

Lesson 2

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

- What is the law of conservation of energy?
- How does friction affect energy transformations?
- How are different types of energy used?

Vocabulary

law of conservation of energy

p. 430

friction p. 431

 **Multilingual eGlossary**

Energy Transformations

Inquiry

What's that sound?

Blocks of ice breaking off the front of this glacier can be bigger than a car. Imagine the loud rumble they make as they crash into the sea. But after the ice falls into the sea, it will melt gradually. All of these processes involve energy transformations—energy changing from one form to another.



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Chapter 13

ENGAGE


Is energy lost when it changes form? 

Energy can have different forms. What happens when energy changes from one form to another?

- 1 Read and complete a lab safety form.
- 2 Three students should sit in a circle. One student has 30 **buttons**, one has 30 **pennies**, and one has 30 **paper clips**.
- 3 Each student should exchange 10 items with the student to the right and 10 items with the student to the left.
- 4 Repeat step 3.



Think About This

1. If the buttons, the pennies, and the paper clips represent different forms of energy, what represents changes from one form of energy to another?
2.  **Key Concept** If each button, penny, and paper clip represents one unit of energy, does the total amount of energy increase, decrease, or stay the same? Explain your answer.

Changes Between Forms of Energy

It is the weekend and you are ready to make some popcorn in the microwave and watch a movie. Energy changes form when you make popcorn and watch TV. As shown in **Figure 5**, a microwave changes electric energy into **radiant** energy. Radiant energy changes into thermal energy in the popcorn kernels.

The changes from electric energy to radiant energy to thermal energy are called energy transformations. As you watch the movie, energy transformations also occur in the television. A television transforms electric energy into sound energy and radiant energy.

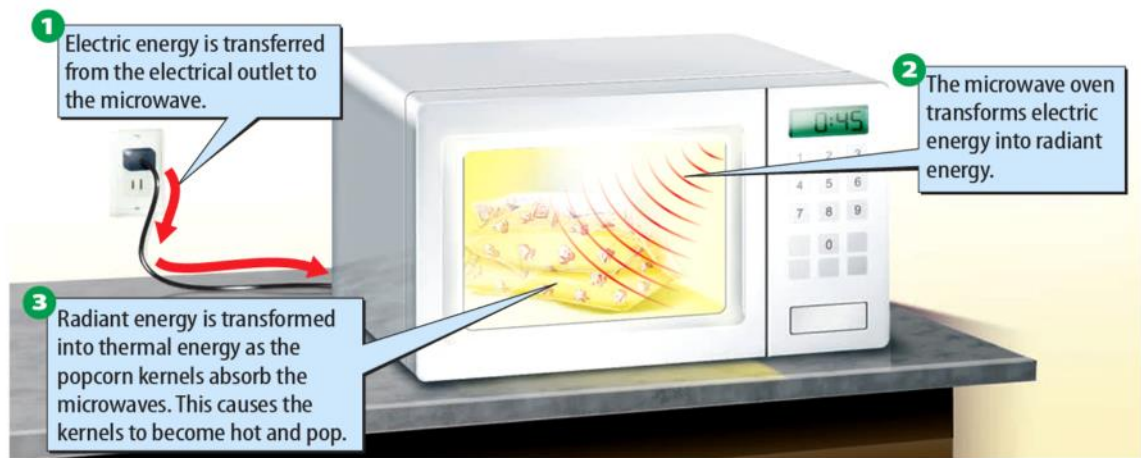
SCIENCE USE V. COMMON USE

radiant

Science Use energy transmitted by electromagnetic waves

Common Use bright and shining; glowing

Figure 5 Energy changes from one form to another when you use a microwave oven to make popcorn.



