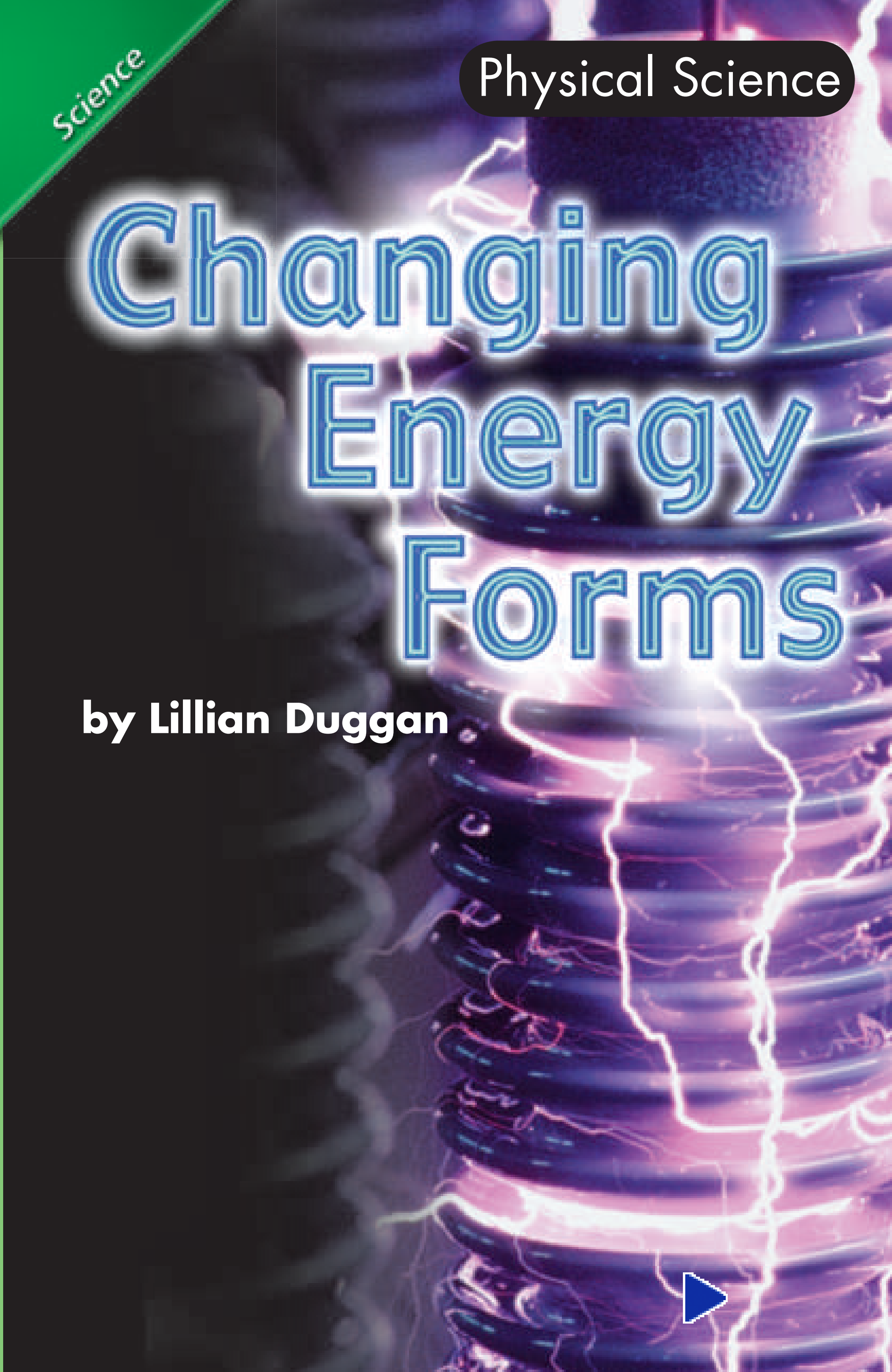
Science

Science

Physical Science

Changing Energy Forms

by Lillian Duggan



Genre	Comprehension Skill	Text Features	Science Content
Nonfiction	Sequence	• Captions • Charts • Diagrams • Glossary	Forms of Energy

