Chapter 15

Energy

15-1 Energy and Its Forms Objectives:

1. How are energy and work related?
2. What factors does the Kinetic Energy of an object depend on?
3. How is Gravitational Potential Energy determined?
4. What are the major forms of Energy?

II. Energy and Work

Whenever work is done, energy is transferred or transformed to another form.

-In fact, one way to define energy is as the ability to do work.
*Energy is measured in Joules

:While work is done only when an object experiences a change in its motion, energy can be present in an object or a system when nothing is happening at all.

:But energy can be observed only when it is transferred from one object to another, as when a slingshot transfers the energy from its elastic band to a stone in the sling.

:The amount of energy transferred from the slingshot can be measured by how much work is done on the stone.

:Because energy is a measure of the ability to do work, energy and work are both measured in Joules (J).

III. Potential Energy

-Stretching a rubber band requires work. If you then release the stretched rubber band, it will fly away from your hand.

-The energy used to stretch the rubber band is stored so that it can be used to do work at a later time.

- But where is the energy between the time you do work on the rubber band and the time you release it?
*Potential energy is Stored energy.

:A stretched slingshot or rubber band stores energy in a form called POTENTIAL ENERGY.

:The rubber band has potential energy because the 2 ends of the band are far away from each other.

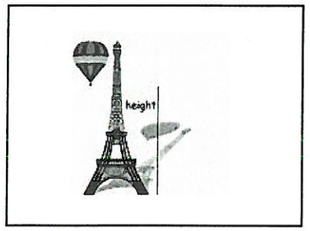
:The energy stored in any type of stretched/compressed elastic material is called ELASTIC POTENTIAL ENERGY.

:An apple will fall if the stem breaks off the branch. The energy that could potentially do work on the apple results from its position above the ground.

:This type of stored energy is called GRAVITATIONAL POTENTIAL ENERGY.

:Any system of 2 or more objects separated by a distance contains GPE resulting from the gravitational attraction between the 2 objects.

*GPE depends on both Mass and Height.



:The higher the object, the more GPE
:The lower the height, the smaller the GPE

:The heavier the object, the larger the GPE
:The lighter the object, the smaller the GPE
:Because it results from the force of gravity, GPE depends both on the mass of the objects in a system and on the distance between them.

GPE = Mass x Free-Fall Acceleration x Height
GPE = mgh g = 9.8 m/s²

Calculate GPE for the following.....

1. A car with a mass of 1200 kg at the top of a 42 m high hill.
   GPE = ?
   m = 1200kg
   g = 9.8m/s²
   h = 42m
   GPE = mgh
   GPE = (1200)(9.8)(42)
   GPE = 493,920 J

2. A 65 kg climber on the top of Mt. Everest (8800m high).

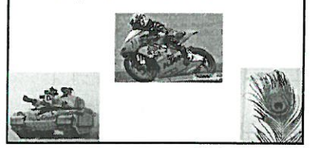
GPE = ?
m = 65kg
g = 9.8m/s²
h = 8800m
GPE = mgh
GPE = (65)(9.8)(8800)
GPE = 5,605,600 J

3. A 0.52 Kg bird flying at an altitude of 550 m.
   GPE = ?
   m = 0.52kg
   g = 9.8m/s²
   h = 550m
   GPE = mgh
   GPE = (0.52)(9.8)(550)
   GPE = 2,802.8 J

IV. Kinetic Energy

- Once an apple starts to fall from the branch of a tree, it has the ability to do work.
- Because the apple is moving, it can do work when it hit's the ground or lands on the head of someone under a tree.
- The energy that an object has because it is in motion is called KINETIC ENERGY.

*Kinetic Energy depends on Mass and Speed
:The kinetic energy of an object depends on the object's mass.
:As an apple falls, it accelerates.



:The kinetic energy of the apple - its ability to do work- increases as it speeds up.
:The kinetic energy of an object depends on the square of the object's speed.

KE = (½) x Mass x Speed squared
= (½) mv²

1. What is the KE of an 8 kg mass at 5 m/s?

KE= ?
M = 8 Kg
V = 5 m/s

- KE = ½ MV²
- KE = ½ (8)(5)²
- KE = ½(8)(25)
- KE = 100 J

2. A 6 kg mass has a KE of 75 J, what is its velocity?

- KE = 75 J
- M = 6 Kg
- V = ?

- $KE = \frac{1}{2} MV^2$
- $V = \sqrt{2\ KE / M}$
- $V = \sqrt{2\ (75) / 6}$
- V = 5 m/s

What has more energy, a 20 kg mass moving at 9 m/s, or a 4 kg mass 25 m above the floor?

- KE = ?
- M = 20 Kg
- V = 9 m/s

- $KE = 1/2\ MV^2$
- $KE = \frac{1}{2} (20)(9)^2$
- KE = 810 J

- PE = ?
- M = 4 Kg
- $G = 9.8\ m/s^2$
- H = 25m

- PE = mgh
- PE = (4)(9.8)(25)
- PE = 980 J

V. Forms of Energy

A. Mechanical
: Not limited to machines
: Sum of an object's PE and KE
: Energy in Motion
: Speeding train, bouncing balls, sprinting athletes



B. Thermal

: Total PE and KE of all particles microscopic
: Anything that gives off heat to emit visible light
: Molten metal, the sun

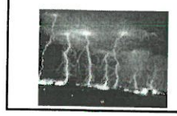

C. Chemical

: Energy stored in chemical bonds
: When bonds are broken, they release energy
: Fuels, coal, gas



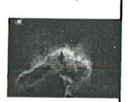
D. Electrical

: Energy associated with electric charges
: Batteries, nature---lightning




E. Electromagnetic

: Form of energy that travels through space in the form of waves
: X-Rays, IR, Gamma, UV, Microwaves, and Radio waves

F. Nuclear

: The energy stored in atomic nuclei
: Nuclear power plant, the sun (nuclear fission) (nuclear fusion)