

# Energy and Energy Transformations

## Energy Transformations

### Key Concepts

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

### Mark the Text

#### Identify Main Ideas

Highlight the sentences in this lesson that talk about how energy changes form. Use the highlighted sentences to review.

#### Visual Check

**1. Identify** Which energy transformation pops the corn kernels?

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### ..... Before You Read .....

**What do you think?** Read the three statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

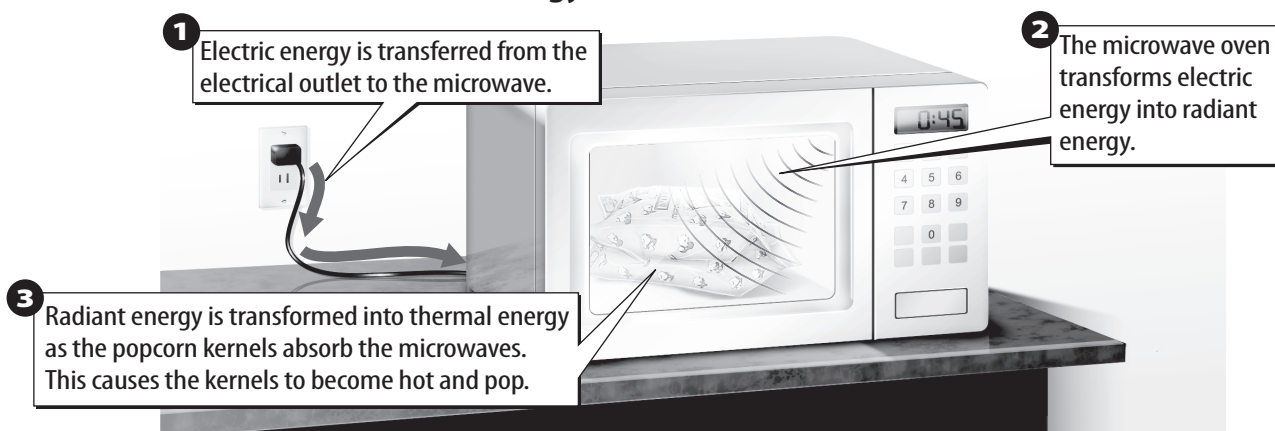
Before	Statement	After
	3. Energy can change from one form to another.	
	4. Energy is destroyed when you apply the brakes on a moving bicycle or a moving car.	

### ..... Read to Learn .....

## Changes Between Forms of Energy

Have you ever made popcorn in a microwave oven to eat while watching television? Energy changes form when you make popcorn, as shown in the figure below. A microwave oven changes electric energy into radiant energy. Radiant energy changes into thermal energy in the popcorn kernels. These changes from one form of energy to another are called energy transformations. As you watch TV, energy transformations occur in the television. A television transforms electric energy into sound energy and radiant energy.

### Energy Transformation



## Changes Between Kinetic and Potential Energy

Energy transformations also occur when you toss a ball upward. The ball slows down as it rises and speeds up as it falls. The ball's speed and height change as the energy changes from one form to another.


### Kinetic Energy to Potential Energy

In the figure to the right, notice that the ball is moving fastest and has the most kinetic energy (KE) as it leaves the girl's hands. As the ball moves upward, its speed and kinetic energy decrease. However, the ball's potential energy (PE) increases because the ball's height increases. The ball's kinetic energy is changing to potential energy. At the ball's highest point, its gravitational potential energy is greatest, and its kinetic energy is lowest.

### Potential Energy to Kinetic Energy

As the ball moves downward, its potential energy decreases. At the same time, the ball's kinetic energy increases because its speed increases. As the ball drops, potential energy changes to kinetic energy. When the ball reaches the boy's hands, the ball's kinetic energy is once again at its highest value. Energy changes between kinetic energy and potential energy as the ball moves. The bars in the figure show that the ball's total energy does not change.

