

Forms of Energy

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Printed: November 16, 2014

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CHAPTER 1

Forms of Energy

Lesson Objectives

- Identify different forms of energy.
- Describe how energy changes form.

Lesson Vocabulary

- chemical energy
- electrical energy
- electromagnetic energy
- mechanical energy
- sound energy
- thermal energy

Introduction

The young man in **Figure 1.1** is playing an electric guitar in a rock concert. He plucks the strings of the guitar with skill, and the sounds of the music thrill the crowd. The bright stage lights in the otherwise dark concert hall add to the excitement, although they make it hot on stage. This scene represents energy in several different forms. Do you know what they are? You'll find out in this lesson.



FIGURE 1.1

How many different forms of energy can you identify in this picture?

Comparing Forms of Energy

Energy, or the ability to do work, can exist in many different forms. The photo in **Figure 1.1** represents six of the eight different forms of energy that are described in this lesson. The guitarist gets the energy he needs to perform from chemical energy in food. He uses mechanical energy to pluck the strings of the guitar. The stage lights use electrical energy and give off both light energy and thermal energy, commonly called heat. The guitar also uses electrical energy, and it produces sound energy when the guitarist plucks the strings. For an introduction to all these forms of energy, go to this URL: <http://www.need.org/needpdf/FormsofEnergy.pdf> .

For an interactive animation about the different forms of energy, visit this URL: <http://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=651> .

After you read below about different forms of energy, you can check your knowledge by doing the drag and drop quiz at this URL: <http://www.think-energy.co.uk/ThinkEnergy/11-14/activities/TypesEnergy.aspx> .

Mechanical Energy

Mechanical energy is the energy of an object that is moving or has the potential to move. It is the sum of an object's kinetic and potential energy. In **Figure 1.2**, the basketball has mechanical energy because it is moving. The arrow in the same figure has mechanical energy because it has the potential to move due to the elasticity of the bow. What are some other examples of mechanical energy?



FIGURE 1.2

Kinetic and potential energy add up to mechanical energy.

Energy associated with the movement and potential movement of objects is called mechanical energy.

Chemical Energy

Energy is stored in the bonds between atoms that make up compounds. This energy is called **chemical energy**, and it is a form of potential energy. If the bonds between atoms are broken, the energy is released and can do work. The wood in the fireplace in **Figure 1.3** has chemical energy. The energy is released as thermal energy when the wood burns. People and many other living things meet their energy needs with chemical energy stored in food. When food molecules are broken down, the energy is released and may be used to do work.

**FIGURE 1.3**

Chemical energy is stored in wood and released when the wood burns.

Electrical Energy

Electrons are negatively charged particles in atoms. Moving electrons have a form of kinetic energy called **electrical energy**. If you've ever experienced an electric outage, then you know how hard it is to get by without electrical energy. Most of the electrical energy we use is produced by power plants and arrives in our homes through wires. Two other sources of electrical energy are pictured in **Figure 1.4**.



An average lightning bolt has about 500 million joules of electrical energy!



Over its lifetime, an AA battery may provide about 9000 joules of electrical energy.

FIGURE 1.4

A lightning bolt is a powerful discharge of electrical energy. A battery contains stored chemical energy and converts it to electrical energy.

Nuclear Energy

The nuclei of atoms are held together by powerful forces. This gives them a tremendous amount of stored energy, called nuclear energy. The energy can be released and used to do work. This happens in nuclear power plants when nuclei fission, or split apart. It also happens in the sun and other stars when nuclei fuse, or join together. Some of the sun's energy travels to Earth, where it warms the planet and provides the energy for photosynthesis (see **Figure 1.5**).

Thermal Energy

The atoms that make up matter are in constant motion, so they have kinetic energy. All that motion gives matter thermal energy. **Thermal energy** is defined as the total kinetic energy of all the atoms that make up an object. It



FIGURE 1.5

In the sun, hydrogen nuclei fuse to form helium nuclei. This releases a huge amount of energy, some of which reaches Earth.

depends on how fast the atoms are moving and how many atoms the object has. Therefore, an object with more mass has greater thermal energy than an object with less mass, even if their individual atoms are moving at the same speed. You can see an example of this in **Figure 1.6**.

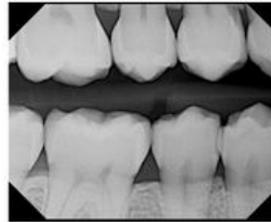


FIGURE 1.6

Atoms are moving at the same speed in the soup on the spoon as they are in the soup in the pot. However, there are more atoms of soup in the pot, so it has more thermal energy.