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Vocabulary

electric circuit

electric current

electric motor

energy

generator

kinetic energy

magnetic domain

potential energy

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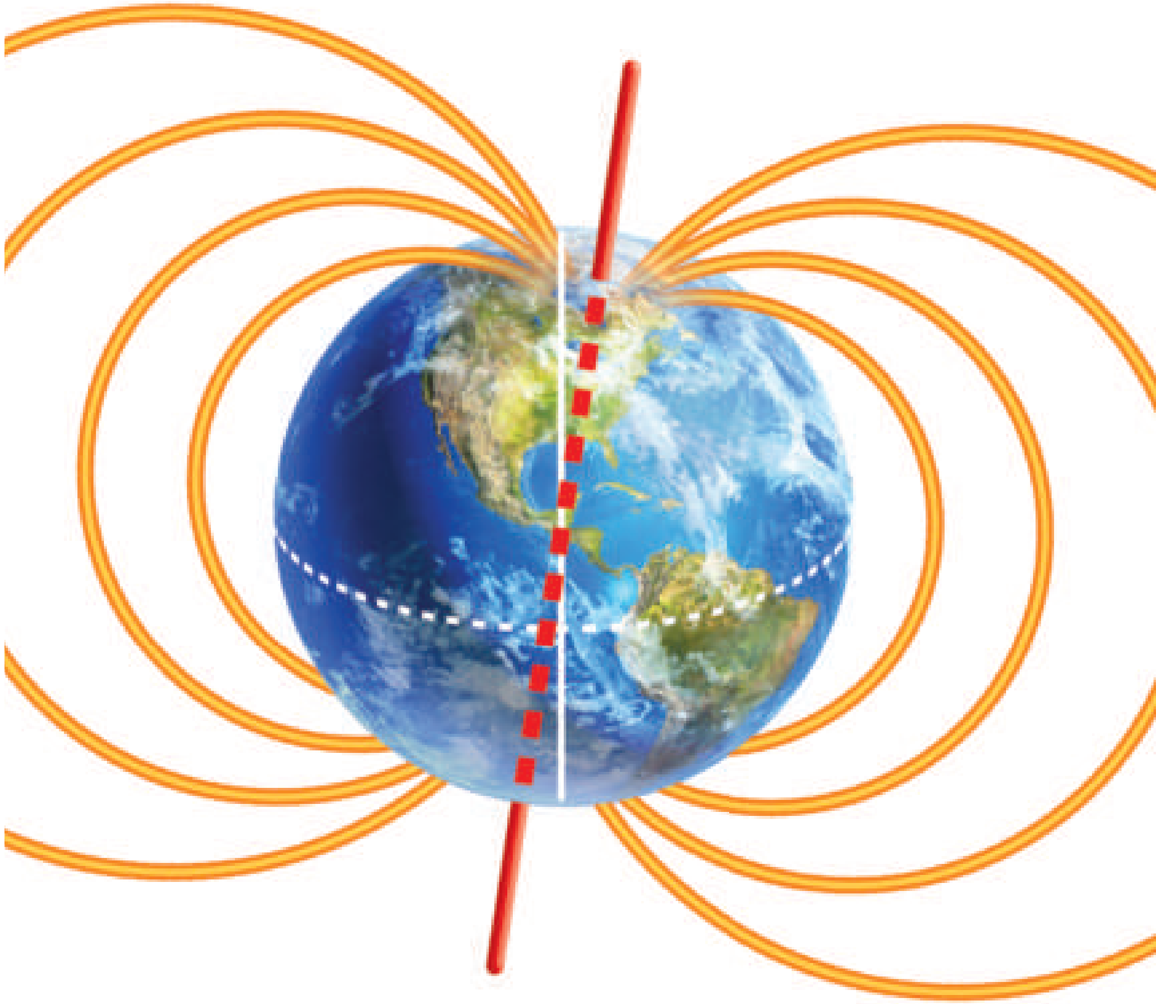

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Scott Foresman

How can energy change?

