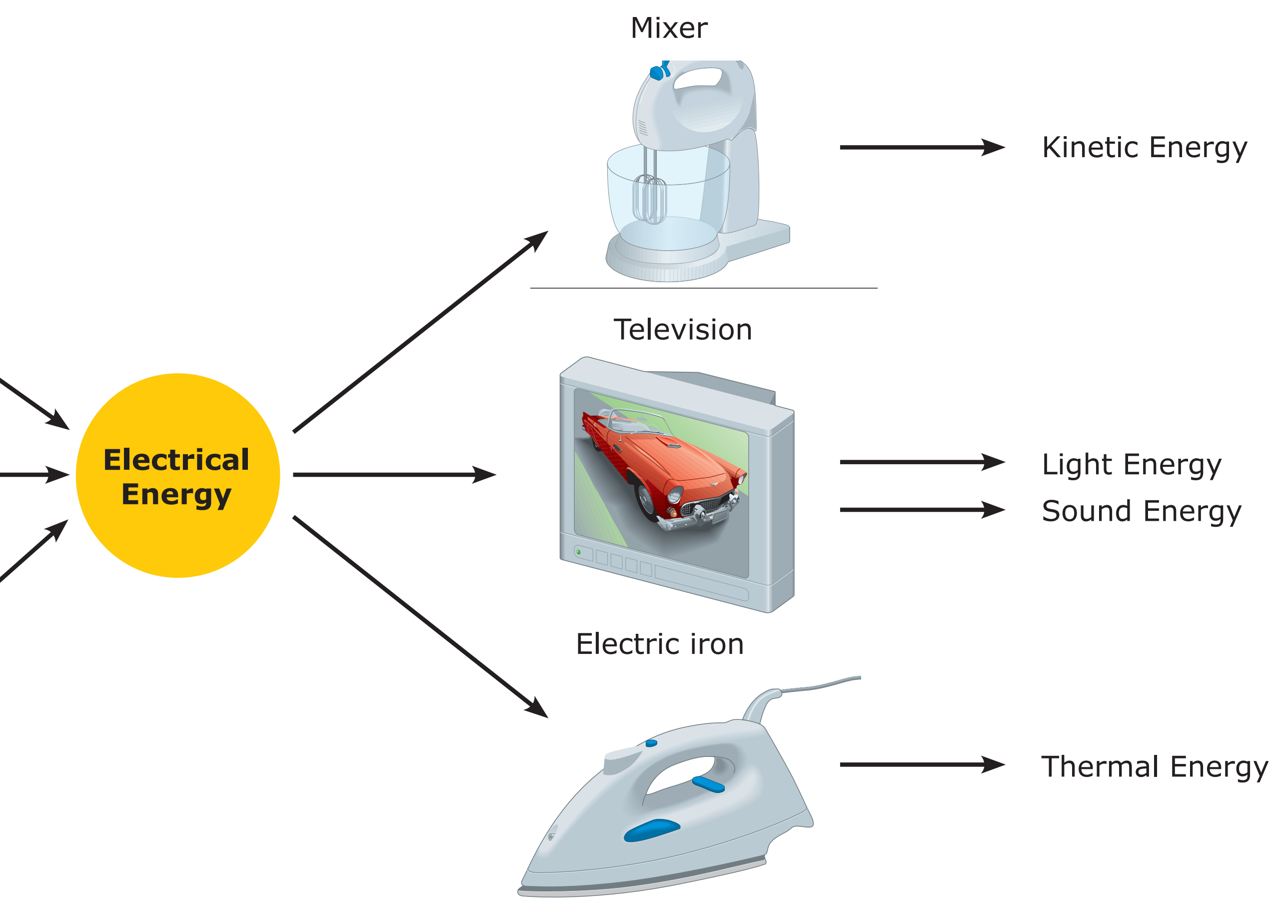
Thermoelectric Plant

Uranium



Thermonuclear Plant

Wind Turbines



Glossary

activate – to set in operation or motion

atmospheric – relating to phenomena—such as lightning—that occur in the air

attract – pull closer

battery – an object that stores and provides an electric current

charge – a positive or negative electrical state, usually producing a force

circuit – a path, such as a wire, through which an electric current may flow

circuit breaker – a switch that automatically interrupts the flow of an electric current under certain conditions

