



*Yesterday, these trees were green and growing. Today, leaves and branches are being changed by fire. How are these changes in the trees different from just chopping the trees down?*

### Learning Objectives

- Identify energy and matter.
- Explain the difference between potential energy and kinetic energy.
- Identify the different forms of energy.
- Describe how heat energy changes matter.
- Compare and contrast physical and chemical changes.
- LAB ACTIVITY: Explore how energy can be transformed from one form to another.
- SCIENCE IN YOUR LIFE: Relate cooking to the ways that energy changes substances.

## Words to Know

<b>potential energy</b>	energy that is stored in matter
<b>kinetic energy</b>	energy that comes from movement
<b>light energy</b>	energy in the form of moving waves of light
<b>heat energy</b>	energy in the form of moving molecules
<b>electrical energy</b>	energy in the form of electrons moving through a substance
<b>chemical energy</b>	energy stored in molecules
<b>mechanical energy</b>	energy in the form of parts moving in a machine
<b>nuclear energy</b>	energy stored in the nucleus of an atom
<b>nuclear fission</b>	the breakup of the nucleus of an atom
<b>nuclear fusion</b>	the joining together of two or more atomic nuclei

## Words to Know

**potential energy** energy that is stored in matter

**kinetic energy** energy that comes from movement

## What Is Energy?

The whole world is made up of matter. It takes energy to power all that matter. Energy is the ability to do work or produce heat. In science, to do work means to make something move. Energy makes things move. Without energy, rivers would not flow. The Earth would not go around the sun. You would not move a muscle. Nothing would move at all.

Energy has no mass. Yet it is as real as matter. There is energy in all things, whether they are moving or they are standing still.

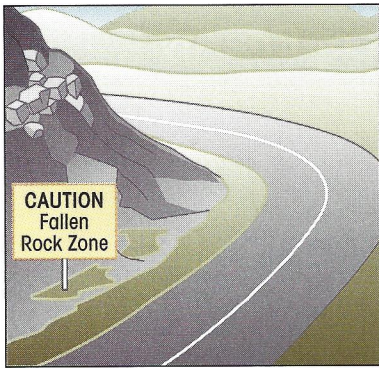
The universe has all the energy it will ever have. Energy cannot be created or destroyed. However, it can change form.

✓ **What does it mean to do work?**

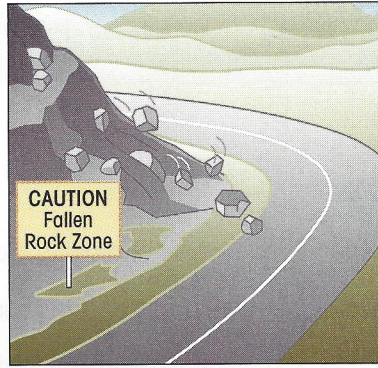
## Potential and Kinetic Energy

There are two main kinds of energy. One kind can be stored in matter. This is called **potential energy**. Energy can also be released from matter, which sometimes sets matter in motion. The kind of energy that comes from such movement is called **kinetic energy**.

A stick of wood stores energy. When the wood burns, it releases energy. The energy it releases is in the form of heat and light.



**Figure 15-1** *The rocks on the ledge have potential energy.*



**Figure 15-2** *The falling rocks have kinetic energy.*

Water held back by a dam has potential energy. A running river has kinetic energy. A rock perched on the edge of a cliff has potential energy. If the rock begins to fall, the potential energy changes into kinetic energy. During the change from one kind of energy to another, some of the energy is given off as heat.

Where do you get your energy? The energy your body needs comes from the food you eat. It is stored in your cells. As you move around, walk to school, think about a math problem, or play sports, digested food provides you with power in the form of kinetic energy.

✓ **When does an object have kinetic energy?**

## Lesson Review

1. What is needed to make something move?
2. What are the two main kinds of energy?
3. Where does the human body get the energy it needs to function?
4. **CRITICAL THINKING** You stop your bicycle at the top of a hill. What change in energy happened?

## Words to Know

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## Light Energy

Potential and kinetic energy can exist in many different forms. Energy in the form of moving waves of light is called **light energy**. The main source of light energy on Earth is the sun. This is also what we know as solar energy. Many people use solar energy to heat their homes.

✓ **What is the main source of light energy on Earth?**

## Heat Energy

Energy in the form of moving molecules is called **heat energy**. Hot objects contain more heat energy than cold objects. The molecules in a hot object move faster. By rubbing your hands together, you can increase the amount of heat energy in your palms. Notice how they become warmer.

✓ **Which object has more heat energy, a hot cup or a cold cup? Why?**

## Electrical Energy

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Energy in the form of electrons moving through a substance is called **electrical energy**. Remember that electrons have a negative electrical charge. The electrical energy is carried along by a flow of electrons. Lightning is a form of electrical energy.