Forms of Energy

Every change, from cutting an apple to flipping a switch, involves energy. This is because energy is needed to do work. For this reason, energy and work are both measured in the same unit, the joule.

When you do work on an object, you transfer energy from yourself to the object. **Energy** is the ability to cause change or to do work. It is a property of all matter.

If an object is moving or in a position to move, it has mechanical energy. **Kinetic energy** is the mechanical energy of a moving object. All moving objects have kinetic energy. **Potential energy** is mechanical energy due to position. A book on your desk has potential energy. If any object is above the ground, it has potential energy.

Some animals use electrical energy as a defense mechanism. This electric catfish shocks its predators to keep them away.

There are many forms of energy. Chemical energy is stored in the bonds that hold atoms together. Food has chemical energy that is transferred to your body when you eat it. Gasoline has chemical energy that cars use. Nuclear energy is stored inside the nucleus of an atom. At nuclear power plants, reactions take place that cause atoms to break apart, releasing this energy.

Thermal energy is energy in the form of heat. Thermal energy moves from one object to another. Electrical energy powers televisions and lights. It comes from the movement of electrons.

The light beam from this high-powered laser changes to thermal energy. It cuts through metal by melting it.

Energy Changes

Energy changes happen around you and inside you all the time. Drinking a glass of orange juice involves many energy changes, starting with the Sun. The Sun's nuclear energy changes to radiant energy, which travels to Earth. On Earth the leaves of an orange tree take in this energy. They change it into chemical energy. The chemical energy is stored in the plant's cells.

When you drink a glass of orange juice, you take in this stored chemical energy. Some chemical energy is changed to thermal energy to keep you warm. Some chemical energy is changed to kinetic energy when you move.

Geothermal energy is released by geysers.

Every energy form can be used to do work. When wind or moving water knock down trees or move rocks, they use kinetic energy as a force to do work. Hot underground springs have geothermal energy. They can release a lot of stored energy through geysers.

All forms of energy can be changed into thermal energy. When you rub your hands together, they get warm. The mechanical energy you use to rub your hands together changes to thermal energy. This energy change is caused by friction.

Thermal energy is also released when an object burns. When wood burns, some of the chemical energy stored in the wood changes to thermal energy.

Each of these objects has stored energy. Can you tell which type of energy each object has?

Conservation of Mass and Energy

When energy changes from one form to another, the amount of total energy does not change. Only the form of the energy changes. Think about what happens when you let a rubber ball drop onto a hard floor. The ball bounces lower and lower until it stops. With each bounce, some kinetic energy is changed into heat and sound energy. The kinetic energy lost by the ball is transferred to the air and the floor.

These light wands and the firefly convert chemical energy into light energy.

Scientists used to call the idea that energy is never lost the *law of conservation of energy.* They had a similar law about matter, called the law of conservation of mass. This law was discovered in 1784 by Antoine Lavoisier. It stated that matter cannot be created or destroyed.

Recently, scientists discovered that under rare conditions, energy and matter can be changed into one another. One example of this is nuclear energy, which is a result of matter changing into energy. Due to this discovery, scientists now use the name *law of conservation of mass and energy.* It states that the total amount of matter and energy does not change.