closed circuit – a pathway over which an electric current can flow continuously

coil – a number of turns of insulated wire, used to form an electromagnet

combustion – a chemical reaction with the rapid combination of oxygen to produce heat and light

commutator – a switching device in electric motors and generators that causes a current to reverse direction

component – one of the parts that make up a whole

conductor – a material, object, or substance that carries an electric current

consumption – the act or process of using

contact – a connection between two conductors that allows an electric current to flow

defect – something that is wrong or does not work

device – a mechanism or invention designed or used for a particular purpose

dynamic – moving; a flow of electric charge

efficient – acting or producing effectively with minimum waste or effort

electrode – a conductor through which an electric current enters or leaves a circuit

electromagnet – a magnet made from a coil of insulated wire wrapped around an iron core that becomes magnetized only when an electric current flows through the wire

electron – a part of an atom that has a negative charge

electroscope – a device used to detect electric charges

emit – to release or send out

energy – the ability to do work

filament – a fine wire that is heated by the flow of current until it gives off light

flashlight – portable device to provide light

fluorescent – a type of cool light produced by a substance when exposed to ultra-violet light

fuse – a safety device that protects an electric circuit; usually containing a wire that melts and opens the circuit when the current reaches an unsafe level

generator – a device that converts mechanical energy into electrical energy

hydroelectric – generating electricity through the use of water power

illumination – an amount of light; brightness

insulator – a material, object, or substance that does not carry an electric current or that prevents the passage of electricity

journals – notebooks containing detailed records of experiments

kinetic energy – the energy of motion

model – a small representation of something

open circuit – a broken pathway through which the flow of an electric current is stopped

parallel circuit – a circuit that has more than one path for the current to travel

photosensitive – act of changing when exposed to light

potential energy – stored energy

renewable resource – any natural substance or energy source that can be replaced naturally over time

repel – push away

resistor – a material that slows the flow of an electric current

rotor – the turning part of an electrical or mechanical device

sensor – a device that detects a change in its surroundings

series circuit – a circuit that has only one path for the current to travel

short circuit – a low-resistance path that allows most of the current in an electric circuit to flow from one pole to the other directly

static – not in motion; an electric charge that accumulates on an insulated body

switch – a device used to open or close an electric circuit

technique – method or way to accomplish a task

terminal – a point at which a wire can be connected to an electric device

thermal – related to, using, producing, or caused by heat

watt – a measurement related to energy and electricity that is used to describe light bulbs

Does it light?

NAME: ______________________ DATE: ____ / ____ / ____

1


____

2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3


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4


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5


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6


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7


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8


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9


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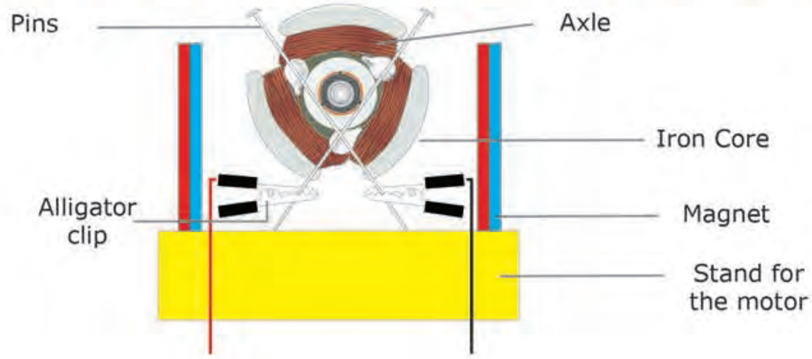
CTC!

