# Lesson 1

# Forms of Energy

## Reading Guide

### Key Concepts

**ESSENTIAL QUESTIONS**

- What is energy?
- What are potential and kinetic energy?
- How is energy related to work?
- What are the different forms of energy?

### Vocabulary

**energy** p. 421
**kinetic energy** p. 422
**potential energy** p. 422
**work** p. 424
**mechanical energy** p. 425
**sound energy** p. 425
**thermal energy** p. 425
**electric energy** p. 425
**radiant energy** p. 425
**nuclear energy** p. 425

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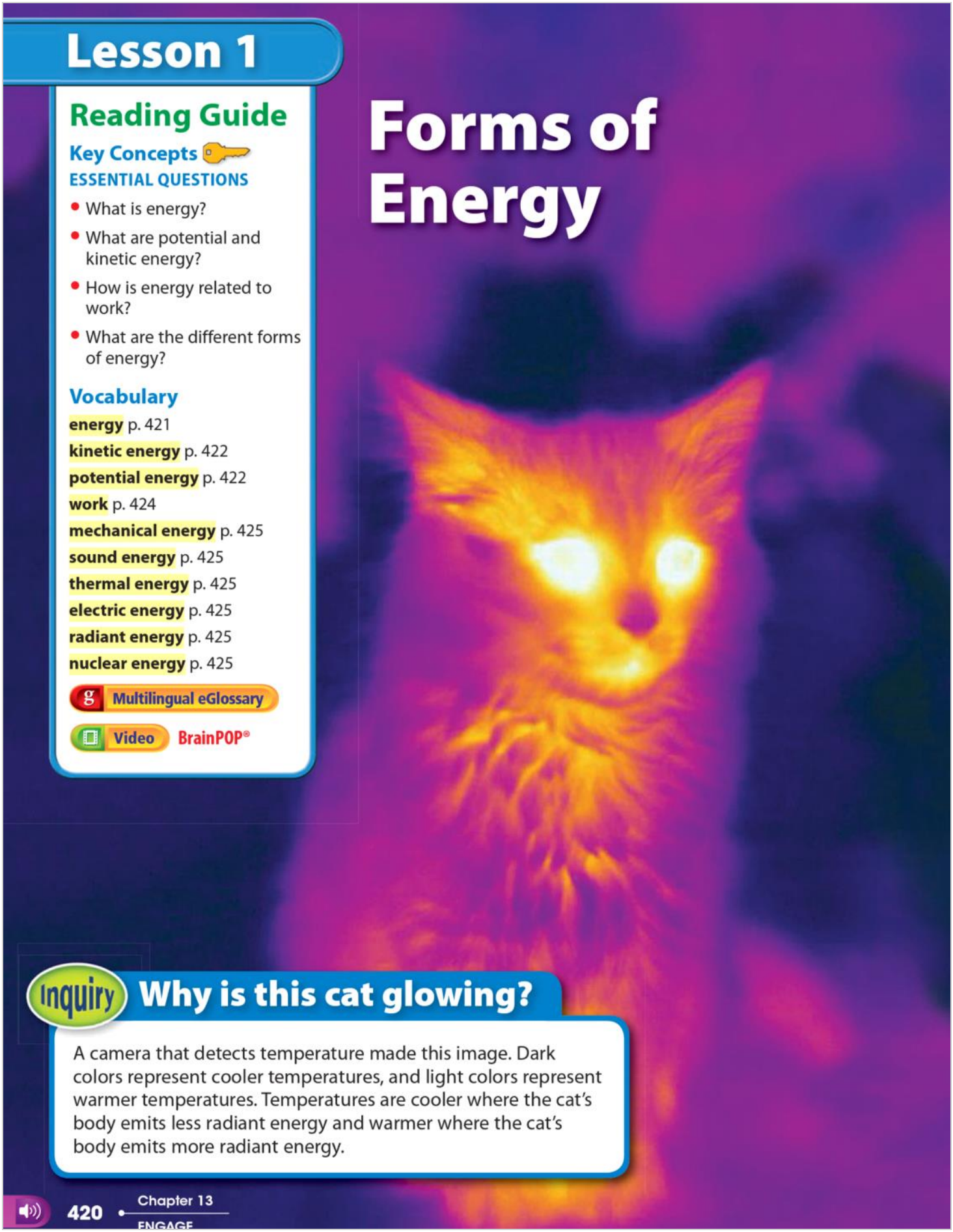


Inquiry

## Why is this cat glowing?

A camera that detects temperature made this image. Dark colors represent cooler temperatures, and light colors represent warmer temperatures. Temperatures are cooler where the cat's body emits less radiant energy and warmer where the cat's body emits more radiant energy.

