SECTION 3

Conservation of Energy

Many roller coasters have a mechanism that pulls the cars up to the top of the first hill. But the cars are on their own for the rest of the ride.

As the cars go up and down the hills on the track, their potential energy is converted into kinetic energy and back again. But the cars never return to the same height at which they started. Does energy get lost somewhere along the way? No, it is just converted into other forms of energy.

What You Will Learn

- Explain how energy is conserved within a closed system.
- Explain the law of conservation of energy.
- Give examples of how thermal energy is always a result of energy conversion.
- Explain why perpetual motion is impossible.

Vocabulary

friction
law of conservation of energy

READING STRATEGY

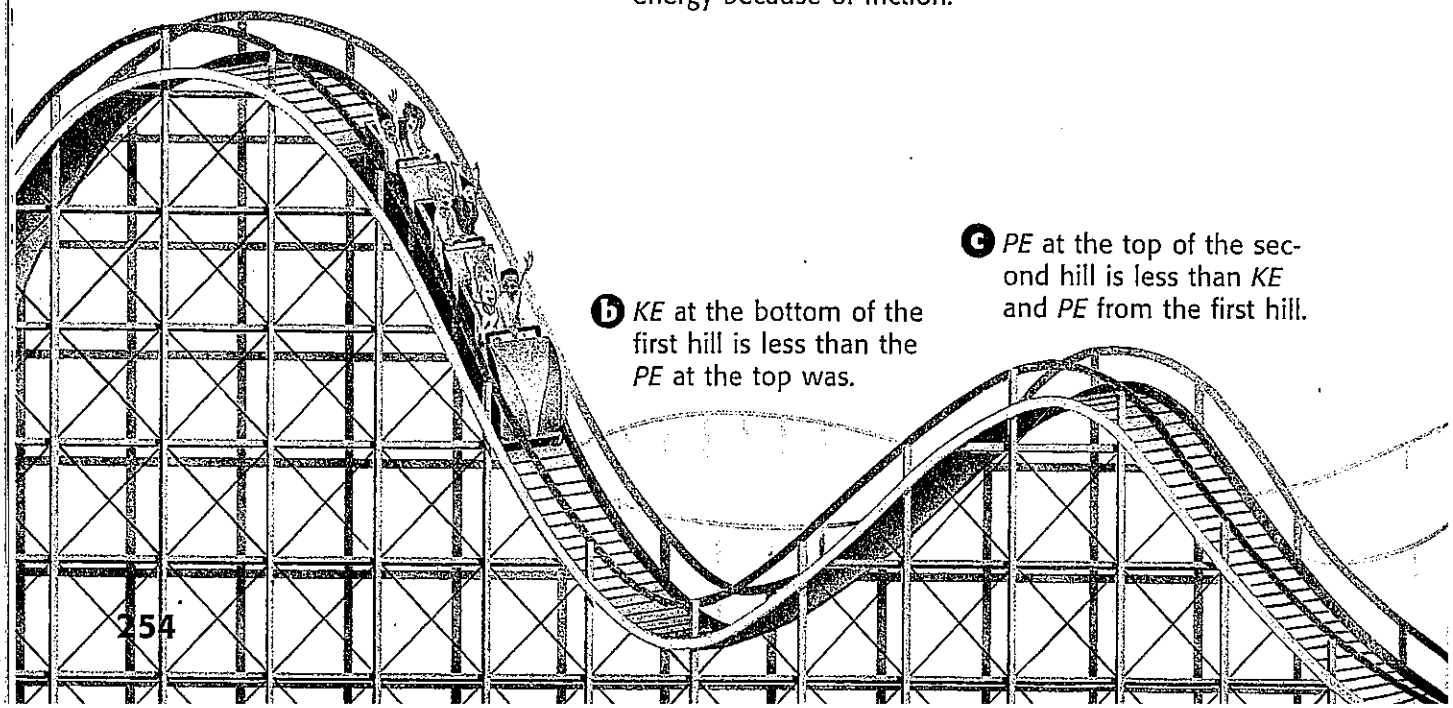
Paired Summarizing Read this section silently. In pairs, take turns summarizing the material. Stop to discuss ideas that seem confusing.

Where Does the Energy Go?

To find out where a roller coaster's original potential energy goes, you have to think about more than just the hills of the roller coaster. Friction plays a part too. **Friction** is a force that opposes motion between two surfaces that are touching. For the roller coaster to move, energy must be used to overcome friction. There is friction between the cars' wheels and the track and between the cars and the air around them. As a result, not all of the potential energy of the cars changes into kinetic energy as the cars go down the first hill. Likewise, as you can see in **Figure 1,** not all of the kinetic energy of the cars changes back into potential energy.

Figure 1 **Energy Conversions in a Roller Coaster**

Not all of the cars' potential energy (*PE*) is converted into kinetic energy (*KE*) as the cars go down the first hill. In addition, not all of the cars' kinetic energy is converted into potential energy as the cars go up the second hill. Some of it is changed into thermal energy because of friction.



