Name _____ Class _____ Date _____

CHAPTER 9 Energy and Energy Resources

SECTION 1

What Is Energy?

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

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

National Science Education Standards

PS 3a, 3d, 3e, 3f

What Is Energy?

A tennis player needs energy to hit a ball with her racket. The ball has energy as it flies through the air. Energy is all around you, but what is energy?

In science, **energy** is the ability to do work. *Work* is done when a force makes an object move in the direction of the applied force. How do energy and work help you play tennis? The tennis player does work on her racket by applying a force to it. The racket does work on the ball to make it fly into the air.

When the racket does work on the ball, energy moves from the racket to the ball. Energy is the reason the racket can do work. So, work is the transfer of energy. Both work and energy are written in the units joules (J). ☑

STUDY TIP

Make a Venn Diagram to compare and contrast kinetic energy and potential energy. Make a list of other forms of energy and tell if they are kinetic energy or potential energy.

READING CHECK

1. Identify When work is done by one object on another, what is transferred?

_____

Work is done by the tennis player on the racket.

↓

Energy moves from the _____ _____ to the _____.

↓

The tennis racket does work on the ball.

↓

Energy moves from the _____ _____ to the _____.

TAKE A LOOK

2. Identify Fill in the process chart to show how energy moves when work is done on an object.

What Is Kinetic Energy?

When the tennis player hits the ball with the racket, energy moves from the racket to the ball. The tennis ball has kinetic energy. **Kinetic energy** is the energy of motion. All moving objects have kinetic energy. Like all other forms of energy, kinetic energy can be used to do work. The kinetic energy of a hammer does work on a nail. This is seen in the figure below. ☑

READING CHECK

3. Identify For an object to have kinetic energy, what must it be doing?

_____

When you swing a hammer, it is moving. It has kinetic energy. This energy does work on the nail driving it into the wood.

CALCULATING KINETIC ENERGY

You can calculate the kinetic energy of an object by using the following equation.

$$kinetic\ energy = \frac{mv^2}{2}$$

The m is the object's mass in kilograms. The v is the object's speed. The kinetic energy of an object is large if:

- the object has a large mass, or
- the object is moving fast

Math Focus

4. Calculate What is the kinetic energy of a 0.50 kg hammer that hits the floor at a speed of 10 m/s?

What is the kinetic energy of a car that has a mass of 1,000 kg and is moving at a speed of 20 m/s?

Step 1: Write the equation for kinetic energy.

$$kinetic\ energy = \frac{mv^2}{2}$$

Step 2: Place values into the equation and solve.

$$kinetic\ energy = \frac{1{,}000\ \text{kg} \times (20\ \text{m/s})^2}{2} = 200{,}000\ \text{J}$$

The kinetic energy of the car is 200,000 J.

What Is Potential Energy?

An object does not have to be moving to have energy. **Potential energy** is the energy an object has because of its position. This kind of energy is harder to see because we do not see the energy at work. In the figure below, when the bow is pulled back, it has potential energy. Work has been done on it, and that work has been turned into potential energy. ☑

The bow and the string have energy that is stored as potential energy. When the man lets go of the string, the potential energy does work on the arrow.

READING CHECK

5. Identify What causes an object to have potential energy?

_____

_____

Critical Thinking

6. Infer What would the man need to do to give the arrow more potential energy?

_____

_____

GRAVITATIONAL POTENTIAL ENERGY

When you lift an object, you do work on it. You move it in an opposite direction from the force of gravity. As you lift the object, you transfer energy to the object and give it gravitational potential energy. The amount of *gravitational potential energy* of an object depends on the object's weight and its distance from the ground.

CALCULATING GRAVITATIONAL POTENTIAL ENERGY

The gravitational potential energy of an object can be determined by using the following equation:

gravitational potential energy = *weight* × *height*

The weight is in newtons (N) and the height is in meters (m). Gravitational potential energy is written in newton × meters (N × m). This is the same as a joule (J).

Let's do a calculation. What is the gravitational potential energy of a book with a weight of 13 N at a height of 1.5 m off the ground?

Step 1: *gravitational potential energy* = *weight* × *height*

Step 2: *gravitational potential energy* = 13 N × 1.5 m = 19.5 J

The book now has 19.5 J of potential energy.

Math Focus

7. Calculate What is the potential energy of a 300 N rock climber standing 100 m from the base of a rock wall?

What Is Mechanical Energy?