✓ What part of the atom produces electrical energy?

## Chemical Energy

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Energy stored in molecules is called **chemical energy**. When molecules react with each other, the energy stored in them may be released. Cars use chemical energy stored in gasoline. Humans use chemical energy stored in food.

✓ What form of energy is stored in food?

## Mechanical Energy

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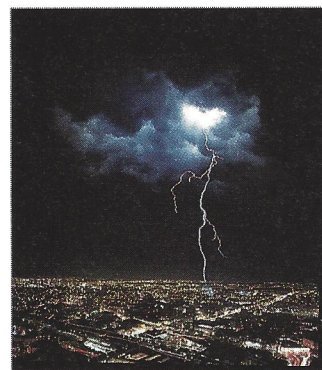
The energy in the form of parts moving in a machine is called **mechanical energy**. A windmill changes the mechanical energy of the spinning blades into electrical energy. A power plant turns the mechanical energy of a spinning turbine into the electrical energy that you use every day.

✓ What form of energy do the moving parts of a machine have?

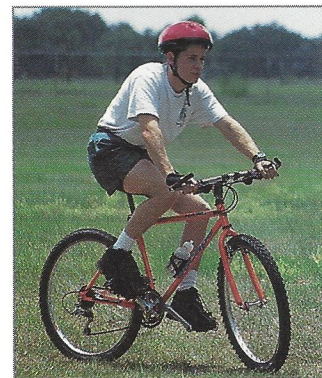
## Nuclear Energy

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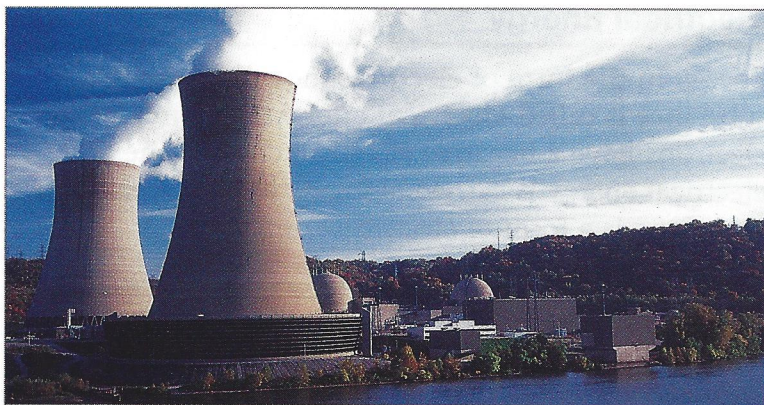
The energy stored in the nucleus of an atom is called **nuclear energy**. This energy is released when the nucleus is broken apart. The breakup of the nucleus is called **nuclear fission**. Nuclear fission of a large number of atoms results in a huge release of energy. Nuclear power plants use nuclear fission to make electricity.



*Lightning is a form of electrical energy.*



*Bicycles also use mechanical energy.*



*Nuclear power plants produce electricity from nuclear fission.*

Huge amounts of energy are also released when two or more nuclei join together, or fuse. This process is called **nuclear fusion**.

✓ What is it called when a nucleus breaks up and releases energy?

## Energy in Different Forms

You have learned that energy can neither be created nor destroyed. However, it can change form. Solar panels on a house can change light energy into heat energy. The chemical energy in a battery can get turned into electrical energy. A water wheel can turn the kinetic energy of a river into mechanical energy. This ability of energy to change forms is a property of energy.

✓ What is a special property of energy?

## Lesson Review

1. What are the names of six different forms of energy?
2. What type of energy does chemical energy become when you turn on a battery-operated radio?
3. **CRITICAL THINKING** Which form of energy is most important to your life? Explain your answer.

## Matter and Heat Energy

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All changes in matter need some kind of energy. Heat energy can change matter. It causes the molecules in a substance to move faster and farther apart. When enough heat is added, many solids will change to liquids. This is the process of melting. Ice is the solid form of water. When you add enough heat to ice, it melts.

When you add more heat to a liquid, the molecules move even faster. They also move farther apart. With enough heat, molecules will begin to break away from the substance. The substance then changes into a gas. This is the process of evaporation.

Heat energy can be taken away from matter. When enough heat is taken away from a gas, the gas turns into a liquid. This is the process of condensation. If you take enough heat away from a liquid, it becomes a solid. This is the process of freezing.

You have probably noticed a light mist of water on the grass in the morning. This is called *dew*. Dew is caused by condensation. At night, the air cools. This cooling causes water vapor in the air to change into liquid water. As the sun warms the ground, the dew will evaporate.

### Remember

The process of a liquid changing to a gas is called evaporation. Condensation is the process of a gas changing to a liquid.

