Physics - Outcome 2
Energy and Energy Transformations

At the end of this section students will understand and calculate the two types of energy studied ir Science 10, kinetic and potential energy. This outcome has been broken down into 3 smaller outcomes. At the end of **Outcome 2**, there will be an assignment and a quiz.

A website that may help with the topics below

Outcome 2a: Students will learn the difference between kinetic and potential energy and learn to calculate the potential or kinetic energy of an object

Key Concepts:
- What is energy?
- What is the difference between potential and kinetic energy?
- How do you calculate potential energy?
- How do you calculate kinetic energy?

Outcome 2b: Students will learn that objects can possess more than one type of energy and how to calculate the mechanical energy of an object.

Key Concepts
- What is mechanical energy?
- How do you calculate the amount of mechanical energy an object has?

Outcome 2c: Students will understand how to examine and identify the energy transforms that occur in different systems (ex. Power plants, engines, etc).

Key Concepts
- What kinds of energy conversions occur in common systems
- What are some major energy conversions important to humans?

Outcome 2d: Students will understand that not all energy used by a system is converted into useful output.

Key Concepts
- What is energy efficiency and how is it calculated?

Tentative Timeline for Outcome 2

Outcome 2a:

What is energy?

hp://www.api.org/classroom/curricula/what-is-energy.cfm

- Energy is the ability of an object to do work (think back to the definion of work)

- There are many different forms of energy
    - Mechanical energy, which includes
        - Potenal energy, stored in a system.
        - Kinec energy, from the movement of maer.

    - Radiant or solar energy, which comes from the light and warmth of the sun.

    - Thermal energy, associated with the heat of an object.

    - Chemical energy, stored in the chemical bonds of molecules.

    - Electrical energy, associated with the movement of electrons.

    - Nuclear energy, found in the nuclear structure of atoms.

- One form of energy can be converted to another form - examples??

Potential Energy

Define **potential energy:**

- Energy that is stored and held in readiness

- Energy that has the potential to do work

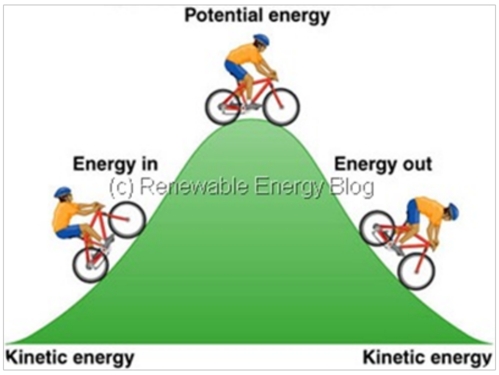
Types of Potential Energy

i. Gravitational Potential Energy

- When an object is lifted against gravity, and held, it contains gravitational potential energy.

- This energy is equal to the input energy (work) that went into lifting it up.

- Ex. The free fall ride at WEM has stored potential energy at the top <u>before</u> it falls.
- Ex. A ball that has been thrown in the air has gravitational potential energy when it reaches its highest point.



i. Elastic Potential Energy

- If force is used stretch an elastic material over a distance and if the elastic material is held in position, it has gained "elastic potential energy"

- A stretched and held elastic, a bow string that has been pulled back and held, a spring that is held down are all examples that have elastic potential energy

ii. Chemical Potential Energy

- Energy in the chemical bonds have energy that can be used to do work

- Ex. Chemical bonds in food or fuels like gasoline

Gravitaonal Potenal Energy - $E_{p(grav)}$ (pg. 173-175)

A book that has a mass of 1.2kg was picked up off of the floor and placed on a shelf that was 1.5m high. What was the book's gravitaonal potenal energy?

Work is done when a person picks up a book that has a defined mass and lis it a distance off the ground and puts it on a shelf.

Work = mad

W = (1.2kg) x (9.81m/s^2) x (1.5m)
= 17.66J
= 18J

What happened to the energy that went into liing the book?

It is now stored as gravitaonal potenal energy within the book. The books potenal energy on top of the shelf is equal to the work that was put into liing it in the first place.