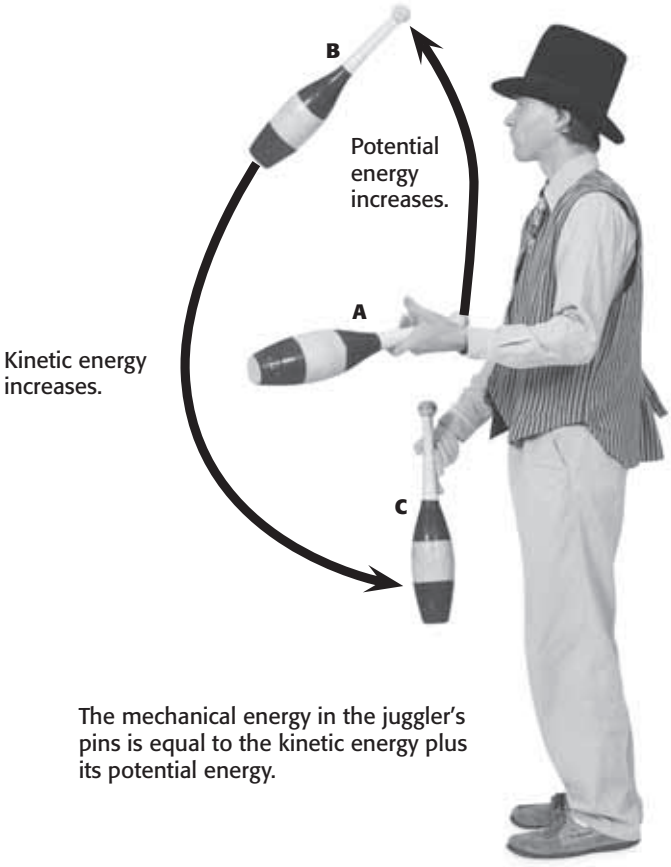
Look at the figure below. All the energy in the juggler's pins is in the form of mechanical energy. **Mechanical energy** is the total energy of motion and position of an object. In other words, it is the kinetic energy plus the potential energy of an object. ☑

READING CHECK

8. Identify Adding what two energies gives the mechanical energy of an object?

_____

_____



The mechanical energy in the juggler's pins is equal to the kinetic energy plus its potential energy.

TAKE A LOOK

9. Identify In the figure, circle the pin with the most potential energy.

MECHANICAL ENERGY IN A JUGGLER'S PIN

The mechanical energy of an object doesn't change unless energy is transferred to or from another object.

Look again at the figure of the juggler. The juggler moves the pin by doing work on it. He gives the pin kinetic energy. When he lets go of the pin, the pin's kinetic energy changes into potential energy. As the pin goes up, it slows down. When all of the pin's kinetic energy is turned into potential energy, it stops going up.

When the pin starts to fall, its energy is mostly potential energy. As it falls, the potential energy is changed back into kinetic energy. At different times, the pin may have more kinetic energy or more potential energy. The total mechanical energy at any point is always the same.

Say It

Discuss Suppose a batter hits a pop-up in baseball that goes straight up. With a partner, discuss the changes in kinetic and potential energy as the ball leaves the bat and rises to its highest height.

What Are the Other Forms of Energy?

Energy can be in a form other than mechanical energy. The other energy forms are thermal, chemical, electrical, sound, light, and nuclear energy. All of these energy forms are connected in some way to kinetic energy and potential energy.

THERMAL ENERGY

Matter is made of particles that are moving. These particles have kinetic energy. *Thermal energy* is all the kinetic energy from the movement of the particles in an object. ☑

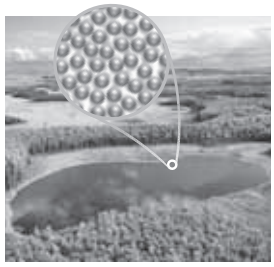
READING CHECK

10. Describe What is thermal energy?

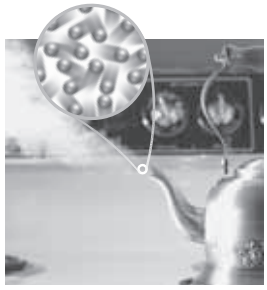
The figure below shows the thermal energy of particles at different temperatures. Particles move faster at higher temperatures than at lower temperatures. The faster the particles move, the greater their kinetic energy and thermal energy are.

The Thermal Energy in Water

The particles in an ice cube vibrate in fixed positions and do not have a lot of kinetic energy.



The particles in water in a lake can move more freely and have more kinetic energy than water particles in ice do.



The particles in water in steam move rapidly, so they have more energy than particles in liquid water do.

