Chapter 15: Energy

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Warm-Up Oct. 15

1. What is energy?
2. What is the unit for energy?
3. What are the 2 main types of energy?

Section 15.1: Energy and Its Forms

- Energy is the ability to do work or supply heat.
- When work is done on an object, the energy is transferred to that object.
- Both work and energy are measured in Joules (J).

Energy

- Many forms of energy can be classified into two general types: kinetic energy and potential energy.

Kinetic Energy

- Kinetic energy is the energy of motion.
- Formula for kinetic energy

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

KE = kinetic energy (J)

m = mass (kg)

v = velocity (m/s)

Kinetic Energy

- Notice that increasing the mass would increase the kinetic energy.
- However, increasing the speed would increase the kinetic energy.

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

½ (50kg)(10m/s)² = 2500J

(100kg)(0m/)² = 5 00J double

½( )(20 s)² = 100 0J ple)

SKIP!

- Remember: 1 kg·m²/s² = 1J

Practice Problems

- A 0.10kg bird is flying at a constant speed of 8.0m/s. What is the bird's kinetic energy?
- A 70.0kg man is walking at a speed of 2.0m/s. What is his kinetic energy?
- A 50.0kg cheetah has a kinetic energy of 18,000J. How fast is the cheetah running?

SKIP!

Practice Problems

- A 0.10kg bird is flying at a constant speed of 8.0m/s. What is the bird's kinetic energy?

  ½(0.10kg)(8.0m/s)² = 3.2J

- A 70.0kg man is walking at a speed of 2.0m/s. What is his kinetic energy?

  ½(70.0kg)(2.0m/s)² = 140J

- A 50.0kg cheetah has a kinetic energy of 18,000J. How fast is the cheetah running?

  Square root [2(18,000kg·m²/s²)/50.0kg] = 27m/s

SKIP!

Potential Energy

- Potential Energy is energy that is stored as a result of position or shape.
- Ex: Lifting a book increases its stored energy, but letting the book go turns the energy into kinetic energy.
- Two forms of potential energy are gravitational potential energy and elastic potential energy.

Gravitational Potential Energy

- Potential energy that depends on an object's height is called gravitational potential energy.
- This type of potential energy increases when an object is raised to a higher level.

Gravitational Potential Energy

- Formula for potential energy

PE = mgh

PE = potential energy (J)
m = mass (kg)
g = acceleration due to gravity (9.8 m/s^2)
h = height (m)

Gravitational Potential Energy

- Notice that <u>increasing</u> either the <u>mass</u> of the object or its <u>height</u> increases its <u>gravitational potential energy</u>.

$$PE = mgh$$

(5[illegible]kg)([illegible]8m/[illegible]^2)(10[illegible]) = [illegible]900

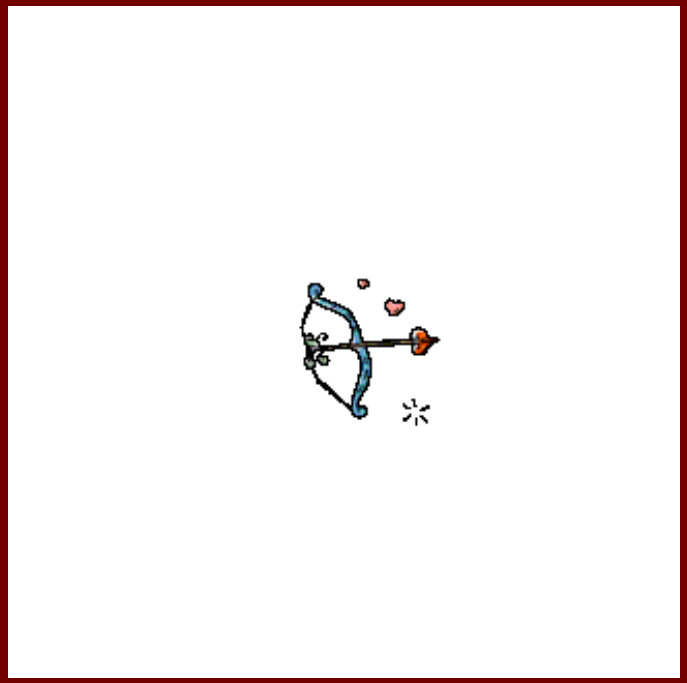
([illegible]0kg)(9.8m/s^2)(10m) = [illegible]980 J (dou[illegible]e)

(50kg)([illegible]m/[illegible])(2[illegible]m) = [illegible]800 (double)

SKIP!