Energy Is Conserved Within a Closed System

A *closed system* is a group of objects that transfer energy only to each other. For example, a closed system that involves a roller coaster consists of the track, the cars, and the air around them. On a roller coaster, some mechanical energy (the sum of kinetic and potential energy) is always converted into thermal energy because of friction. Sound energy also comes from the energy conversions in a roller coaster. If you add together the cars' kinetic energy at the bottom of the first hill, the thermal energy due to overcoming friction, and the sound energy made, you end up with the same total amount of energy as the original amount of potential energy. In other words, energy is conserved and not lost.

friction a force that opposes motion between two surfaces that are in contact

law of conservation of energy the law that states that energy cannot be created or destroyed but can be changed from one form to another

Law of Conservation of Energy

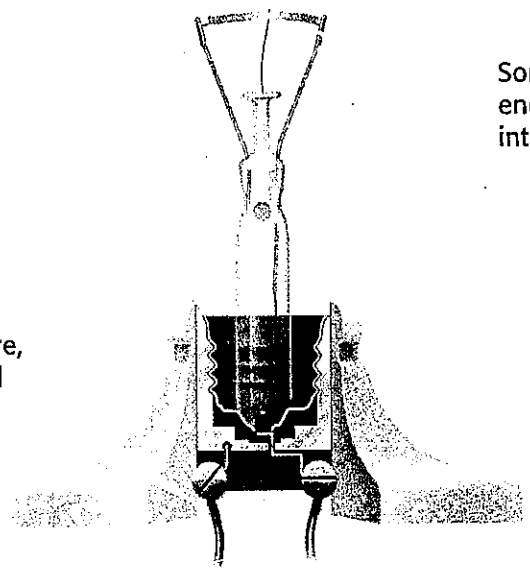
Energy is conserved in all cases. Because no exception to this rule has been found, this rule is described as a law. According to the **law of conservation of energy,** energy cannot be created or destroyed. The total amount of energy in a closed system is always the same. As **Figure 2** shows, energy can change from one form to another. But all of the different forms of energy in a system always add up to the same total amount of energy. It does not matter how many energy conversions take place.

Reading Check Why is the conservation of energy considered a scientific law? *(See the Appendix for answers to Reading Checks.)*

Figure 2 Energy Conservation in a Light Bulb

Some energy is converted into thermal energy, which makes the bulb feel warm.

As electrical energy is carried through the wire, some of it is converted into thermal energy.



Some electrical energy is converted into light energy.

No Conversion Without Thermal Energy

Any time one form of energy is converted into another form, some of the original energy always gets converted into thermal energy. The thermal energy due to friction that results from energy conversions is not useful energy. That is, this thermal energy is not used to do work. Think about a car. You put gas into a car. But not all of the gasoline's chemical energy makes the car move. Some wasted thermal energy will always result from the energy conversions. Much of this energy leaves through the radiator and the exhaust pipe.

Perpetual Motion? No Way!

People have sometimes tried to make a machine that would run forever without any additional energy. This perpetual (puhr PECH oo uhl) motion machine would put out exactly as much energy as it takes in. But that's impossible, because some waste thermal energy always results from energy conversions. The only way a machine can keep moving is to have a constant supply of energy. For example, the "drinking bird" shown in **Figure 3** uses thermal energy from the air to evaporate the water from its head. So, it is not a perpetual motion machine.

Reading Check Why is "perpetual motion" impossible?

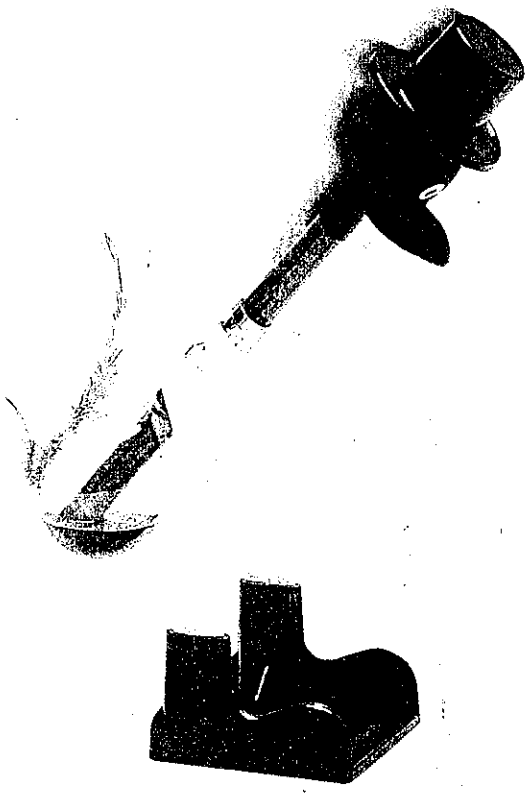
SCHOOL to HOME

Energy Conversions

With an adult, find three examples of energy conversions that take place in your home. In your **science journal,** write down the kinds of energy that go into each conversion and the kinds of energy that result. For each type of energy that is output, indicate whether the energy is useful.

ACTIVITY

Figure 3 The "Drinking Bird"



1. When the bird "drinks," the felt covering its head gets wet.
2. When the bird is upright, water evaporates from the felt, which decreases the temperature and pressure in the head. Fluid is drawn up from the tail, where pressure is higher, and the bird tips downward.
3. After the bird "drinks," fluid returns to the tail, the bird flips upright, and the cycle repeats.

Name _____ Date _____

Conservation of Energy

Define closed system:

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Give an example of a closed system:

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Describe the Law of Conservation of Energy:

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During any energy conversion, some of the original energy always gets converted in

_____ **energy.**