## Inquiry Launch Lab

20 minutes

### Can you change matter?

You observe many things changing. Birds change their positions when they fly. Bubbles form in boiling water. The filament in a lightbulb glows when you turn on a light. How can you cause a change in matter?

1. Read and complete the lab safety form.
2. Half-fill a **foam cup** with **sand.** Place the bulb of a **thermometer** about halfway into the sand. *Do not stir.* Record the temperature in your Science Journal.
3. Remove the thermometer and place a **lid** on the cup. Hold down the lid and shake the cup vigorously for 10 min.
4. Remove the lid. Measure and record the temperature of the sand.

#### Think About This

1. What change did you observe in the sand?
2. How could you change your results?
3. **Key Concept** What do you think caused the change you observed in the sand?

## What is energy?

It might be exciting to watch a fireworks display, such as the one shown in **Figure 1.** Over and over, you hear the crack of explosions and see bursts of colors in the night sky. Fireworks release energy when they explode. **Energy** *is the ability to cause change.* The energy in the fireworks causes the changes you see as bursting flashes of light and hear as loud booms.

Energy also causes other changes. The plant in **Figure 1** uses the energy from the Sun and makes food that it uses for growth and other processes. Energy can cause changes in the motions and positions of objects, such as the nail in **Figure 1.** Can you think of other ways energy might cause changes?

**Key Concept Check** What is energy?

**Word Origin**

**energy**
from Greek *energeia*, means "activity"

**Figure 1** The explosion of fireworks, the growth of a plant, and the motion of a hammer all involve energy.

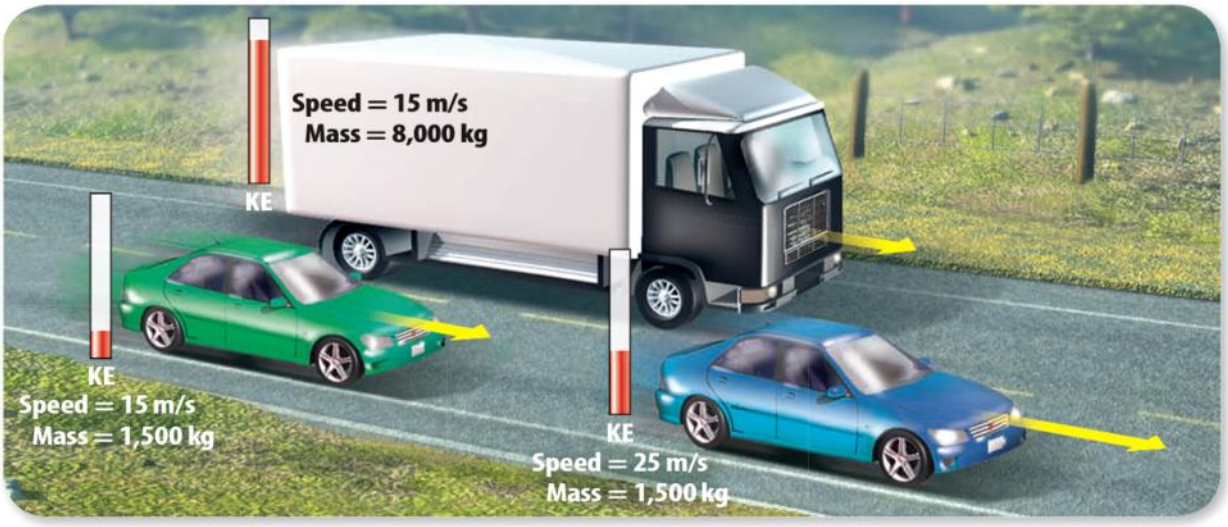



**Figure 2** The kinetic energy (KE) of an object depends on its speed and its mass. The vertical bars show the kinetic energy of each vehicle.

## Kinetic Energy—Energy of Motion

Have you ever been to a bowling alley? When you rolled the ball and it hit the pins, a change occurred—the pins fell over. This change occurred because the ball had a form of energy called kinetic (kuh NEH tik) energy. **Kinetic energy** *is energy due to motion.* All moving objects have kinetic energy.

### Kinetic Energy and Speed

An object's kinetic energy depends on its speed. The faster an object moves, the more kinetic energy it has. For example, the blue car has more kinetic energy than the green car in **Figure 2** because the blue car is moving faster.

