9.6 Work-Energy Theorem

The work-energy theorem states that whenever work is done, energy changes.

- The **work-energy theorem** describes the relationship between work and energy.
- Work equals change in kinetic energy. In equation form, Work = ΔKE, where the delta symbol, Δ, means "change in." The work in this equation is the *net* work.
- If you push a box across a floor at a constant speed, you are pushing just hard enough to overcome friction. In this example, the net force and net work are zero, and KE = 0.
- Kinetic energy often appears hidden in different forms of energy. Random molecular motion is sensed as *heat. Sound* consists of molecules vibrating in rhythmic patterns. *Light* energy originates in the motion of electrons in atoms. Electrons in motion make *electric currents.*

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9.7 Conservation of Energy

✓ **The law of conservation of energy states that energy cannot be created or destroyed. It can be transformed from one form into another, but the total amount of energy never changes.**

- The study of the various forms of energy and the transformations from one form into another is the **law of conservation of energy.**
- Everywhere along the path of a pendulum bob, the sum of potential energy and kinetic energy is the same. At the highest points, the energy is only potential energy. At the lowest point, the energy is only kinetic energy.
- The sun shines because some of its nuclear energy is transformed into radiant energy. In nuclear reactors, nuclear energy is transformed into heat.
- Some electric-generating plants transform the energy of falling water into electrical energy. Electrical energy then travels through wires to homes.

9.6 Work-Energy Theorem (pages 151–152)

25. Express the work-energy theorem.

____

26. Explain this equation: Work = ΔKE.

____

27. Is the following sentence true or false? If you push against a heavy refrigerator, and it doesn't slide, then you are not doing work on the refrigerator.

____

28. Suppose you push against a box so that it moves across a horizontal surface. Explain how to determine the change in kinetic energy in each of the following cases.
    a. The surface has no friction. ______________________________
    b. The surface has some friction. ______________________________
    c. The box moves at a constant speed across a surface that has some friction.

____

29. Is the following sentence true or false? The maximum friction that the brakes of a car can supply is nearly the same whether the car moves slowly or quickly.

____

Match each form of hidden kinetic energy with its description.

	Form of Kinetic Energy	Description
______	**30.** heat	a. consists of molecules vibrating in rhythmic patterns
______	**31.** sound	b. produced by electrons in motion
______	**32.** electricity	c. results from random molecular motion

9.7 Conservation of Energy (pages 153–154)

33. The energy an arrow delivers to a target is slightly less than the energy it had when it was flying toward the target. What happened to the lost energy?

____

34. Express the law of conservation of energy.

____

35. The wound spring of a toy car has 10 J of potential energy. Only 8 J of this energy changes to kinetic energy as the car moves. What happens to the remaining 2 J of energy?

____

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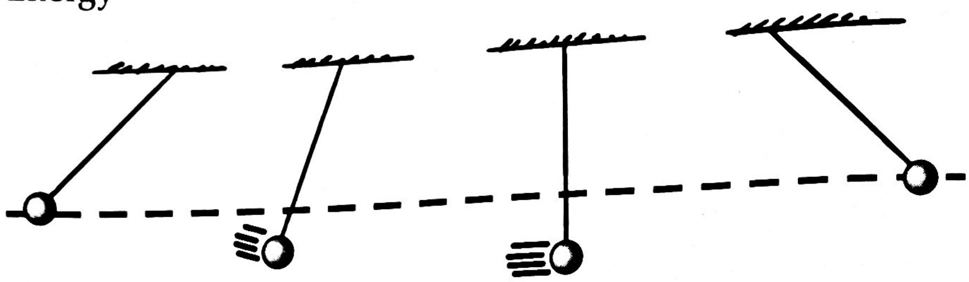

36. The figure above shows the energy of a swinging pendulum bob at different points along its path.

a. If you ignore friction, how does the energy of the bob at the highest points of its path compare to the energy at the lowest point of its path?

____

____

b. How does friction affect the pendulum?

____

37. The sun shines because some of its nuclear energy is transformed into ______________________ energy.

38. In nuclear reactors, nuclear energy is transformed into ______________________.

39. Suppose a person in distress leaps from a burning building onto a firefighter's trampoline near the ground.

a. Describe the change in potential energy, kinetic energy, and total energy as the person falls.

____

b. Suppose the person has 10,000 J of potential energy just before jumping. What are the person's potential energy and kinetic energy upon reaching the trampoline?

____

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Gravitational Potential Energy

Calculate the increase in potential energy when a crane lifts a 2,000-kg car a vertical distance of 10 m. The acceleration due to gravity (g) is 10 m/s^2.

1. Read and Understand

What information are you given?

Mass of the car, $m = 2{,}000$ kg

Height of the car, $h = 10$ m

2. Plan and Solve

What unknown are you trying to calculate?

Gravitational potential energy = PE

What mathematical equation can you use to calculate the unknown?

Gravitational potential energy, PE = mgh

Substitute the information you know into the equation.

$$PE = mgh$$
$$= (2{,}000 \text{ kg})(10 \text{ m/s}^2)(10 \text{ m})$$

Multiply to find the unknown.

PE = 200,000 J = 200 kJ

3. Look Back and Check

Is your answer reasonable?

The magnitude of the potential energy is 100 times the mass of the car. This is reasonable because the car is lifted 10 m.

Math Practice

On a separate sheet of paper, solve the following problems.

1. A football player throws a ball with a mass of 0.34 kg. What is the gravitational potential energy of the ball when it is 5.0 m above the ground?

2. A 2.0-kg book is on a shelf that is 1.6 m high. What is the gravitational potential energy of the book relative to the ground?

3. A 36-kg girl walks to the top of stairs that are 2.0-m high. How much gravitational potential energy does the girl gain?

4. A can of soup has a mass of 0.35 kg. The can is moved from a shelf that is 1.2 m off the ground to a shelf that is 0.40 m off the ground. How does the gravitational potential energy of the can change?