Electromagnetic Energy

Energy that the sun and other stars release into space is called **electromagnetic energy**. This form of energy travels through space as electrical and magnetic waves. Electromagnetic energy is commonly called light. It includes visible light, as well as radio waves, microwaves, and X rays (**Figure 1.7**).



A radio tower (left) sends radio waves through the air. Radios in the area can pick up the energy and convert it to sound.

A microwave oven (above right) sends microwaves through food, causing it to cook quickly.

An X-ray machine sends out X rays that pass through soft tissues such as skin but not through hard tissues such as teeth. The X rays create an image on film (bottom right).

FIGURE 1.7

Radio waves, microwaves, and X rays are examples of electromagnetic energy.

Sound Energy

The drummer in **Figure 1.8** is hitting the drumheads with drumsticks. This causes the drumheads to vibrate. The vibrations pass to surrounding air particles and then from one air particle to another in a wave of energy called **sound energy**. We hear sound when the sound waves reach our ears. Sound energy can travel through air, water, and other substances, but not through empty space. That's because the energy needs particles of matter to pass it on.



FIGURE 1.8

Vibrating objects such as drumheads produce sound energy.

How Energy Changes Form

Energy often changes from one form to another. For example, the mechanical energy of a moving drumstick changes to sound energy when it strikes the drumhead and causes it to vibrate. Any form of energy can change into any other form. Frequently, one form of energy changes into two or more different forms. For example, when wood burns, the wood's chemical energy changes to both thermal energy and light energy. Other examples of energy conversions are described in **Figure 1.9**. You can see still others at this URL: <http://fi.edu/guide/hughes/energychangeex.html> .

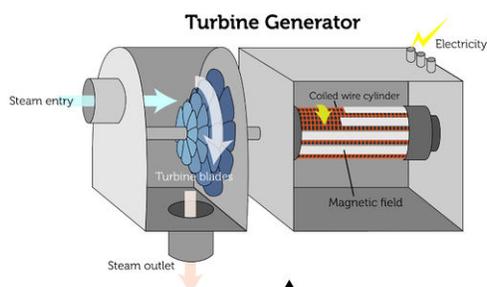
You can check your understanding of how energy changes form by doing the quizzes at these URLs:

- <http://www.think-energy.co.uk/ThinkEnergy/11-14/activities/EnergyTrans2.aspx>
- <http://www.poweringourfuture.com/students/energy/2.html>

A toaster changes electrical energy to thermal energy, which toasts the bread.



During photosynthesis, plants change light energy from the sun to chemical energy stored in food. Organisms that eat plants change the chemical energy in food to other forms of energy, such as thermal energy and kinetic energy.



In a steam turbine, thermal energy heats water to create steam. The steam turns the turbine blades, giving them mechanical energy. The turning blades cause a coil of wire to rotate around a magnet. This generates electrical energy.



A blender changes electrical energy to sound energy and to the mechanical energy of the turning blades. The rapidly turning blades blend the food.

FIGURE 1.9

Energy is constantly changing form. Can you think of other examples of energy conversions?

Energy is conserved in energy conversions. No energy is lost when energy changes form, although some may be released as thermal energy due to friction. For example, not all of the energy put into a steam turbine in **Figure 1.9** changes to electrical energy. Some changes to thermal energy because of friction of the turning blades and other moving parts. The more efficient a device is, the greater the percentage of usable energy it produces. Appliances with an "Energy Star" label like the one in **Figure 1.10** use energy efficiently and thereby reduce energy use.

Lesson Summary

- Forms of energy include mechanical, chemical, electrical, nuclear, thermal, electromagnetic, and sound energy. These forms of energy can occur as either kinetic or potential energy.

**FIGURE 1.10**

The U.S. government's Energy Star program certifies the energy efficiency of appliances. Look for this label to identify those that are energy efficient.

- Energy often changes from one form to another. Any form of energy can change into any other, and one form may change into two or more different forms. Energy is always conserved when it changes form.

Lesson Review Questions

Recall

1. Define mechanical energy.
2. Give an example of chemical energy.
3. What is electrical energy?
4. Name two processes that release nuclear energy.
5. List three types of electromagnetic energy.

Apply Concepts

6. If you were on the moon, no sound energy would be able to reach your ears. Explain why. (*Hint:* The moon has no atmosphere.)
7. State how energy is converted by the following electrical devices: light bulb, alarm clock, hair dryer.

Think Critically

8. Relate the thermal energy of an object to the object's atoms.

Points to Consider

In this lesson, you read about electrical appliances that convert electrical energy to other forms of energy, such as thermal energy or sound energy.

- What form of energy is converted to electrical energy when electric current is generated?
- What natural resources might provide the energy needed to generate electricity?

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