

Chapter 15 Energy

Summary**15.1 Energy and Its Forms**

Energy is the ability to do work. Recall that work is done when a force moves an object. When work is done on an object, energy is transferred, or passed on, to that object. Therefore, work is actually a transfer of energy. Like work, energy is measured in joules (J). There are two general types of energy: kinetic energy and potential energy.

Kinetic energy is the energy of motion. All moving objects have kinetic energy. The kinetic energy of a moving object depends on the object's mass and speed. The greater the mass or speed of the object, the more kinetic energy it has. To calculate the kinetic energy of an object, you multiply half the object's mass (m) times its speed (v) squared:

$$\text{Kinetic energy} = \frac{1}{2} mv^2$$

Potential energy is energy that is stored in an object as a result of its position or shape. Two types of potential energy are gravitational potential energy and elastic potential energy. An object gains gravitational potential energy when it is raised to a greater height. The gravitational potential energy of an object depends on the object's mass (m), the force of gravity (g), and the object's height (h). The formula for gravitational potential energy is

$$\text{Potential energy} = mgh$$

An object gains elastic potential energy when it is stretched or is pressed together. For example, stretching a rubber band or pressing a spring gives the object elastic potential energy.

Energy can take several different forms. Major forms of energy are mechanical energy, thermal energy, chemical energy, electrical energy, electromagnetic energy, and nuclear energy.

- Mechanical energy is the sum of an object's potential and kinetic energy. A speeding train has mechanical energy.
- Thermal energy is the sum of the potential and kinetic energy of all the particles in an object. The faster the particles move, the higher the object's thermal energy and the warmer the object becomes. Hot molten metal contains a great deal of thermal energy.
- Chemical energy is the stored energy that holds together chemical compounds. When the compounds break down, the energy is released. A fuel such as gasoline is a rich store of chemical energy.
- Electrical energy is the transfer of electric charges. Lightning bolts are produced by electrical energy.
- Electromagnetic energy is energy that travels through space as waves. Sunlight and X-rays are examples of electromagnetic energy.
- Nuclear energy is the stored energy that holds together the nucleus of an atom. This energy can be released by breaking apart heavy nuclei. Nuclear fission is a process that splits the nucleus apart to release nuclear energy.

15.2 Energy Conversion and Conservation

Energy can be changed from one form to another. The process of changing energy from one form to another form is called energy conversion. A wind-up toy demonstrates energy conversion. When you turn the key of the toy, elastic potential energy is stored in a spring. When the spring is released, the potential energy is changed into kinetic energy, and the toy moves.

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When energy changes from one form to another, the total amount of energy stays the same. This supports the law of conservation of energy. The law states that energy cannot be created or destroyed. This law is one of the most important concepts in science.

A very common energy conversion is a change from gravitational potential energy to kinetic energy. This occurs whenever an object falls due to the force of gravity. Throughout the fall, the object's potential energy decreases, while its kinetic energy increases. However, the sum of the object's potential and kinetic energy remains the same because of the conservation of energy.

The change from gravitational potential energy to kinetic energy occurs when a pendulum swings downward from its highest point to its lowest point. As the pendulum swings back upward again, the kinetic energy changes back to gravitational potential energy. Another example of this type of energy conversion is a pole vaulter. A pole-vaulter changes kinetic energy to potential energy to propel herself into the air. Then, gravitational potential energy changes back to kinetic energy as the pole-vaulter falls back to the ground.

In the early 1900s, physicist Albert Einstein showed that energy and mass can be changed into each other. In other words, energy is released as matter is destroyed, and matter can be created from energy.

15.3 Energy Resources

Energy resources may be renewable or nonrenewable. Nonrenewable energy resources are limited in amount and take millions of years to replace. They include oil, natural gas, coal, and uranium. Several nonrenewable energy resources, including oil and coal, are known as

fossil fuels. They are called fossil fuels because they were formed underground from the remains of dead organisms. Fossil fuels are the most commonly used fuels. They are relatively cheap and widely available. However, using fossil fuels creates pollution.

Renewable energy resources can be replaced in a relatively short period of time. They include

- hydroelectric energy—energy from flowing water
- solar energy—energy from sunlight
- geothermal energy—energy from the heat beneath Earth's surface
- biomass energy—chemical energy stored in living things

These sources of energy can be changed into other, more usable forms of energy, such as electrical or thermal energy. Using renewable energy resources creates less pollution than using fossil fuels.

Fossil fuels may become scarce and expensive in the future. We can make these energy resources last longer by using them more slowly. Two ways to make fossil fuels last longer are to reduce our energy needs and to use energy more efficiently. Finding ways to use less energy or to use energy more efficiently is known as energy conservation. Examples of energy conservation include

- turning off lights when they are not being used
- carpooling or using mass transportation such as buses and subways
- using energy-efficient appliances, cars, and light bulbs