Section 3

Energy Transformations and Conservation

Reading Preview

Key Concepts

- How are different forms of energy related?
- What is a common energy transformation?
- What is the law of conservation of energy?

Key Terms

- energy transformation
- law of conservation of energy
- matter

Target Reading Skill

Asking Questions Before you read, preview the red headings and ask a *what* or *how* question for each heading. As you read, write the answers to your questions.

Energy Transformations

Question	Answer
What is an energy transformation?	An energy transformation is . . .

Lab zone Discover Activity

What Would Make a Card Jump?

1. Fold an index card in half.
2. In the edge opposite the fold, cut two slits that are about 2 cm long and 2 cm apart.
3. Keep the card folded and loop a rubber band through the slits. With the fold toward you, gently open the card like a tent and flatten it against your desk.
4. Predict what will happen to the card if you let go. Then test your prediction.

Think It Over

Drawing Conclusions Describe what happened to the card. Based on your observations, what is the relationship between potential and kinetic energy?

The spray bounces off your raincoat as you look up at the millions of liters of water plunging toward you. The roar of the water is deafening. Are you doomed? Fortunately not—you are on a sightseeing boat at the foot of the mighty Niagara Falls. The waterfall carries the huge amount of water that drains from the upper Great Lakes. It lies on the border between Canada and the United States.

What many visitors don't know, however, is that Niagara Falls serves as much more than just a spectacular view. The Niagara Falls area is the center of a network of electrical power lines. Water that is diverted above the falls is used to generate electricity for much of the surrounding region.

▼ **Niagara Falls is more than 50 meters high.**

Energy Transformations

What does flowing water have to do with electricity? You may already know that the mechanical energy of moving water can be transformed into electrical energy. **Most forms of energy can be transformed into other forms.** A change from one form of energy to another is called an **energy transformation.** Some energy changes involve single transformations, while others involve many transformations.

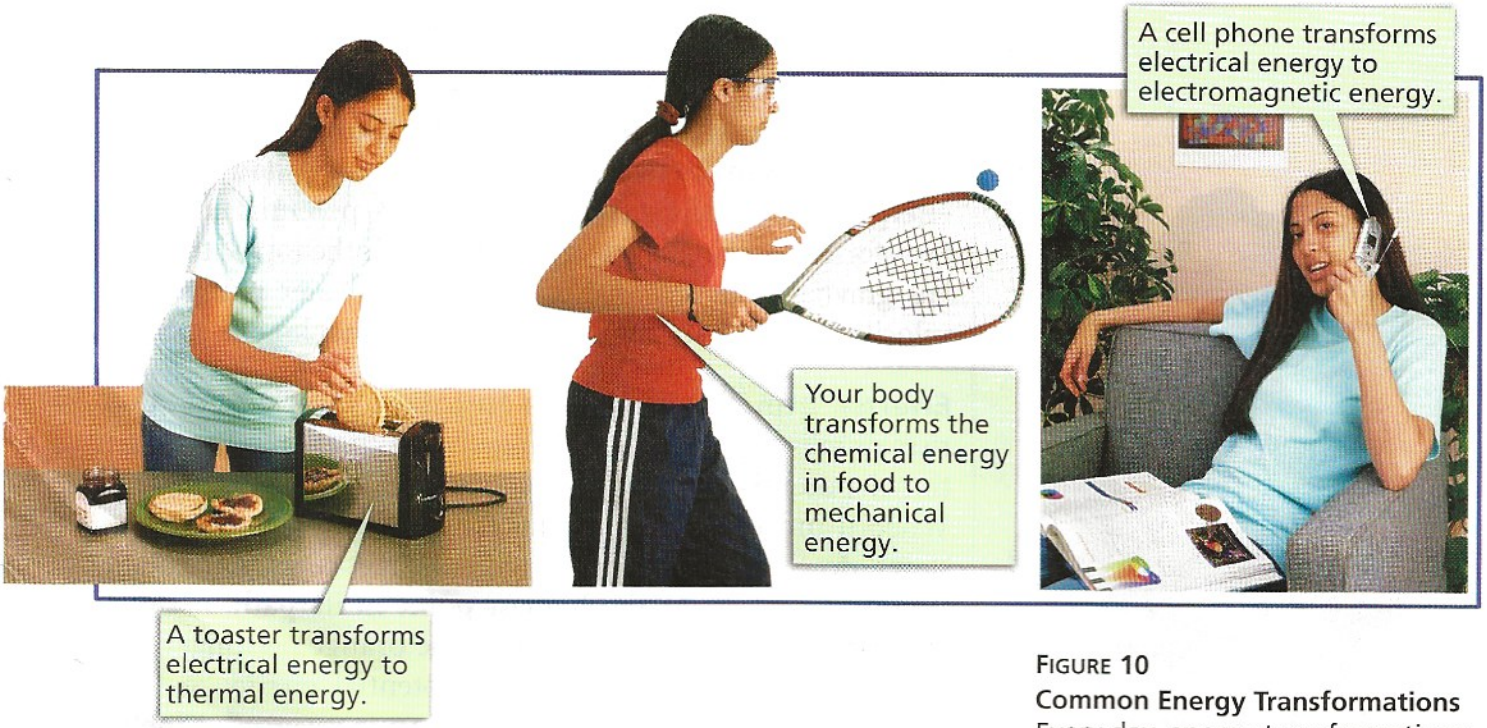

FIGURE 10
Common Energy Transformations Every day, energy transformations are all around you. Some of these transformations happen inside you! **Observing** *What other energy transformations do you observe every day?*