Conservation of Energy

Concepts in Motion Animation

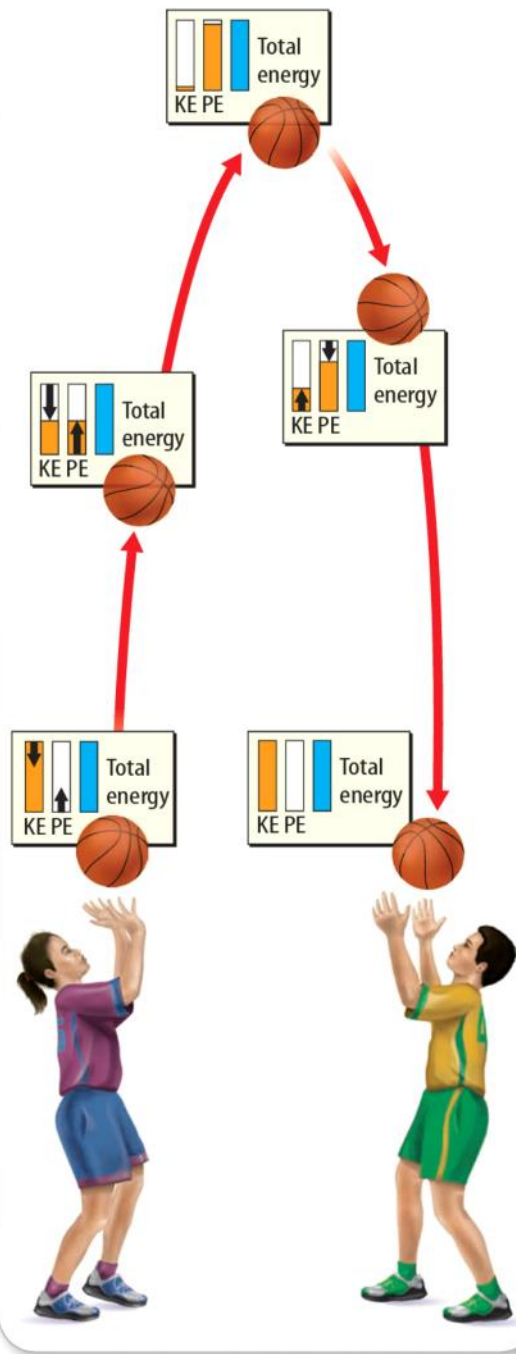


Figure 6 The ball's kinetic energy (KE) and potential energy (PE) change as it moves.

Visual Check When is the gravitational potential energy the greatest?



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Chapter 13
EXPLAIN

Changes Between Kinetic and Potential Energy

Energy transformations also occur when you toss a ball upward, as shown in **Figure 6**. The ball slows down as it moves upward and then speeds up as it moves downward. The ball's speed and height change as energy changes from one form to another.

Kinetic Energy to Potential Energy

The ball is moving fastest and has the most kinetic energy as it leaves your hand, as shown in **Figure 6**. As the ball moves upward, its speed and kinetic energy decrease. However, the potential energy is increasing because the ball's height is increasing. Kinetic energy is changing into potential energy. At the ball's highest point, the gravitational potential energy is at its greatest, and the ball's kinetic energy is at its lowest.

Potential Energy to Kinetic Energy

As the ball moves downward, its potential energy decreases. At the same time, the ball's speed increases. Therefore, the ball's kinetic energy increases. Potential energy is transformed into kinetic energy. When the ball reaches the other player's hand, its kinetic energy is at the maximum value again.

Reading Check Why does the potential energy decrease as the ball falls?

The Law of Conservation of Energy

The total energy in the universe is the sum of all the different forms of energy everywhere. According to the **law of conservation of energy**, energy can be transformed from one form into another or transferred from one region to another, but energy cannot be created or destroyed. The total amount of energy in the universe does not change.

Key Concept Check What is the law of conservation of energy?

Friction and the Law of Conservation of Energy

Sometimes it may seem as if the law of conservation of energy is not accurate. Imagine riding a bicycle, as in **Figure 7**. The moving bicycle has mechanical energy. What happens to this mechanical energy when you apply the brakes and the bicycle stops?

When you apply the brakes, the bicycle's mechanical energy is not destroyed. Instead the bicycle's mechanical energy is transformed to thermal energy, as shown in **Figure 7**. The total amount of energy never changes. The additional thermal energy causes the brakes, the wheels, and the air around the bicycle to become slightly warmer.

