Name: _____

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16 Potential and Kinetic Energy

7.1-C14

Getting the Idea

Key Words

energy
potential energy
kinetic energy

Energy is a word you use often in everyday life. You know that you need energy to climb stairs or to carry your books. When you are advised to eat a good healthy meal, you are told that it will give you energy. If you are tired and want to go to sleep, you say that you do not have the energy to stay awake. What is energy? The scientific definition of energy is really not much different from the way you use the word in everyday life.

What Is Energy?

Energy is the ability to do work. As you learned in Lesson 15, work is a measure of force applied over a distance to move an object. All energy is classified into two broad categories: potential energy and kinetic energy. Either form of energy can change into the other. You need energy in order to get things done. For example, you know that your body must use energy if you want to pick up a box and move it across a room.

Potential Energy

Potential energy (*PE*) is energy an object has because of its position or composition. Potential energy is stored energy. It has the "potential" to do work. A rock at the edge of a cliff has potential energy due to its position. Gravitational force can pull the rock down to the bottom of the cliff. Fuel such as gasoline or coal also has potential energy. When the fuel burns, the energy stored in its chemical bonds is released.

Did You Know?

Both energy and work are measured in units called joules. The unit was named after the English physicist James Prescott Joule (1818–1889).

Like work, potential energy is measured in joules (J). Near Earth, you can calculate an object's gravitational potential energy (*GPE*) near Earth by the following formula:

$$GPE = mgh$$

In the formula above, m is mass in kilograms, g is acceleration due to gravity, and h is height in meters. Suppose a rock at the edge of a cliff has a mass of 10 kg, and its height above the ground below is 100 m. As you learned in Lesson 14, acceleration due to gravity near Earth's surface is 9.8 m/s^2. So the rock's gravitational potential energy is 9800 J.

$$GPE = 10 \times 9.8 \times 100$$
$$GPE = 9800 \text{ J}$$

Kinetic Energy

Kinetic energy (*KE*) is the energy of motion. The amount of kinetic energy an object has depends on two factors: the object's mass and its speed. An object's kinetic energy changes if its mass or its speed changes.

You can calculate the amount of kinetic energy an object has using the formula:

$$KE = \frac{1}{2} mv^2$$

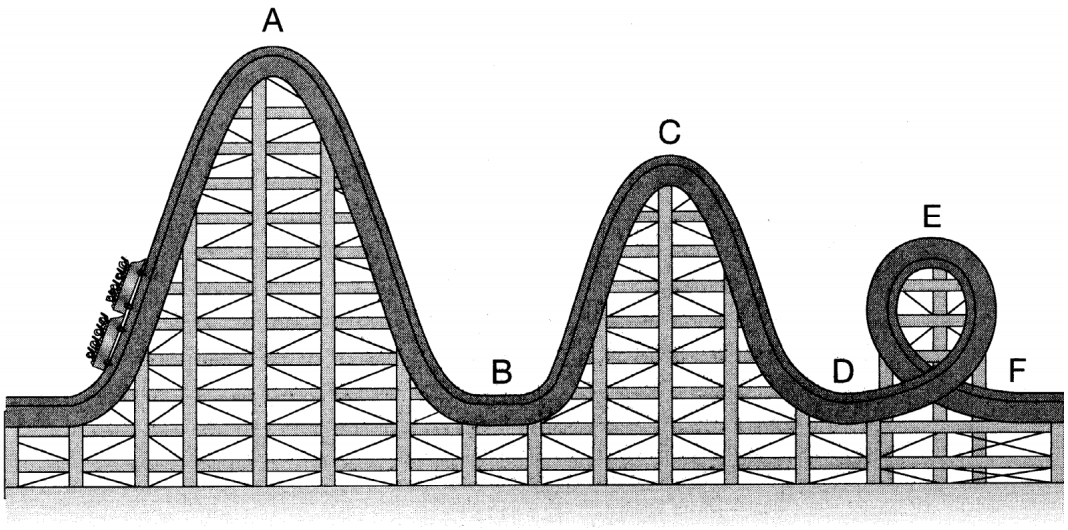
In the formula above, m is mass in kilograms, and v is speed in meters per second. At one point in its fall from the cliff, the 10-kg rock is moving at a speed of 20 m/s. You can calculate its kinetic energy as follows:

$$KE = \frac{1}{2} \times 10 \times 20^2$$
$$KE = 0.5 \times 10 \times 400$$
$$KE = 2000 \text{ J}$$

Potential and Kinetic Energy Transformations

Potential energy can change to kinetic energy, and vice versa. Picture a car on a roller coaster. At the top of a hill, the car has mostly potential energy. As the car rolls down the hill, it moves faster and faster. More and more of its potential energy changes to kinetic energy. At the bottom of the hill, it has mostly kinetic energy. As the kinetic energy pushes the car up the next hill, the kinetic energy changes back to potential energy.

In the diagram below, the roller coaster car has mostly potential energy at points A, C, and E. At points B, D, and F, the car has mostly kinetic energy.



In an ideal system, the total amount of energy would stay the same. The car's potential energy at the top of the hill would equal its kinetic energy at the bottom of the hill. In such a system, the roller coaster car could go up and down hills forever. But in real life, friction changes some of the energy to heat. The wheels of the roller coaster get hot. Because the energy that is changed to heat is not useful energy, it is sometimes described as "lost" energy. But the energy is not really "lost." It is just changed to another form of energy.

LESSON REVIEW

1. An apple is hanging from a tree branch. A gust of wind blows the tree, and the apple falls. Which of the following describes the apple's energy just as the apple hits the ground?

   A. Its potential energy is zero.

   B. Its kinetic energy is zero.

   C. Its kinetic energy is twice its potential energy.

   D. Its kinetic energy equals its potential energy.

2. As a ball rolls down a hill, it has less potential energy than it did at the top of the hill. Some of the ball's potential energy

   A. disappears.

   B. decreases friction.

   C. creates even more energy.

   D. changes to kinetic energy.

3. A roller coaster car has the most kinetic energy when it is

   A. at the top of a hill.

   B. halfway down a hill.

   C. just reaching the bottom of a hill

   D. three-quarters of the way down a hill

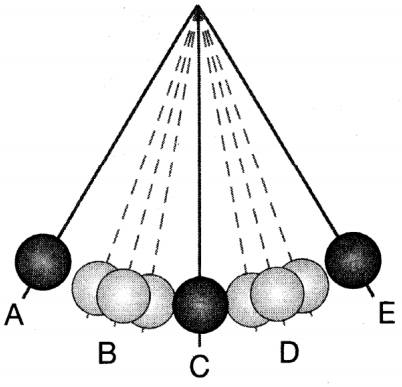
4. A bowling ball with a mass of 5 kg is rolling at a speed of 2 m/s. What is its kinetic energy?

   A. 20 J **C.** 15 J

   B. 5 J **D.** 10 J

DISCUSSION QUESTION

As a pendulum swings, its energy is constantly changed from potential energy to kinetic energy and back again. Study the diagram below.



At which point in its swing does the pendulum have the least potential energy and the most kinetic energy? Explain your answer.