Elastic Potential Energy

- The potential energy of an object that is stretched or compressed is known as elastic potential energy.

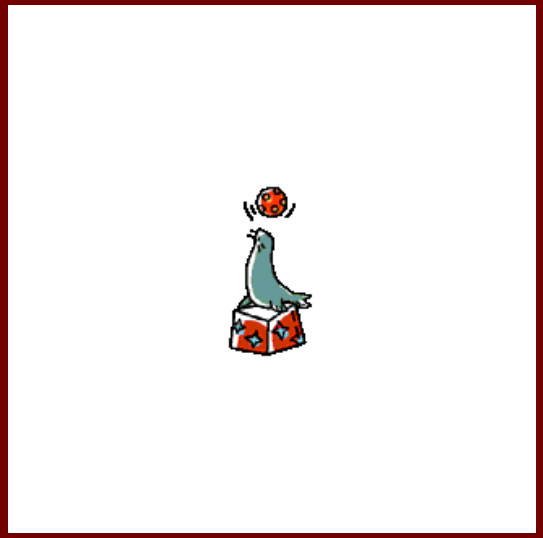


Forms of Energy

- The major forms of energy are mechanical energy, thermal energy, chemical energy, electrical energy, electromagnetic energy, and nuclear energy.
- Each form of energy can be converted into other forms of energy.

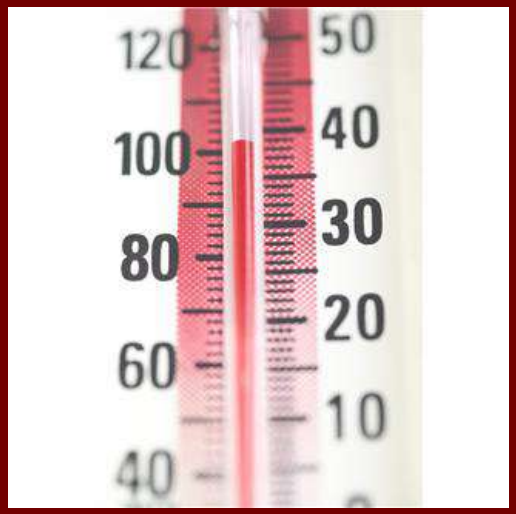
Mechanical Energy

- The energy associated with the motion and position of everyday objects is mechanical energy.
- Mechanical energy is the sum of an object's kinetic and potential energy.



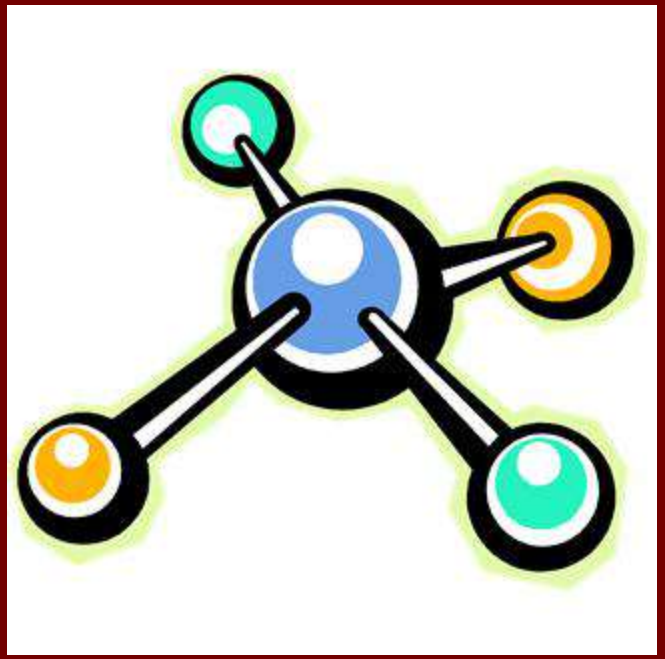
Thermal Energy

- The total potential and kinetic energy of all the microscopic particles in an object make up its thermal energy.
- When an object's atoms move faster, its thermal energy increases and the object becomes warmer.