✓ What causes matter to change its state?

## Two Ways to Change Matter

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### Physical Change

A physical change affects only the state, shape, or volume of matter. If you drop a plate and break it, for example, the shape has changed. However, it is still a plate. No chemical change has occurred.



Crushing, tearing, and grinding are all examples of physical changes. Freezing, melting, boiling, and condensation are also physical changes. Ice has the same chemical makeup as water. It just has less heat energy in it.

### Chemical Change

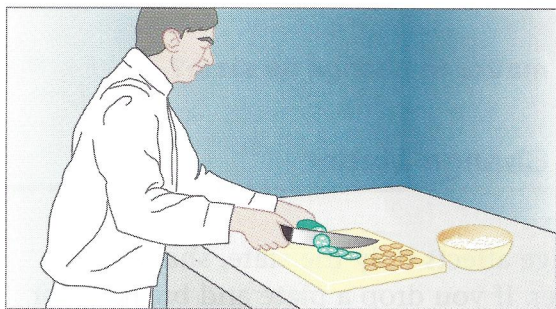
In a chemical change, a substance that has new properties is produced. Compounds are always the result of a chemical change. For example, a kind of acid is formed when milk sours. A change in odor tells you a chemical change has taken place.

Another example of a chemical change is burning wood. The wood and oxygen from the air combine to turn the wood into ashes. Several new gases are also released into the air.

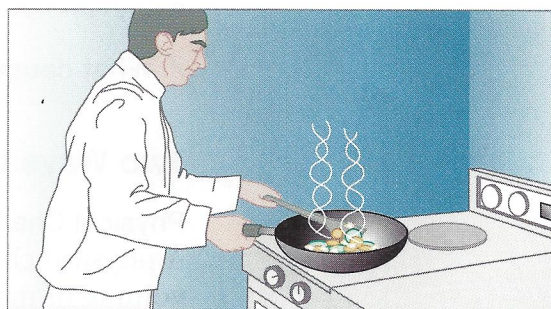
Sometimes you know that a chemical change has taken place by the way something looks. When iron rusts, you can tell a new substance has formed by looking at it. But not all chemical changes are easily seen.

One sign that a chemical change has happened is that energy is released, as when a match burns. Or energy might be absorbed, as when a cake bakes. Another sign is the release of a gas, such as the exhaust fumes from a car.

✓ **What are the two main kinds of changes matter can undergo?**



**Figure 15-3** *Chopping vegetables causes a physical change.*



**Figure 15-4** *Cooking vegetables causes a chemical change.*

## Lesson Review

1. What happens to a liquid if you take away enough heat energy?
2. An apple rots. What two things show you that a chemical change happened?
3. Is frying an egg a physical change or a chemical change? Explain your answer.
4. **CRITICAL THINKING** If you place a blown-up balloon in the freezer and take it out in a few minutes, you will see drops of water inside the balloon. How did the drops of water get inside the balloon?

## Modern Leaders in Science

### ROY PLUNKETT

In 1938, the Du Pont company asked Roy Plunkett to make a new *refrigerant*. A refrigerant is a gas used to cool the air in refrigerators and air conditioners. So Plunkett mixed up a bottle of gas chemicals that he thought might work. Then he put the bottle aside.

When Plunkett returned to the bottle, he found something very strange. Instead of a gas, the bottle contained a very slippery, white powder.

Plunkett did not know it right away, but he had created one of the first plastics. Today we know this plastic as Teflon. It is used as a nonstick coating on pans and cooking utensils.

**CRITICAL THINKING** What type of change does Plunkett's discovery show?



Roy Plunkett



## LAB ACTIVITY

### Changing Forms of Energy

#### BACKGROUND

When you turn on a hair dryer, electrical energy changes to mechanical and heat energy. When you eat an apple, chemical energy changes to heat energy in your body. You know that energy is neither created nor destroyed. It just changes its form.

#### PURPOSE

You will observe how energy changes from one form to another.

#### MATERIALS

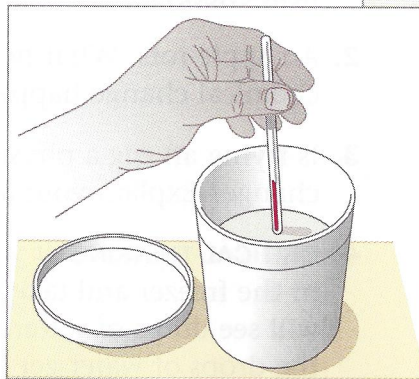
paper, pencil, safety goggles, sand, plastic container with lid, alcohol thermometer, timer

#### WHAT TO DO

1. Copy the chart to the right.
2. Put on your safety goggles. Do not take them off until everyone is done with the activity.
3. Place sand in a plastic container until it is about half full.
4. Place the end of the thermometer in the middle of the sand. Leave the thermometer in the sand for about two minutes. Remove the thermometer. Record the temperature of the sand in the "Before" part of the table.
5. Place the lid firmly on the container. Shake the container rapidly for three minutes.
6. Remove the lid. Right away, take the temperature of the sand. Record this reading in the "After" part of the table.