You can figure out the book's gravitaonal potenal energy by using the formula:

$E_{p(grav)} = mgh$

m = mass (kg)
g = acceleraon due to gravity (m/s^2) 9.81m/s^2
h = height off ground (m)

Example: Terry has a 20kg television perched on his TV stand. It sits 1.1m above the floor. Calculate the TV's gravitaonal potenal energy relave to the floor.

m = 20kg
h = 1.1m
g = 9.81m/s^2

$E_p = mgh$
$= (20kg)(9.81\frac{m}{s^2})(1.1m)$
$= 215.82 \; kg \cdot \frac{m^2}{s^2}$ J
$= 215.82 J$
$= 0.22 kJ$ or $2.2 \times 10^2 J$

Elastic Potential Energy - $E_{p(elastic)}$

It took a hunter 560N of force to pull the bowstring back 0.450m. What is the elastic potential energy of the held bowstring?

Work is done when the person pulls back the bowstring back.

W = Fd

= 560N x 0.450m
= 252J

The 252J of energy that went into pulling back the bowstring is now held as elastic potential energy. If the string were to be released, the same amount of energy would be the output (assuming a frictionless environment)

You can use the following formula to figure out the Elastic Potential Energy

$E_{p(elas)}$ = Fd

$N \cdot m$

$1 N = 1 \frac{kg \cdot m}{s^2}$

F = Force (N)
d = distance (m)

Example: What would be the elastic potential energy be of a trampoline that was jumped on with a force of 400N and extended 0.25m?

F = 400N
d = 0.25m

$E_p = Fd$
$= (400N)(0.25m)$
$= 100 N \cdot m = 100 J$
$= 0.10 kJ$
$= 1.0 \times 10^2 J$

Practice Sheet 1

1. The gravitational potential energy relative toe the ground of a 6.1kg owl is 1260J. How far from the ground is the owl perched?

m: 6.1kg
h: ?
Ep: 1260J

Ep: mgh
1260J: 59.841 × (h)
h: 21.055... m : **21m**

2. A weightlifter hoisted a barbell 1.90m off the ground and held it there momentarily. The gravitational potential energy of the barbell equaled the work input of 1600J. What is the mass of the barbell?

Ep: 1600 J
m: ?
h: 1.90m
g: 9.81m/s²

Ep : mgh
1600J : m (9.81m/s²)(1.90m)
m: 85.84.... kg : **85.8kg**

3. An object with a mass of 1.80kg is on top of a table that is 0.750m off the floor. The object is raised off the tabletop 1.0 m and held there.
   a. What is the gravitational potential energy in relation to the tabletop?

m: 1.80kg
h: 1.0 m
g: 9.81m/s²

Ep : mgh
: (1.80kg)(9.81m/s²)(1.0m)
: 17.658 J : **18J**

   b. What is the gravitational potential energy in relation to the floor?

m: 1.80m
h: 1.75m
g: 9.81m/s²

Ep: mgh
: (1.80kg)(9.81m/s²)(1.75m)
: 30.90...J : **31 J**

4. A spring was compressed and held with a force of 10.0N. The elastic potential energy of the spring was 1.25J. How far was the spring compressed, in centimeters?

Ep: 1.25J
F: 10.0N
d: ?

Ep: Fd
1.25J: (10.0N) d
d: **0.125m or 12.5cm**

5. An elastic that is stretched 10.0cm has 320J of stored potential energy. Calculate the force required to stretch the elastic? Remember to change cm to m.

d: 10.0cm : 0.100m
Ep: 320J
F: ?

Ep: Fd
320J : F (0.100m)
F: 3200N : **3.20kN or 3.20×10³ N**

6. A person jumping on a trampoline exerts an average force of 500 N in stretching the trampoline a distance of 0.750 m. Calculate the elastic potential energy stored in the trampoline.

Ep: ?
F: 500N
d: 0.750m

Ep : Fd
: (500N)(0.750m)
: **375 J**

7. An elastic that is stretched 10.0 cm has 320 J of stored elastic potential energy. Calculate the force needed to stretch the elastic.

8. A 60.0 kg person climbs a ladder and stands on top of a building. If the person has 210 J of potential energy, how high is the building?

m: 60.0kg
Ep: 210J
h: ?
g: 9.81m/s²

Ep : mgh
210J : (60.0kg)(9.81m/s²)(h)
h: 0.356778.... m
: **0.357m or 35.7cm**