Single Transformations Sometimes, one form of energy needs to be transformed into another to get work done. You are already familiar with many such energy transformations. For example, a toaster transforms electrical energy to thermal energy to toast your bread. A cell phone transforms electrical energy to electromagnetic energy that travels to other phones.

Your body transforms the chemical energy in your food to mechanical energy you need to move your muscles. Chemical energy in food is also transformed to the thermal energy your body uses to maintain its temperature.

Multiple Transformations Often, a series of energy transformations is needed to do work. For example, the mechanical energy used to strike a match is transformed first to thermal energy. The thermal energy causes the particles in the match to release stored chemical energy, which is transformed to thermal energy and the electromagnetic energy you see as light.

In a car engine, another series of energy conversions occurs. Electrical energy produces a spark. The thermal energy of the spark releases chemical energy in the fuel. The fuel's chemical energy in turn becomes thermal energy. Thermal energy is converted to mechanical energy used to move the car, and to electrical energy to produce more sparks.

Reading Checkpoint **What is an example of a multiple transformation of energy?**

Lab zone Skills Activity

Classifying

Many common devices transform electrical energy into other forms. Think about the following devices in terms of energy transformations.

- steam iron
- ceiling fan
- digital clock
- dryer

For each device, describe which form or forms of energy the electrical energy becomes. Do these devices produce single or multiple transformations of energy?

FIGURE 11
Juggling The kinetic energy of an orange thrown into the air becomes gravitational potential energy. Its potential energy becomes kinetic energy as it falls.

Transformations Between Potential and Kinetic Energy

One of the most common energy transformations is the transformation between potential energy and kinetic energy. In waterfalls such as Niagara Falls, potential energy is transformed to kinetic energy. The water at the top of the falls has gravitational potential energy. As the water plunges, its velocity increases. Its potential energy becomes kinetic energy.

Energy Transformation in Juggling Any object that rises or falls experiences a change in its kinetic and gravitational potential energy. Look at the orange in Figure 11. When it moves, the orange has kinetic energy. As it rises, it slows down. Its potential energy increases as its kinetic energy decreases. At the highest point in its path, it stops moving. Since there is no motion, the orange no longer has kinetic energy. But it does have potential energy. As the orange falls, the energy transformation is reversed. Kinetic energy increases while potential energy decreases.

Energy Transformation in a Pendulum In a pendulum, a continuous transformation between kinetic and potential energy takes place. At the highest point in its swing, the pendulum in Figure 12 has no movement, so it only has gravitational potential energy. As it swings downward, it speeds up. Its potential energy is transformed to kinetic energy. The pendulum is at its greatest speed at the bottom of its swing. There, all its energy is kinetic energy.

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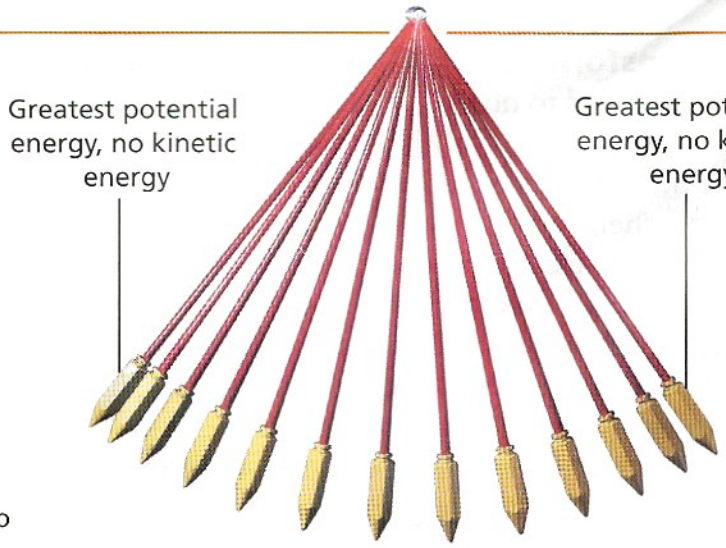

FIGURE 12
Pendulum
A pendulum continuously transforms energy from kinetic to potential energy and back.
Interpreting Diagrams *At what two points is the pendulum's potential energy greatest?*