Electric Motor

ELECTRICITY

NAME: ____________________ DATE: ____ / ____ / ____

The picture shows the elements of the motor you are observing:



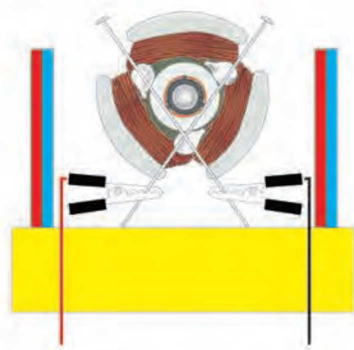
1 While the rotor is spinning, remove the magnets by carefully displacing them from the rotor.

- Is the rotor still spinning?

Replace the magnets in their original position and watch the rotor. Then disconnect the switch.

2 Record what you observe while the motor is running and complete the picture according to the following indications:

- Put a sign (+) close to the alligator clip connected to the battery's positive pole and a sign (-) close to the battery's negative pole.
- Turn on the motor by activating the switch. Draw an arrow to show in which direction the motor is spinning.

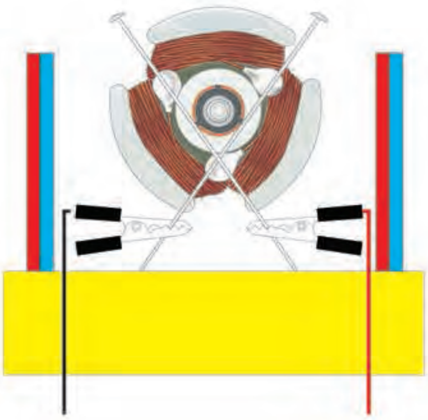


3 You will now analyze different situations with the motor running. In each situation notice the rotor's spinning and mark its direction by directional arrows. Record which poles are connected to the alligator clips using the (+) and (-) signs. At the end of each observation go back to the initial assembly.

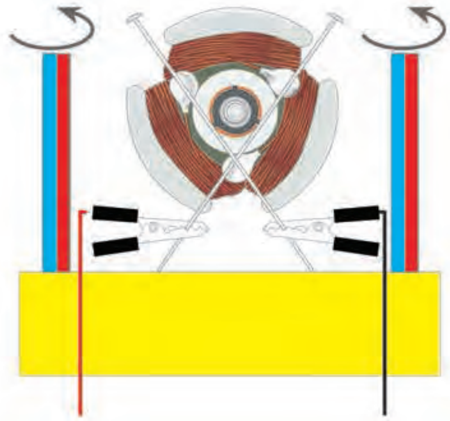
CTC!

Electric Motor

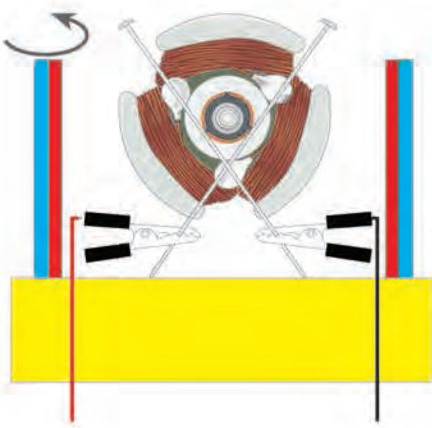
A. Invert the connection of the alligator clip in the pins.



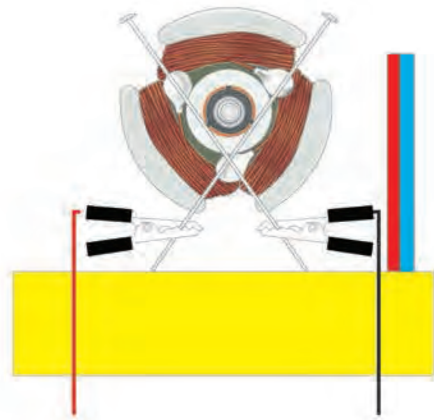
B. Invert each magnet, keeping them in the same hole.



c. Invert only one of the magnets.



d. Remove one of the magnets.



4 Remove the other magnet and start the switch. Bring one clip close to one of the iron cores of the rotor.

- What happens?

5 Turn off the switch. Again, bring one clip close to one of the iron cores of the rotor.

- Does the effect observed in item 4 continue?

Electricity

sangari **active science**