#### DRAW CONCLUSIONS

- What happened to the temperature of the sand when it was shaken?
- What can you say about the energy change that took place?



*Measure the temperature of the sand.*

Temperature of Sand	
Before	After

## SCIENCE IN YOUR LIFE

### Cooking and Energy

Energy and foods are related to each other in several ways. One way involves the changes that occur in foods when they are cooked. You have probably eaten cooked eggs. However, you have probably never eaten raw eggs. Cooking greatly improves the taste of eggs.

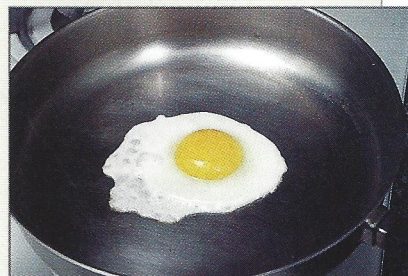
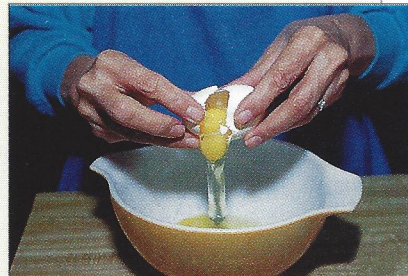
Cooking involves adding energy to food. Chemical changes occur in food when energy is added. Cooking changes the taste, appearance, and texture of the food. It might also kill bacteria that are in the raw food.

The food itself contains energy. Your body changes the chemical energy in food into energy that can be used for all body functions.

The amount of chemical energy in food is measured in units called *calories*. If you look at a food label, it will tell you how many calories are in a certain amount of the food.

Use the calorie chart to write a healthy meal plan that contains 500 to 600 calories.

Calories in One Serving of Certain Foods			
Food	Calories	Food	Calories
Apple	80	Grapes	40
Bagel	200	Ground beef	245
Banana	105	Kiwi fruit	45
Beef roast	315	Lettuce	5
Bologna	180	Milk	120
Broccoli	40	Orange	60
Carrot	30	Pickle, dill	5
Cheese	115	Popcorn	55
Chicken	140	Wheat bread	65



*Adding energy to food causes chemical changes to occur.*

#### Critical Thinking

What happens to the calories in the food you eat?

**Summary**

There are two main kinds of energy, but energy can come in many different forms. Energy interacts with matter. This causes certain changes in matter.

**Lesson 15.1**

Energy is the ability to do work, produce heat, or, in science, to make things move. Energy has no mass, but energy is present in all things. Potential energy is energy stored in matter. Kinetic energy comes from movement. Energy cannot be destroyed or created, but it can change forms.

**Lesson 15.2**

Some forms of energy are heat energy, light energy, electrical energy, chemical energy, nuclear energy, and mechanical energy.

**Lesson 15.3**

Changes in matter can be either physical or chemical. A physical change affects only the state, shape, or volume of matter. A chemical change affects the chemical makeup of the substance.

chemical energy

electrical energy

heat energy

kinetic energy

light energy

nuclear fission

nuclear fusion

potential energy

**Vocabulary Review**

Match each definition with a term from the list.

1. Energy that comes from movement
2. Energy in the form of electrons moving through a substance
3. The joining together of two or more atomic nuclei
4. Energy in the form of moving molecules
5. Energy stored in molecules
6. Energy that is stored
7. The breakup of the nucleus of an atom
8. Energy in the form of moving waves of light

## Chapter Quiz

Write your answers on a separate sheet of paper.

1. How much mass does energy have?
2. What is stored energy? What is energy of motion? Give an example of each.
3. What are six forms of energy? Give an example of each.
4. What nuclear process takes place in a nuclear reactor?
5. Can you use up energy? Explain your answer.
6. What happens to a liquid if you add enough heat to it?
7. What causes matter to change?
8. What is one way to make a physical change in a wooden chair?
9. What is one way to make a chemical change in a wooden chair?
10. How do you know a chemical change takes place when a log burns?

### Test Tip

Reread the summaries for each chapter before the quiz. They usually cover the main points and tie the pieces of the chapter together.

## Research Project

When you turn on a light switch, you are using electricity that has been changed from some other type of energy. This change takes place in a power plant. Three main types of power plants are hydroelectric, coal-burning, and nuclear. Choose a type of power plant and research it. Draw a diagram or flow chart to show how the “source energy” is changed to “electric energy.”