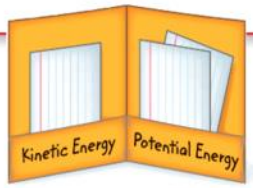
### Kinetic Energy and Mass

A moving object's kinetic energy also depends on its mass. If two objects move at the same speed, the object with more mass has more kinetic energy. For example, the truck and the green car in **Figure 2** are moving at the same speed, but the truck has more kinetic energy because it has more mass.

**Key Concept Check** What is kinetic energy?

**FOLDABLES®**

Make a 18-cm fold along the long edge of a sheet of paper to make a two-pocket book. Label it as shown. Organize information about the forms of energy on quarter sheets of paper, and put them in the pockets.




## Potential Energy—Stored Energy

Energy can be present even if objects are not moving. If you hold a ball in your hand and then let it go, the gravitational interaction between the ball and Earth causes a change to occur. Before you dropped the ball, it had a form of energy called potential (puh TEN chul) energy. **Potential energy** *is stored energy due to the interactions between objects or particles.* Gravitational potential energy, elastic potential energy, and chemical potential energy are all forms of potential energy.

## Gravitational Potential Energy

Even when you are just holding a book, gravitational potential energy is stored between the book and Earth. The girl shown in **Figure 3** increases the gravitational potential energy between her backpack and Earth by lifting the backpack higher from the ground.

The gravitational potential energy stored between an object and Earth depends on the object's weight and height. Dropping a bowling ball from a height of 1 m causes a greater change than dropping a tennis ball from 1 m. Similarly, dropping a bowling ball from 3 m causes a greater change than dropping the same bowling ball from only 1 m.

**Reading Check** What factors determine the gravitational potential energy stored between an object and Earth?

## Elastic Potential Energy

When you stretch a rubber band, as in **Figure 3,** another form of potential energy, called elastic (ih LAS tik) potential energy, is being stored in the rubber band. Elastic potential energy is energy stored in objects that are compressed or stretched, such as springs and rubber bands. When you release the end of a stretched rubber band, the stored elastic potential energy is transformed into kinetic energy. This transformation is obvious when it flies across the room.

## Chemical Potential Energy

Food, gasoline, and other substances are made of atoms joined together by chemical bonds. Chemical potential energy is energy stored in the chemical bonds between atoms, as shown in **Figure 3.** Chemical potential energy is released when chemical reactions occur. Your body uses the chemical potential energy in foods for all its activities. People also use the chemical potential energy in gasoline to power cars and buses.

**Key Concept Check** In what way are all forms of potential energy the same?

### Potential Energy

**Figure 3** There are different forms of potential energy.

**Gravitational Potential Energy**
Gravitational potential energy increases when the girl lifts her backpack.

**Elastic Potential Energy**
The rubber band's elastic potential energy increases when it is stretched.

**Chemical Potential Energy**
Foods and other substances, including glucose, have chemical potential energy stored in the bonds between atoms.

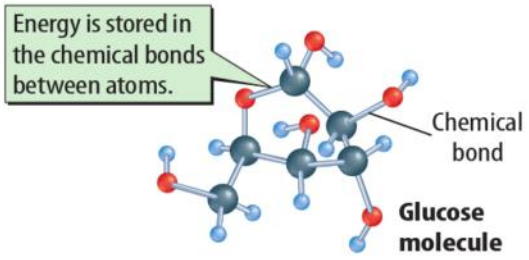



**Figure 4** The girl does work on the box as she lifts it and increases its gravitational potential energy. The colored bars show the work that the girl does (W) and the box's potential energy (PE).

## Energy and Work

You can transfer energy by doing work. **Work** *is the transfer of energy that occurs when a force makes an object move in the direction of the force while the force is acting on the object.* For example, as the girl lifts the box onto the shelf in **Figure 4,** she transfers energy from herself to the box. She does work only while the box moves in the direction of the force and while the force is applied to the box. If the box stops moving, the force is no longer applied, or the box movement and the applied force are in different directions, work is not done on the box.

**Key Concept Check** How is energy related to work?

An object that has energy also can do work. For example, when a bowling ball collides with a bowling pin, the bowling ball does work on the pin. Some of the ball's kinetic energy is transferred to the bowling pin. Because of this connection between energy and work, energy is sometimes described as the ability to do work.

## Other Forms of Energy

Some other forms of energy are shown in **Table 1.** All energy can be measured in joules (J). A softball dropped from a height of about 0.5 m has about 1 J of kinetic energy just before it hits the floor.

