Chapter 15 Energy

A. Energy and Work

1. Energy is the ability to do work.
2. Energy is transferred by a force moving an object through a distance.
3. Work is a transfer of energy, therefore they are both measured in joules.

B. Kinetic Energy (KE)

1. Kinetic energy is known as the energy of motion. *Kinetos* means "moving" in Greek.
2. KE depends on the object's mass and speed.

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

m = mass (must be in kg)
v = speed (must be in m/s)

a. doubling the mass doubles the KE
b. doubling the speed QUADRUPLES the KE

What is the KE of a 10kg rock rolling at 5 m/s?

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

m = 10 kg
v = 5 m/s

$$KE = \frac{(10kg)\ (5\ m/s)(5\ m/s)}{2}$$

$$KE = \frac{250\ \ kg * m^2/sec^2}{2}$$

KE = 125 Joules

C. Potential Energy (PE)

1. Potential energy is the energy stored in an object due to its position or shape.
2. One particular type of potential energy is gravitational potential energy (GPE). It is the type of PE that we will be concerned with in this class.
   a. GPE depends on the object's mass, height, and the acceleration of gravity.

      GPE = mass * gravity * height → GPE = mgh

   b. Height is measured from a reference level and must be in meters.
   c. What is the GPE of a 50 kg person located 5 meters above the ground?

      GPE = m * g * h

      m = 50 kg
      g = 9.8 m/sec^2
      h = 5 m

      GPE = 50 kg * 9.8m/s^2 * 5m

      GPE = 2450 Joules

3. Elastic Potential Energy
   a. The potential energy of an object that is stretched or compressed. It must be able to spring back to original form.
   b. examples: rubber bands, poppers

D. Forms of Energy

1. **Mechanical Energy**
   a. associated with the object's motion and position
   b. It is the sum of the object's P.E. and K.E.
   c. It does not include thermal energy, chemical energy, or other forms of energy associated with the motion or the arrangement of atoms or molecules.

2. **Thermal Energy**
   a. the total P.E. and K.E. of all atomic particles in an object
   b. When an object's atoms move faster, its thermal energy increases and the object warms.

3. **Chemical Energy**
   a. stored in chemical bonds
   b. When the bonds are broken, the released energy can be used to do work.
   c. All chemical compounds store energy, but some store more than others.
      e.g. coal, gasoline, oil

4. **Electrical Energy**
   a. associated with electrical charges
   b. Electric charges can exert energy to do work.

5. **Electromagnetic Energy**
    a. **travels through space in the form of waves**
        e.g. visible light, x-rays, gamma rays, and UV rays are just a few

6. **Nuclear Energy**
    a. **energy stored in atomic nuclei**
    b. **nuclear fission - atom is split to release heat**
    c. **nuclear fusion - atoms are joined together to release heat; the sun uses fusion to convert hydrogen to helium.**

E. Energy Conversion

1. **Energy conversion is the process of converting one form of energy to another.**
   a. **Wind up toy: elastic PE → mechanical energy**
   b. **Batteries in a CD player**
      chemical → Electrical → Sound
   c. **PE of Gas → mechanical energy in car**

F. Conservation of Energy

1. **Law of Conservation of Energy: states that energy cannot be created or destroyed**
   a. **can be converted from one form to another**
   b. **in a closed system, the amount of E present in the beginning of the process will be the same amount of energy at the end of the process**

G. Energy Conversions

1. **The most common energy conversion is between PE and KE.**
   e.g. A rock begins to fall
   a ball thrown in the air

2. **Energy Conversion in Pendulums**
   see page 456

3. **Pole Vault p 457**

4. **Energy Conversion Calculations**
   a. **Mechanical E = KE + PE**
   b. **Conservation of Mechanical Energy**
      $(KE+PE)_{beginning} = (KE+PE)_{end}$

   e.g. p 458 math skills

H. Energy and Mass

1. **Albert Einstein (1879-1955) developed his theory of relativity**

$$E = mc^2$$

   E - energy, M - mass, C- speed of light

2. **Energy is released as matter is destroyed and matter can be created from energy.**

Energy Resources

I. Nonrenewable Energy Resources

1. Nonrenewable resources exist in limited quantity. Once they are used, it may take millions of years to replenish them.
2. Examples of nonrenewable energy resources include oil, natural gas, coal, uranium.
3. Fossil fuels: form underground from previously living organisms; oil, coal, natural gas
   a. Fossil fuels account for the great majority of the world's energy use.
   b. They are relatively inexpensive and readily available.
   c. A major concern is that they release pollution, in many forms, when they are burned.

J. Renewable Energy Resources

1. Renewable energy resources can be replaced in a short period of time.
2. Most originate directly or indirectly from the sun.
3. Hydroelectric: obtained from flowing water
   e.g. grist mill (KE → mechanical energy)
   hydroelectric plant (KE → electrical)
   Problems: dams slow water down, which causes sediment to fall out; fish can't travel past them

4. Solar Energy – convert sunlight
   a. active solar system: fluid is heated in collection plates then transferred throughout the building
   b. passive solar system: sunlight is absorbed in walls and floors to create heat
   c. problems – not very useful in cloudy areas

5. Geothermal Energy – uses heat from within the earth
   a. nonpolluting but not widely available

6. Other renewables
   a. biomass : energy stored in living things
      e.g. wood and peat burned for heat
      corn stalks → alcohol (ethanol)

   b. hydrogen fuel cell – generates electricity by reacting hydrogen with oxygen
      The end product is water, therefore it is nonpolluting.

   c. wind p. 465

K. Conserving Energy Resources
   1. Conservation can occur by reducing energy needs and by increasing the efficiency of energy use.
      examples: mass transportation, car pooling; better light with lower wattage bulbs