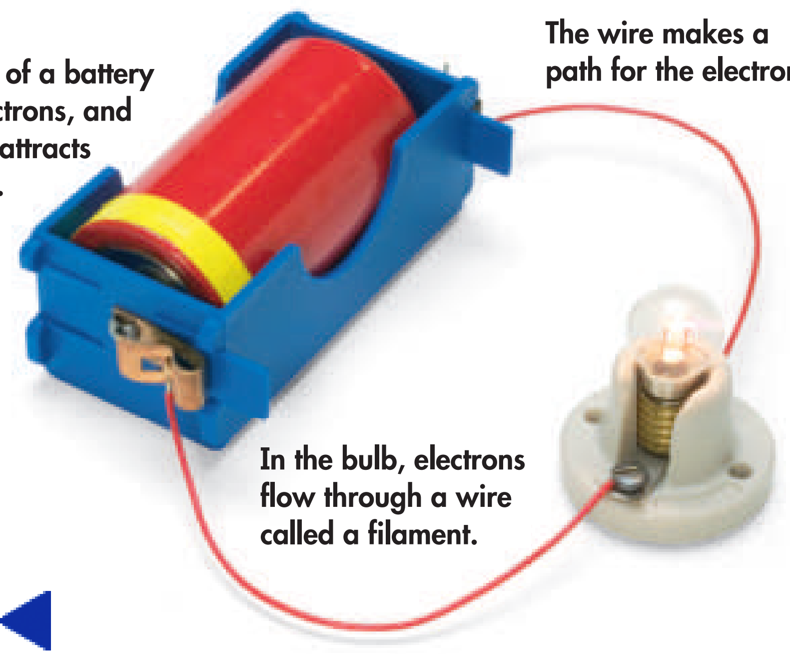
How are electricity and magnetism related?

Electric Current

Atoms have a nucleus of protons and neutrons surrounded by a cloud of electrons. The number of protons inside the nucleus is the same as the number of electrons surrounding it. Protons have a positive charge and electrons have a negative charge. The positive and negative charges cancel each other out. Because of this, atoms do not usually have a charge.

The electrons in some materials can move from atom to atom. This flow of electrons causes an electric charge to move along the atoms. Because the electrons all have negative charges, they push away from each other. The pushing keeps the electrons flowing and creates an electric current. An **electric current** is a flow of electric charge in a material.

A material in which electrons flow easily is a good electrical conductor. Copper is a good conductor. That is why copper is used to make electrical wires. In some materials, electrons do not flow easily. These are called insulators. Rubber is a good insulator.



Electric Circuit

An electric current can only flow in a path that leads back to its starting point. An **electric circuit** is a closed path along which current can flow.

A simple electric circuit is made up of several parts. First, it has a source of electrical energy, such as a battery. Second, it has a wire through which the current flows. Third, a circuit has a device that uses the electrical energy that flows through the wire. The device changes the electrical energy into another form of energy. A light bulb changes it to light energy. Many electric circuits have a switch. When the switch is open, the path of the circuit is broken. Current cannot flow because the circuit is no longer complete.

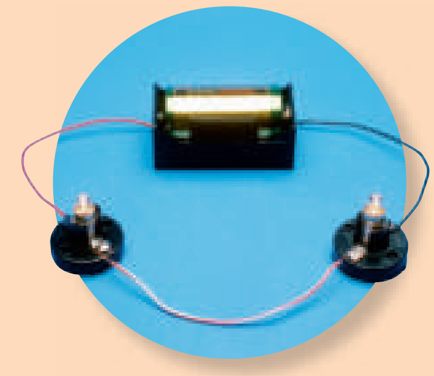
The energy source in the circuit pushes electrons along. Some energy sources provide a stronger push than others. The strength of the push is measured in volts.

Series and Parallel Circuits

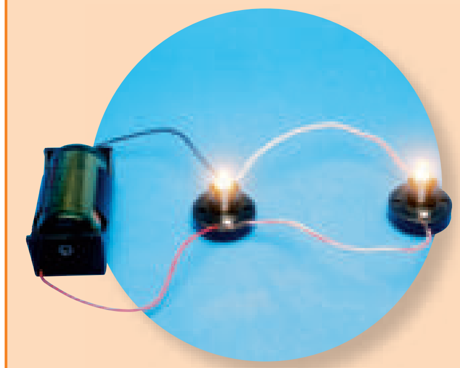
Circuits can be set up in series and parallel circuits. In a series circuit, there is only one path for the flow of electrons. The current flows through each light bulb. If you remove one of the light bulbs, the current will no longer flow.

In a parallel circuit, the current can flow along more than one path. If one bulb is removed, the current can still flow. The other bulb will continue to glow.