Friction between the bicycle's brake pads and the moving wheels transforms mechanical energy into thermal energy. **Friction** is a force that resists the sliding of two surfaces that are touching.

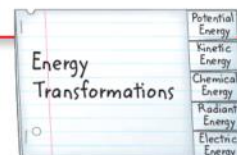
 **Key Concept Check** How does friction affect energy transformations?

There is always some friction between any two surfaces that are rubbing against each other. As a result, some mechanical energy always is transformed into thermal energy when two surfaces rub against each other.

It is easier to pedal a bicycle if there is less friction between the bicycle's parts. With less friction, less of the bicycle's mechanical energy is transformed into thermal energy. One way to reduce friction is to apply a lubricant, such as oil, grease, or graphite, to surfaces that rub against each other.

FOLDABLES®

Cut three sheets of paper in half. Use the six half sheets to make a side-tab book with five tabs and a cover. Use your book to organize your notes on energy transformations.



WORD ORIGIN

friction

from Latin *fricare*, means "to rub"

Friction and Thermal Energy

 Review  Personal Tutor

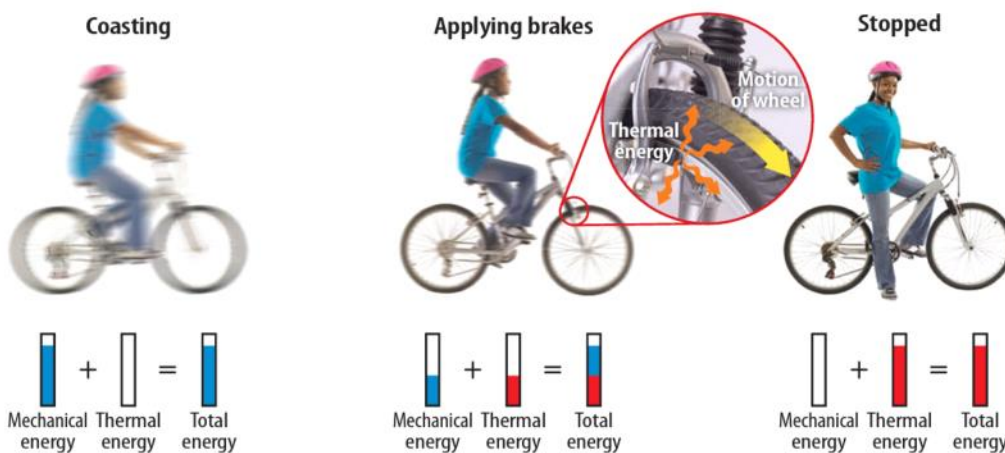


Figure 7 When the girl applies the brakes, friction between the bicycle's brake pads and its wheels transforms mechanical energy into thermal energy. As mechanical energy changes into thermal energy, the bicycle slows down. The total amount of energy does not change.



Math Skills

Solve a One-Step Equation

Electric energy often is measured in units called kilowatt-hours (kWh). To calculate the electric energy used by an appliance in kWh, use this equation:

$$\text{kWh} = \left(\frac{\text{watts}}{1,000} \right) \times \text{hours}$$

Appliances typically have a power rating measured in watts (W)

Practice

A hair dryer is rated at 1,200 W. If you use the dryer for 0.25 h, how much electric energy do you use?



- Math Practice
- Personal Tutor

Using Energy

Every day you use different forms of energy to do different things. You might use the radiant energy from a lamp to light a room, or you might use the chemical energy stored in your body to run a race. When you use energy, you usually change it from one form into another. For example, the lamp changes electric energy into radiant energy and thermal energy.

Using Thermal Energy

All forms of energy can be transformed into thermal energy. People often use thermal energy to cook food or provide warmth. A gas stove transforms the chemical energy stored in natural gas into the thermal energy that cooks food. An electric space heater transforms the electric energy from a power plant into the thermal energy that warms a room. In a jet engine, burning fuel releases thermal energy that the engine transforms into mechanical energy.