CHEMICAL ENERGY

Chemical compounds such as sugar, salt, and water store energy. These compounds are made of many atoms that are held together by chemical bonds. Work is done to join the atoms together to form these bonds. *Chemical energy* is the energy stored in the chemical bonds that hold the compounds together. Chemical energy is a type of potential energy because it depends on the position of the atoms in the compound. ☑

READING CHECK

11. Identify Chemical energy is a form of what type of energy?

STANDARDS CHECK

PS 3d Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced.

12. Describe How does an amplifier make sound?

_____

_____

_____

_____

ELECTRICAL ENERGY

You use electrical energy every day. Electrical outlets in your home allow you to use this energy. *Electrical energy* is the energy of moving particles called electrons. Electrons are the negatively charged particles of atoms.

What happens when you plug an electrical device, such as an amplifier shown in the figure below, into an outlet? You use electrical energy. The electrons in the wires move to the amplifier. The moving electrons do work on the speaker in the amplifer. This makes the sound that you hear from the amplifier.

Electrical energy has both kinetic energy and potential energy. When electrical energy runs through a wire, it uses its kinetic energy. Electrical energy that is waiting to be used is potential energy. This potential energy is in the wire before you plug in an electrical appliance.

TAKE A LOOK

13. Identify What is the energy source for the amplifier? What kind of energy is transmitted by the guitar?

_____

_____

_____

The movement of electrons produces the electrical energy that an amplifier and the microphone use to produce sound.

As the guitar strings vibrate, they cause particles in the air to vibrate. These vibrations transmit sound energy.

SOUND ENERGY

Sound energy is the energy from a vibrating object. *Vibrations* are small movements of particles of an object. In the figure above, the guitar player pulls on the guitar string. This gives the string potential energy. When she lets go of the string, the potential energy turns into kinetic energy. This makes the string vibrate.

When the guitar string vibrates, some of its kinetic energy moves to nearby air particles. These vibrating air particles cause sound energy to travel. When the sound energy reaches your ear, you hear the sound of the guitar.

LIGHT ENERGY

Light helps you see, but not all light can be seen. We use light in microwaves, but we do not see it. *Light energy* is made from vibrations of electrically charged particles. Light energy is like sound energy. They both happen because particles vibrate. However, light energy doesn't need particles to travel. This makes it different than sound energy. Light energy can move through a *vacuum*, which is an area where there is no matter.

Microwave Oven

The energy used to cook food in a microwave is a form of _____ _____.

TAKE A LOOK

14. Identify Complete the sentence found in the figure.

NUCLEAR ENERGY

Another kind of energy is stored in the nucleus of an atom. This energy is *nuclear energy*. This energy is stored as potential energy.

There are two ways nuclear energy can be given off by a nucleus. When two or more small nuclei join together, they give off energy in a reaction called *fusion*. The sun's light and heat come from fusion reactions.

The second way nuclear energy is given off is when a nucleus splits apart. This process is known as *fission*. Large nuclei, like uranium, can be broken apart with fission. Fission is used to create electrical energy at nuclear power plants. ☑

READING CHECK

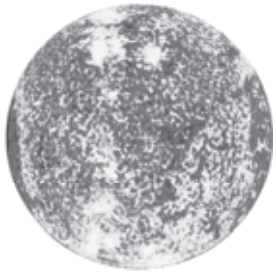
15. Compare How do nuclear fusion and fission differ?

_____

_____

_____

Our Sun



Without _____ _____ that gives the sun its energy, life on Earth would not be possible.

TAKE A LOOK

16. Identify Complete the sentence found in the figure.

Name _____ Class _____ Date _____

Section 1 Review

NSES PS 3a, 3d, 3e, 3f

SECTION VOCABULARY

energy the capacity to do work **kinetic energy** the energy of an object that is due to the object's motion	**mechanical energy** the amount of work an object can do because of the object's kinetic and potential energies **potential energy** the energy that an object has because of the position, shape, or condition of the object

1. **Identify** An object's kinetic energy depends on two things. What are they?

2. **Calculate** A book weighs 16 N and is placed on a shelf that is 2.5 m from the ground. What is the gravitational potential energy of the book? Show your work.

3. **Calculate** What is the kinetic energy of a 2,000 kg bus that is moving at 25 m/s? Show your work.

4. **Explain** A girl is jumping on a trampoline. When she is at the top of her jump, her mechanical energy is in what form? Explain why.

5. **Identify** How are sound energy and light energy similar?

6. **Conclude** Which type of nuclear reaction is more important for life on Earth? Explain why.