Series circuit



Parallel circuit

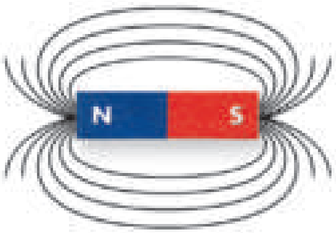


Magnetic Fields

If you have ever played with magnets, you may have noticed that every magnet has a north pole and a south pole. If you put the opposite poles of two magnets together, they will attract, or pull toward each other. But similar poles of magnets will repel, or push away from each other when you try to bring them together. Magnets behave in this way because of their magnetic fields. A magnetic field is the area around a magnet in which it can exert force on another magnet. This field is strongest at the poles.

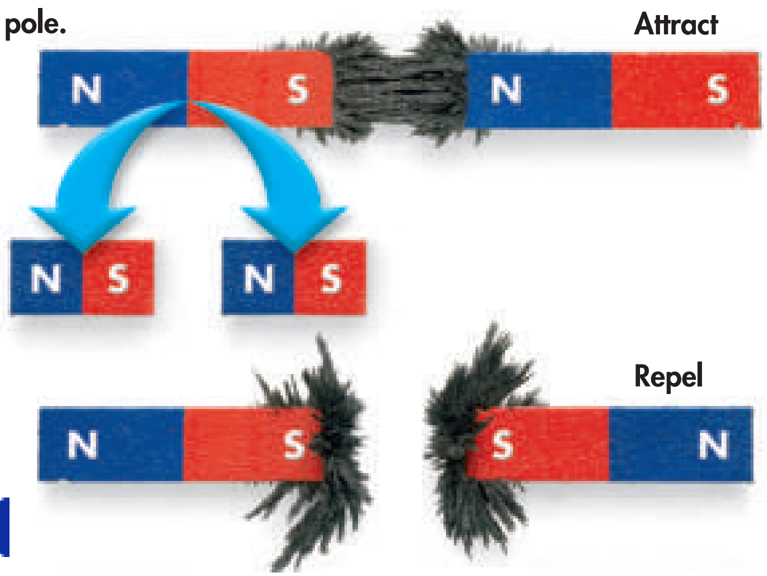
The electrons moving around the nucleus of an atom cause it to be slightly magnetic. But not every material can be magnetic. In most materials the magnetic fields of the atoms face in all different directions and cancel each other out. In some materials, however, the magnetism of the atoms is stronger.

In materials such as iron, cobalt, and nickel, the atoms line up in groups called domains. A **magnetic domain** is a large number of atoms with their magnetic fields pointing in the same direction.



Magnetic field

If you break a magnet, each piece will have a north and a south pole.



Magnetic domains are like small magnets. They each have a north pole and a south pole. If the domains in a material are pointing in different directions, it is not a magnet. Some materials can be made into magnets when placed inside a magnetic field. Their domains will line up with the field. Then the materials will be magnets.

What happens when you break a magnet in half? Do you get a north-pole magnet and a south-pole magnet? No, because the magnetic domains are still pointing in the same direction as the original magnet. So, you get two smaller magnets that each have their own north and south poles.