Using Chemical Energy

During photosynthesis, a plant transforms the Sun's radiant energy into chemical energy that it stores in chemical compounds. Some of these compounds become food for other living things. Your body transforms the chemical energy from your food into the kinetic energy necessary for movement. Your body also transforms chemical energy into the thermal energy necessary to keep you warm.

Using Radiant Energy

The cell phone in **Figure 8** sends and receives radiant energy using microwaves. When you are listening to someone on a cell phone, that cell phone is transforming radiant energy into electric energy and then into sound energy. When you are speaking into a cell phone, it is transforming sound energy into electric energy and then into radiant energy.

Figure 8 A cell phone changes sound energy into radiant energy when you speak.

Sound waves carry energy into the cell phone.



The cell phone converts the energy carried by sound waves into radiant energy that is carried away by microwaves.



Using Electric Energy

Many of the devices you might use every day, such as handheld video games, MP3 players, and hair dryers, use electric energy. Some devices, such as hair dryers, use electric energy from electric power plants. Other appliances, such as handheld video games, transform the chemical energy stored in batteries into electric energy.



Key Concept Check How are different types of energy used?

Waste Energy

When energy changes form, some thermal energy is always released. For example, a lightbulb converts some electric energy into radiant energy. However, the lightbulb also transforms some electric energy into thermal energy. This is what makes the lightbulb hot. Some of this thermal energy moves into the air and cannot be used.

Scientists often refer to thermal energy that cannot be used as waste energy. Whenever energy is used, some energy is transformed into useful energy and some is transformed into waste energy. For example, we use the chemical energy in gasoline to make cars, such as those in **Figure 9**, move. However, most of that chemical energy ends up as waste energy—thermal energy that moves into the air.



Reading Check What is waste energy?

Figure 9 Cars transform most of the chemical energy in gasoline into waste energy.



Inquiry

MiniLab

20 minutes

How does energy change form?




When an object falls, energy changes form. How can you compare energies for falling objects?



- 1 Read and complete a lab safety form.
- 2 Place a piece of **clay** about 10 cm wide and 3 cm thick on a **small paper plate**.
- 3 Drop a **marble** onto the clay from a height of about 20 cm, and measure the depth of the depression caused by the marble. Record the measurement in your Science Journal.
- 4 Repeat step 3 with a heavier marble.

Analyze and Conclude

1. **Infer** Which marble had more kinetic energy just before it hit the clay? Explain your answer.
2.  **Key Concept** For which marble was the potential energy greater just before the marble fell? Explain your answer using the law of conservation of energy.



Lesson 2 Review

✓ Assessment Online Quiz

? Inquiry Virtual Lab

Visual Summary



Energy can change form, but according to the law of conservation of energy, energy can never be created or destroyed.



Friction transforms mechanical energy into thermal energy.



Different forms of energy, such as sound and radiant energy, are used when someone talks on a cell phone.

FOLDABLES

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

4. Energy can change from one form to another.
5. Energy is destroyed when you apply the brakes on a moving bicycle or a moving car.
6. The Sun releases radiant energy.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

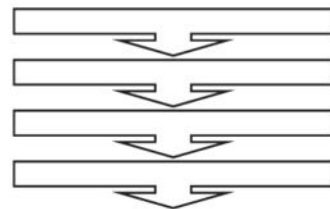
- 1 Use the term *friction* in a complete sentence.

Understand Key Concepts

- 2 Explain the law of conservation of energy in your own words.
- 3 Describe the energy transformations that occur when a piece of wood burns.
- 4 Identify the energy transformation that takes place when you apply the brakes on a bicycle.
- 5 Which energy transformation occurs in a toaster?
 - A. chemical to electric
 - B. electric to thermal
 - C. kinetic to chemical
 - D. thermal to potential

Interpret Graphics

- 6 Organize Information Copy and fill in the graphic organizer below to show how kinetic and potential energy change when a ball is thrown straight up and then falls down.



Critical Thinking

- 7 Judge An advertisement states that a machine with moving parts will continue moving forever without having to add any energy. Can this be correct? Explain.

Math Skills

Review

Math Practice

- 8 Calculate If you use a 1,000-W microwave for 0.15 h, how much electric energy do you use?