Chemical Energy

- Chemical energy is the energy stored in chemical bonds.
- When bonds are broken, the released energy can do work.



Electrical Energy

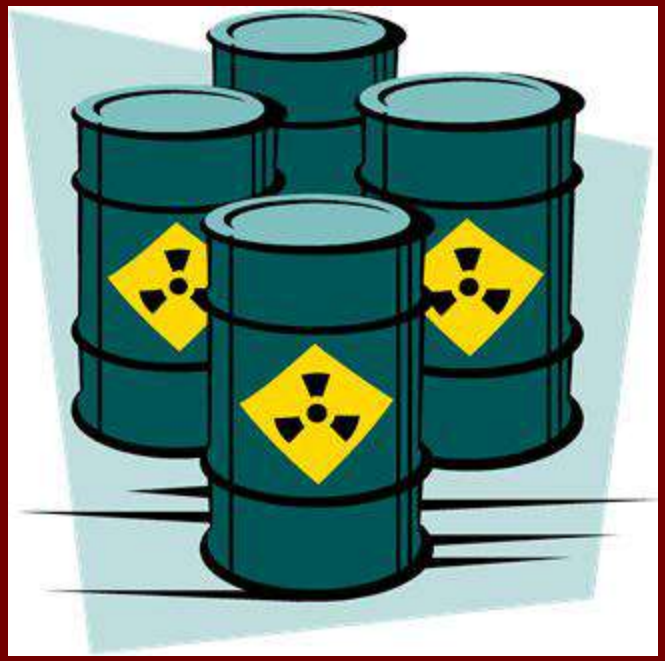
- Electrical energy is the energy associated with electric charges.

Electromagnetic Energy

- Electromagnetic energy is a form of energy that travels through space in the form of waves.

Nuclear Energy

- The energy stored in atomic nuclei is known as nuclear energy.



Section 15.1 Assessment

- Describe the relationship between work and energy.
- How is the kinetic energy of an object determined?
- What factors determine the gravitational potential energy of an object?
- When you heat a pot of water over a flame, what form of energy is added to the water?

Section 15.1 Assessment

- What kind of energy is represented by an archer stretching a bow string?
- Can an object have both kinetic energy and potential energy at the same time?
- A 60.0kg person walks from the ground to the roof of a 74.8m tall building. How much gravitational potential energy does she have?

SKIP!

$(60.0kg)(9.8m/s^2)(74.8m) = 44{,}000J$

Warm-Up Oct. 17

1. What is kinetic energy?
2. If an object has a mass of 10kg and a velocity of 20m/s, what is the kinetic energy?
3. What is the formula for potential energy?

Section 15.2: Energy Conversion and Conservation

- Energy can be converted from one form to another.
- The process of changing energy from one form to another is energy conversion.
- Ex: Light bulbs convert electrical energy into thermal energy and electromagnetic energy.

Conservation of Energy

- The law of conservation of energy states that energy cannot be created or destroyed.
- When energy changes from one form to another, the total energy remains unchanged even though many energy conversions may occur.

Energy Conversions

- The gravitational potential energy of an object is converted to the kinetic energy of motion as the object falls.
- A pendulum consists of a weight swinging back and forth from a rope or string.
- Kinetic energy undergoes constant conversion as a pendulum swings.

Energy Conversions

- When friction is small enough to be ignored, the total mechanical energy remains constant.
- Formula for conversion of mechanical energy

$$(KE + PE)_1 = (KE + PE)_2$$

Sample Problem

- At a construction site, a 1.50kg brick is dropped from rest and hits the ground at a speed of 26.0m/s. Calculate the gravitational potential energy of the brick before it was dropped.