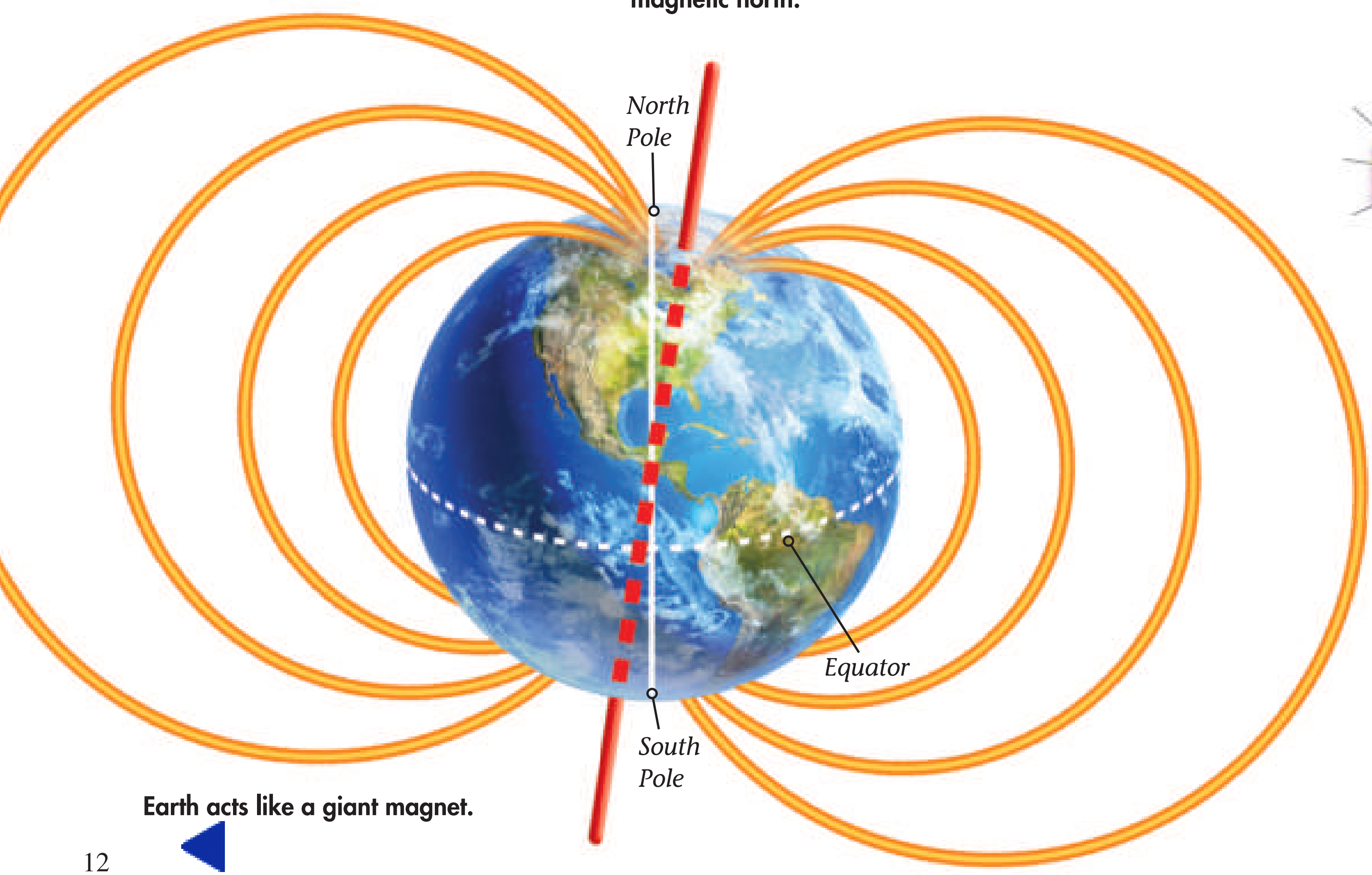

This iron in this frying pan is not magnetized. The magnetic domains of its atoms point in different directions.


Most magnetic domains in a magnet point in the same direction.

Earth as a Magnet

Earth is similar to a giant bar magnet. It is surrounded by a magnetic field. The poles of this imaginary magnet are close to Earth's geographic poles—the North Pole and the South Pole. The lines of magnetic force start inside Earth, push out from one pole, and circle around to the other pole. Scientists think Earth's magnetic field is caused by its spinning and the movement of hot liquid metal deep inside Earth.

A compass needle lines up with Earth's magnetic field. It points to Earth's magnetic north.



