PHYSICS
ENERGY, WORK, POWER
FORM 5

Energy

Energy is defined as the ability to do work and is measures in Joules (J). There are different forms of energy:

1. Nuclear
2. Kinetic
3. Chemical
4. Potential
5. Heat
6. Light
7. Gravitational
8. Sound
9. Elastic Potential
10. Magnetic/Electromagnetic

Nuclear Energy – This is the energy stored within the atom and is released when there is a change in the mass of the atom.

Kinetic Energy – This is the energy an object possesses by virtue of its motion.

Chemical Energy – This is the energy stored in the chemical bonds.

Potential Energy – There are two types of potential energy:

Gravitational Potential Energy – This is the energy an object possesses by virtue of its position.

Elastic Potential Energy – This is the energy of an object possesses by virtue of its state (stretched or unstretched).

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Energy Conversions

Object	Natural Energy	Converted Energy
Electric Water Heater	Electric	Heat
TV	Electric	Light, Sound, Heat
Kettle		
Radio		
Microphone		
Speaker		
Car		
Cell Phone		

When energy is being converted from one form to another, the energy conversion is never 100% efficient, some energy is lost usually in the form of heat.

Law of Conservation of Energy

This states that energy can neither be created nor destroyed but rather converted from one form to another.

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Kinetic Energy

This is the energy an object possesses by virtue of its motion.

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

$KE = kgm^2s^{-2}$

$1J = 1kgm^2s^{-2}$

The unit for kinetic energy is the same for all other types of energy which is the Joule and is a scalar quantity.

Object	1	2	3
Mass	5kg	10kg	5kg
Velocity	3m/s	3m/s	6m/s
KE			

An elevator is connected to heavy weights via several cables and pulleys. When the elevator moves upwards the counter weights will therefore move downwards. Electric energy is used to move the elevator. When the elevator moves upwards, there is an increase in gravitational potential energy. Since at the same time the counter weight moves downwards, it means therefore that the counter weight loses gravitational potential energy.

Energy Conversion:

In short buildings, the speed of the elevator is very low, thus this will result in a decrease in kinetic energy ($\frac{1}{2}mv^2$). This therefore conserves on energy, ie, it is cheaper.

In very tall buildings however the speed of the elevators is usually faster so as to conserve on time.

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Gravitational Potential Energy

This is the energy an object possesses by virtue of its position.

$GPE = mass \times acceleration\ due\ to\ gravity \times height$

$GPE = mgh$

$1J = kg \times m/s^2 \times m = 1kgm^2/s^2$

Changes in height of the object from the ground will result in a change in the gravitational potential energy.

Ex. Calculate the potential energy of lifting a 2kg bucket of water up a 12m building by using a pulley system. (Assume $g = 10ms^{-2}$)

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Work

Work done is defined as the force applied to move an object in the distance of the applied force.

Work is measured in Joules (J) and is a scalar quantity.

$W = F \times d$

$1J = 1N \times 1m = 1Nm$

Ex. Prove that the 1 Joule of work done is equivalent to $1kgm^2/s^{-2}$

Definition of a Joule: One Joule is defined as the work done by or against a force of one Newton when it moves its point of application through a distance of one metre in a direction parallel to the force.

Ex. A box is pushed by a force of 20N over a distance of 4m in a direction parallel to the force. Calculate the work done by the force.

Power

Power is defined as the rate of energy conversion and is measured in Watts.

$$Power = \frac{Energy\ Converted}{Time\ Taken} = \frac{Work\ done}{Time\ Taken}$$

$$Power = \frac{E}{t}$$

$$Watt = \frac{Joule}{Second} = Js^{-1}$$

One Watt is the power of a device that converts one Joule of energy from one form to another every second.

Ex. A bucket of cement mix of mass 12kg is raised through a vertical height of 8m in 10 seconds. Calculate the power used in raising the bucket.

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Efficiency

The efficiency for any machine or device is given by the following formula:

$$Efficiency\ (\%) = \frac{Power\ Output}{Power\ Input} \times 100$$

Efficiency is normally expressed as a percentage and never 100% (due to loss in energy during energy conversions).

Further Reading:

http://www.youtube.com/watch?v=pDK2p1QbPKQ

http://www.physicsclassroom.com/Class/energy

http://www.edinformatics.com/math_science/work_energy_power.htm

http://formulas.tutorvista.com/physics/efficiency-formula.html

http://www.youtube.com/watch?v=jOtKKw9E_OE

http://www.youtube.com/watch?v=9e_UmibcjM8