$(KE + PE)_1 = (KE + PE)_2$

$KE_1 = 0J0J + PE_1 = KE_2 + 0J$

$PE_1 = ?KE_2 = ½\ mv^2$

$KE_2 = ½\ mv^2PE_1 = ½\ (1.50kg)(26.0m/s)^2$

$PE_2 = 0JPE_1 = 507J$

Practice Problems

- A 10kg rock is dropped and hits the ground below at a speed of 60m/s. Calculate the gravitational potential energy of the rock before you dropped it.

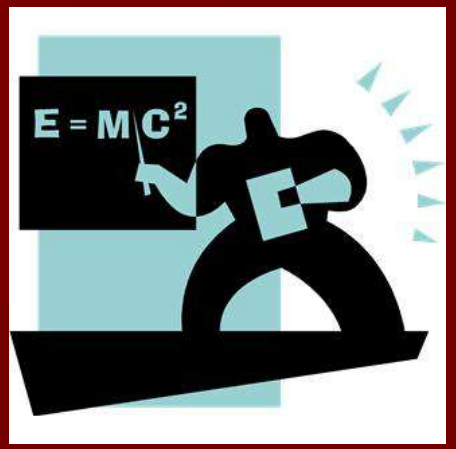
$0J + PE_1 = KE_2 + 0J \quad PE_1 = \frac{1}{2}(10kg)(60m/s)^2 = 18000J$

- A pendulum with a 1.0kg weight is set in motion from a position of 0.40m above the lowest point on the path of the weight. What is the kinetic energy of the pendulum at the lowest point?

$$0J + PE_1 = KE_2 + 0J$$

$$KE_2 = mgh = 1.0kg \times 9.8m/s^2 \times 0.40m = 4J$$

Energy and Mass



- Einstein's $E=mc^2$, says that energy and mass are equivalent and can be converted into each other.
- In other words, energy is released as matter is destroyed, and matter can be created from energy.
- The law of conservation of energy has been modified to say that mass and energy together are always conserved.

Section 15.2 Assessment

- What does the law of conservation of energy state?
- As an object falls in free fall, what energy change is taking place?
- What did Einstein conclude about the relationship between mass and energy?
- What type of energy change results when friction slows down an object?

Section 15.2 Assessment

- Describe the energy of a playground swing at its highest position.
- A 0.15kg ball is thrown into the air and rises to a height of 20.0m. How much kinetic energy did the ball initially have?

$$0J + KE_1 = PE_2 + 0J$$

$$KE_1 = mgh = 0.15kg \times 9.8m/s^2 \times 20.0m = 29J$$

Section 15.3: Energy Resources

- Nonrenewable energy resources exist in limited quantities and cannot be replaced except over the course of millions of years.
- Nonrenewable energy resources include oil, natural gas, coal, and uranium.

Fossil Fuels

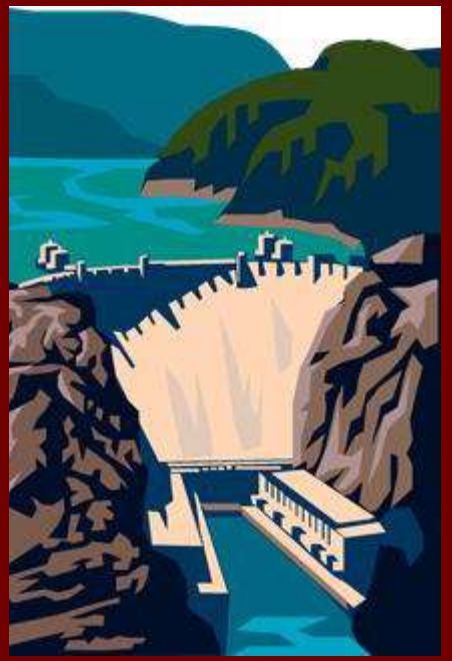
- Oil, natural gas, and coal are known as fossil fuels because they were formed underground from the remains of once-living organisms.
- Fossil fuels are relatively inexpensive and are usually readily available, but their use creates pollution.