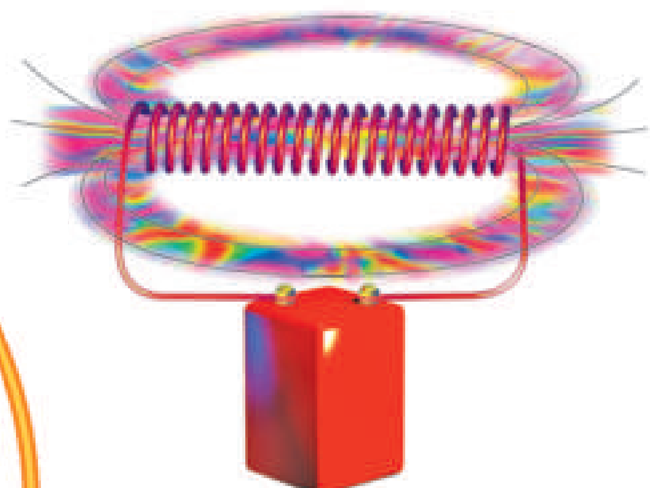
Earth acts like a giant magnet.

Electromagnets

In 1820, Hans Christian Oersted, a physicist and a teacher, found that electric currents produce magnetic fields. The relationship between electric currents and magnetism is called electromagnetism.

When a wire is carrying a current, a magnetic field circles the wire. Shaping the wire into a coil makes the magnetic field similar to the field around a bar magnet. If you add more coils to the wire or put iron into the coil, you make the magnetic field stronger. Iron in the coil is magnetized as current flows through the wire. This adds to the magnetic field.

Electromagnets are useful because they can be turned on and off. When an electromagnet on a crane is turned on, it attracts magnetic objects. When it's turned off, it releases the objects.



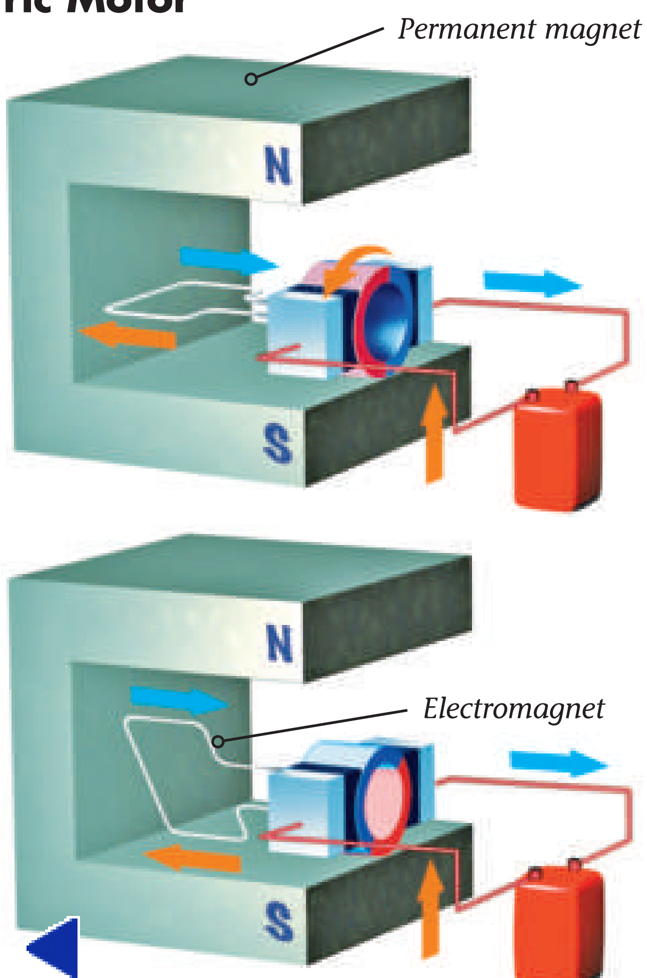
When electricity flows through this wire, a magnetic field forms around it.

Electric Motor

An **electric motor** is a device that changes electrical energy to kinetic energy. It has three parts: a permanent magnet, an electromagnet, and a device that changes the direction of the electric current flowing through the electromagnet.

When current passes through the electromagnet, each pole is attracted to the opposite pole of the permanent magnet. This causes the electromagnet to turn. As the opposite poles line up, the current reverses direction. This causes the electromagnet's poles to switch, so that two like poles are now near each other. These poles push each other away, causing the electromagnet to keep turning. The current on the electromagnet constantly changes direction, which keeps the electromagnet spinning.