### Inquiry MiniLab

**20 minutes**

**Can a moving object do work?**

Is work done when a moving object hits another object?

1. Read and complete a lab safety form.
2. **Tape** one end of a **30-cm grooved ruler** to the edge of a stack of **books** about 8 cm high. Put the lower end of the ruler in a **paper cup** lying on its side.
3. Place a **marble** in the groove at the top end of the ruler and release it.
4. Record your observations in your Science Journal.

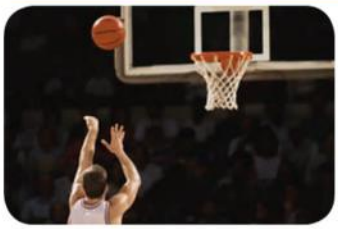
**Analyze and Conclude**

1. **Compare** the kinetic energy of the marble just before and after it hit the cup.
2. **Key Concept** Is work being done on the cup? Explain your answer.

## Table 1 Forms of Energy

### Mechanical Energy

*The sum of potential energy and kinetic energy in a system of objects is* **mechanical energy.** For example, the mechanical energy of a basketball increases when a player shoots the basketball. Both the kinetic energy and gravitational potential energy of the ball increases in the player-ball-ground system.



### Sound Energy

When you pluck a guitar string, the string vibrates and produces sound. *The energy that sound carries is* **sound energy.** Vibrating objects emit sound energy. However, sound energy cannot travel through a vacuum, such as the space between Earth and the Sun.

### Thermal Energy

All objects and materials are made of particles that have energy. **Thermal energy** *is the sum of kinetic energy and potential energy of the particles that make up an object.* Mechanical energy is due to large-scale motions and interactions in a system and thermal energy is due to atomic-scale motions and interactions of particles. Thermal energy moves from warmer objects, such as burning logs, to cooler objects, such as air.

### Electric Energy

An electrical fan uses another form of energy—electric energy. When you turn on a fan, there is an electric current through the fan's motor. **Electric energy** *is the energy an electric current carries.* Electrical appliances, such as fans and dishwashers, change electric energy into other forms of energy.

### Radiant Energy—Light Energy

The Sun gives off energy that travels to Earth as electromagnetic waves. Unlike sound waves, electromagnetic waves can travel through a vacuum. Light waves, microwaves, and radio waves are all electromagnetic waves. *The energy that electromagnetic waves carry is* **radiant energy.** Radiant energy sometimes is called light energy.

### Nuclear Energy

At the center of every atom is a nucleus. **Nuclear energy** *is energy that is stored and released in the nucleus of an atom.* In the Sun, nuclear energy is released when nuclei join together. In a nuclear power plant, nuclear energy is released when the nuclei of uranium atoms are split apart.

**Key Concept Check** Describe three forms of energy.

# Lesson 1 Review

Assessment Online Quiz

## Visual Summary

Energy is the ability to cause change.

The gravitational potential energy between an object and Earth increases when you lift the object.

You do work on an object when you apply a force to that object over a distance.

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.

1. A fast-moving baseball has more kinetic energy than a slow-moving baseball.
2. A large truck and a small car moving at the same speed have the same kinetic energy.
3. A book sitting on a shelf has no 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

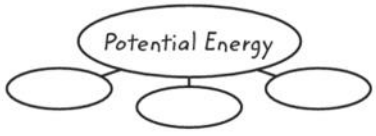
1. **Distinguish** between kinetic energy and potential energy.

## Understand Key Concepts

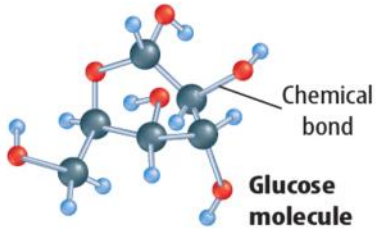
2. **Write** a definition of work.
3. Which type of energy increases when you compress a spring?
   - **A.** elastic potential energy
   - **B.** kinetic energy
   - **C.** radiant energy
   - **D.** sound energy
4. **Infer** How could you increase the gravitational potential energy between yourself and Earth?
5. **Infer** how a bicycle's kinetic energy changes when that bicycle slows down.
6. **Compare and contrast** radiant energy and sound energy.

## Interpret Graphics

7. **Identify** Copy and fill in the graphic organizer below to identify three types of potential energy.




8. **Describe** where chemical potential energy is stored in the molecule shown below.




## Critical Thinking

9. **Analyze** Will pushing on a car always change the car's mechanical energy? What must happen for the car's kinetic energy to increase?