## The Law of Conservation of Energy

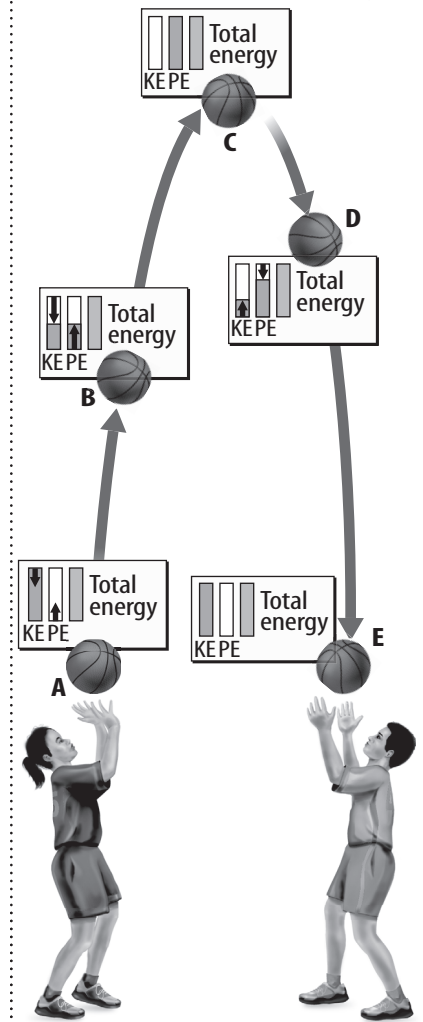
The total energy in the universe is the sum of all the different forms of energy everywhere. *According to the **law of conservation of energy**, energy can be transformed from one form into another or transferred from one region to another, but energy cannot be created or destroyed.* The total amount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

### Friction and the Law of Conservation of Energy

Sometimes it seems as if the law of conservation of energy is not accurate. Imagine riding a bicycle. The moving bicycle has mechanical energy. What happens to this mechanical energy when you apply the brakes?

When you apply the brakes, the bicycle's mechanical energy is transformed into thermal energy as the brake pads rub against the bicycle's wheels. The total amount of energy never changes. The additional thermal energy warms the brakes, the wheels, and the air around the bicycle.

## Conservation of Energy



### Visual Check

**2. Compare** When is the gravitational potential energy the greatest?

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### Key Concept Check

**3. Define** What is the law of conservation of energy?

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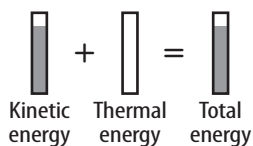


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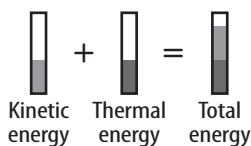
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### Coasting

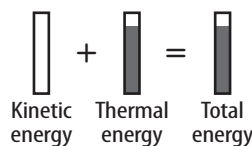


## Friction and Thermal Energy

### Applying brakes



### Stopped



### Visual Check

**4. Explain** Which type of energy is constant in the figure? Why?

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### Key Concept Check

**5. Specify** How does friction affect energy transformations?

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### Math Skills

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).

**6. Solve a One-Step Equation** 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?

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**Friction** When the bicycle's brake pads rub against the moving wheels, friction occurs. **Friction** is a force that resists the sliding of two surfaces that are touching. Friction between the brake pads and the moving wheels transforms the bicycle's mechanical energy into thermal energy as shown in the figure above.

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

**Reducing Friction** 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 to surfaces that rub against each other.

## Using Energy

You use different forms of energy to do different things. You use radiant energy from a lamp to light a room. You use chemical energy stored in your body to run a race. Energy usually changes from one form to another when you use it. For example, a lamp changes electric energy to radiant energy that lights a room. Some of the electric energy also changes to thermal energy. Thermal energy causes the lamp's bulb to become warm to the touch.

## 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 the 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 organisms. Your body transforms the chemical energy from food into the kinetic energy that you use for movement. Your body also transforms chemical energy into the thermal energy that keeps you warm.

## Using Radiant Energy


A cell phone sends and receives radiant energy using microwaves. When you speak into a cell phone, the phone transforms sound energy into electric energy and then into radiant energy. Sound waves from your voice carry energy into the phone. The phone converts the sound energy into electric energy and then into radiant energy. Microwaves carry the radiant energy away. When you listen to someone on a cell phone, the phone is transforming radiant energy into electric energy and then into sound energy.

## Using Electric Energy

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

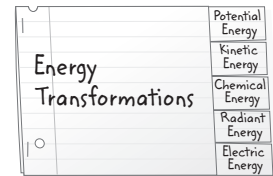
## Waste Energy

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, the chemical energy in gasoline makes cars move. However, most of that chemical energy ends up as waste energy—thermal energy that moves into the air. 

## FOLDABLES®

Make a side-tab book to organize your notes on energy transformations.



### Key Concept Check

**7. Specify** How are different types of energy used?

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### Reading Check

**8. Define** What is waste energy?

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## ..... After You Read .....

### Mini Glossary

**friction:** a force that resists the sliding of two surfaces that are touching

**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

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that provides an example of friction.

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2. Use what you have learned about energy to complete the table.

Energy Change	Example	Energy Change	Example
Kinetic to potential	Throw a ball into the air.	Chemical to thermal	
Electric to thermal		Sound to radiant	A call is received on a cell phone.
Potential to kinetic	An object falls to the ground.	Electric to radiant	
Chemical to electric		Chemical to kinetic	Food is digested to help a person move.

3. Explain one concept you learned from the sentences that you highlighted.

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### What do you think **NOW?**

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?



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