Renewable Energy Resources

- Renewable energy resources are resources that can be replaced in a relatively short period of time.
- Renewable energy resources include hydroelectric, solar, geothermal, wind, biomass, and, in the future, nuclear fusion.

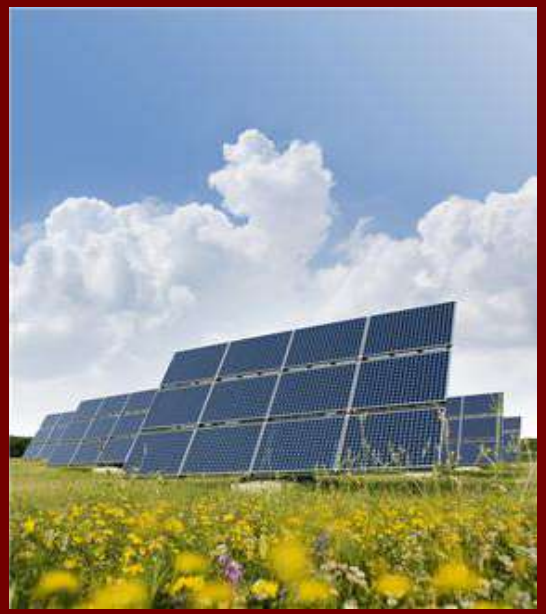
Hydroelectric Energy

- Energy obtained from flowing water is known as hydroelectric energy.
- As water flows downhill its kinetic energy can be used to turn turbines that are connected to electric generators.
- The downside is that dams prohibit fish from swimming upstream to spawn.



Solar Energy

- Sunlight that is converted into usable energy is called solar energy.
- Sunlight can be converted directly into electrical energy by solar cells (photovoltaic cells).
- Solar energy is nonpolluting, but for areas where cloudy days are frequent, solar energy is less practical.



Geothermal Energy

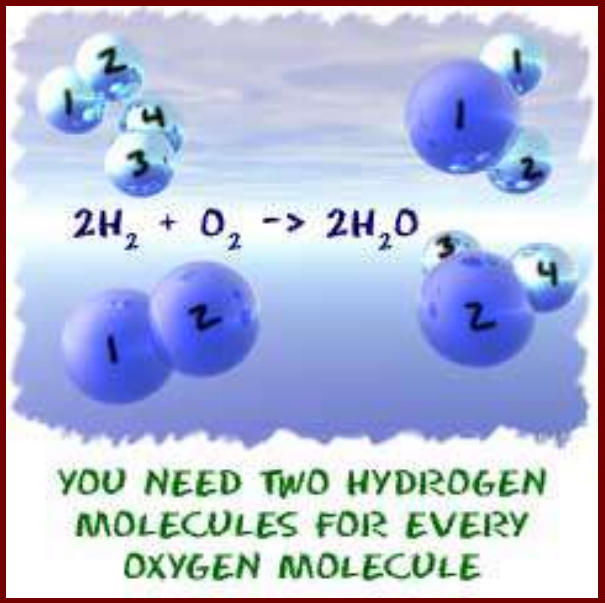
- Geothermal energy is thermal energy beneath the Earth's surface.
- Geothermal energy is nonpolluting, but is not widely available.

Biomass Energy

- The chemical energy stored in living things is called biomass energy.
- Many people around the world burn wood to heat their homes or for cooking.

Hydrogen Fuel Cell

- A hydrogen fuel cell generates electricity by reacting hydrogen with oxygen.
- The end product of fuel cells is water, so they are nonpolluting.



Conserving Energy Resources

- Energy resources can be conserved by reducing energy needs and by increasing the efficiency of energy use.
- Finding ways to use less energy or to use energy more efficiently is known as energy conservation.

Section 15.3 Assessment

- List the major nonrenewable and renewable sources of energy.
- What could be done to make present energy resources last longer?
- Why are coal, oil, and natural gas called fossil fuels?