Electric Motor

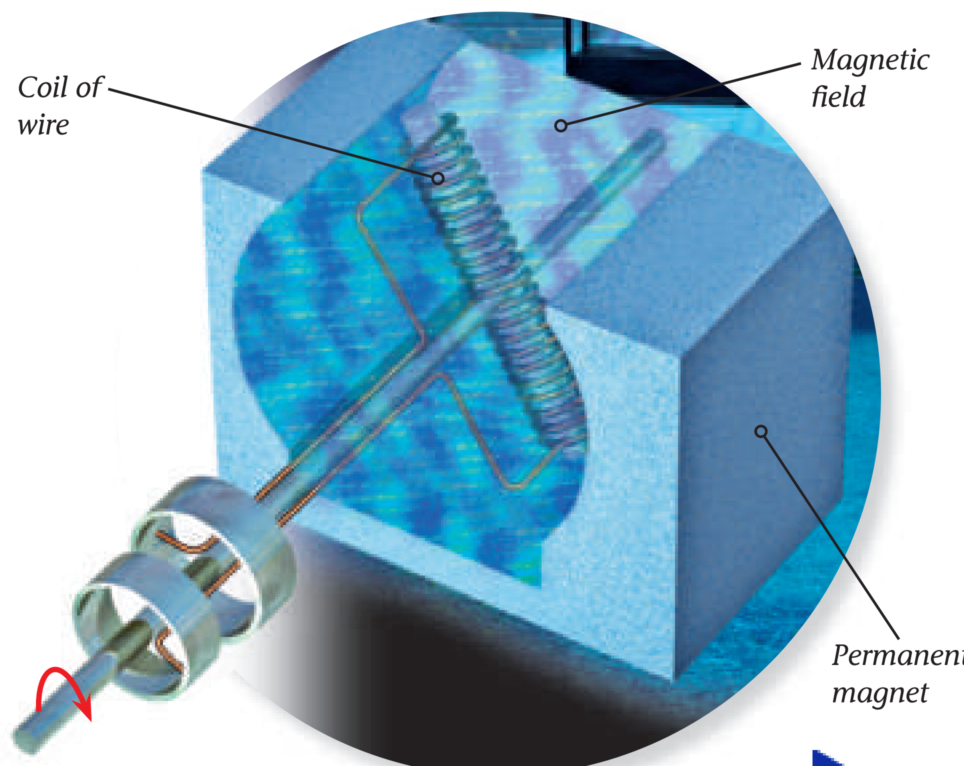


Changing Magnetism into Electricity

Oersted proved that moving electric charges could produce a magnetic field. In 1831, an English scientist named Michael Faraday proved that a magnetic field could produce an electric current. This process is called electromagnetic induction. You can make a changing magnetic field by moving a bar magnet through a wire coil. This causes a current to flow in the wire. The current that is produced gets stronger when you move the magnet faster. Most of the electrical energy we use in our homes, schools, and other buildings is produced by electromagnetic induction.

Generators

A **generator** is a device that changes mechanical energy into electrical energy. A generator has two main parts: a permanent magnet and a wire coil. A source of mechanical energy causes the coil to spin within the field of the magnet. The spinning produces an electric current that changes direction again and again. This type of current is called an alternating current.



Glossary

electric circuit	a closed path along which current can flow
electric current	a flow of electric charge in a material
electric motor	a device that changes electrical energy to kinetic energy
energy	the ability to cause change or to do work
generator	a device that changes mechanical energy into electrical energy
kinetic energy	the energy of a moving object
magnetic domain	a large number of atoms with their magnetic fields pointing in the same direction
potential energy	mechanical energy due to an object's position

What did you learn?

1. What causes an electric charge to move along atoms?
2. What is the difference between a series circuit and a parallel circuit?
3. How can you make an electromagnet stronger?
4. **Writing in Science** The law of conservation of energy states that whenever energy changes from one form to another, the total amount of energy does not change. Explain how this law is related to a bouncing ball. Include details from the book to support your answer.
5. **Sequence** Describe in order the energy changes that are involved in drinking a glass of orange juice, starting with the Sun.