Energy NOTES

Energy is a physical quantity that describes the *ability to make things move.*

- The unit of energy is the *joule* ***(J)***, pronounced "jewel".
- Energy is a ***SCALAR*** quantity, **NOT A VECTOR**, it may have positive or negative values, but it has no direction.

Kinetic Energy

- A moving object has kinetic energy; the **kinetic energy** of an object is described by the equation

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

- m = mass of an object
- v = velocity or speed.

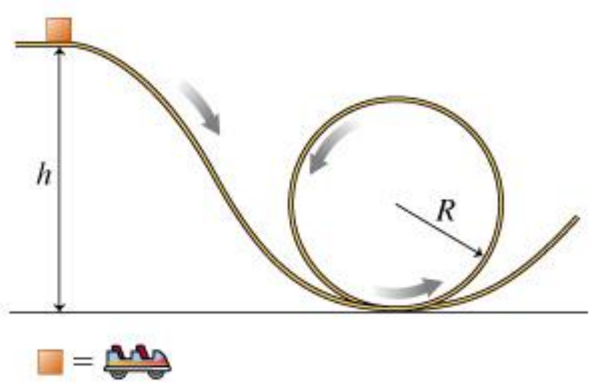
As an example, suppose a 5 kg mass attains a speed of 10 m/s, the amount of kinetic energy (KE) it has is

$KE = \frac{1}{2} (5)(10^2) = 250$ Joules.

Gravitational potential energy

Gravitational potential energy is the energy *stored* in an object has *when it is in a position to fall*. Gravitational potential energy is gained or lost when an object is lifted or lowered in reference to a surface. The surface or "ground" is called the ***reference level***. The formula which describes the amount of gravitational potential energy (PE) an object gains is

$$PE = mgh$$



m = mass
g = the acceleration due to gravity (9.8 m/s^2)
h = the *height* the mass is *above* a reference level.

Gravitational Potential energy may be positive or negative.

Example: suppose a 5 kg mass is lifted 10 meters above the floor, it would gain a potential energy (PE) of (5)(9.8)(10) = 490 Joules.

The Law of Conservation of Energy.

This principle states that for an object (*or system of objects*) in a closed system ***the total amount of energy of the object/s should remain constant***. *Energy cannot be created or destroyed it can only be transferred.*

In other words $$total\ energy\ before\ =\ total\ energy\ after$$

In equation form

$$W + \frac{1}{2}mv_1^2 + mgh_1 = \frac{1}{2}mv_2^2 + mgh_2 + H$$

W – is work or energy ***added*** *to the system (in Joules) - examples?*

H – any ***energy losses*** *that occur from 1 to 2 (in Joules) –examples?*

Work

In Physics "work" is the **same as energy**.
Work just means "the energy required by a force to move an object a certain distance.
Work is measured in **Joules (J)**
Work is a scalar quantity (no direction)
Positive work means energy added to a system
Negative work means energy taken away from a system.

Work is calculated using the following formula:

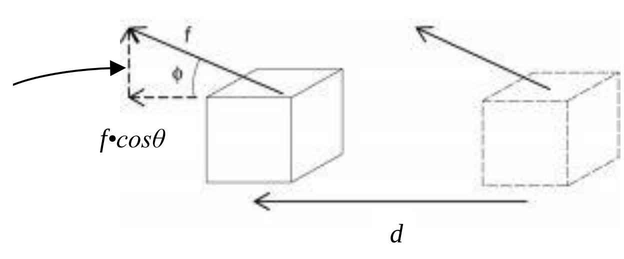
$$W = \vec{f} \cdot \vec{d}$$

f – force in Newtons (N)
d – displacement in Meters (m)

Important point:

The only portion of a force that can do "work" is the component of force that is causing motion. $\vec{f}$ in the equation above must be the component of force that moves the object in the direction of $\vec{d}$

Vertical component does not move box forward
only horizontal component is used to calculate work

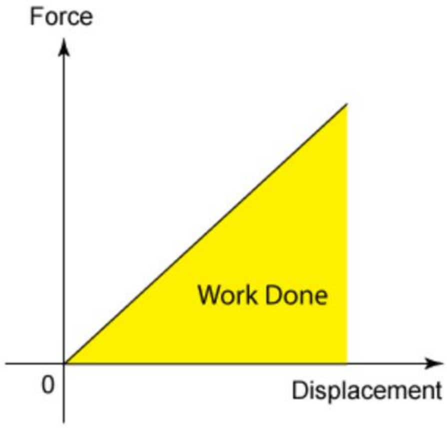


Force vs. Displacement Graphs:

W = F x d is good if our force is ***constant.***

When we have a situation ***changing*** Force, we have to find a new solution:

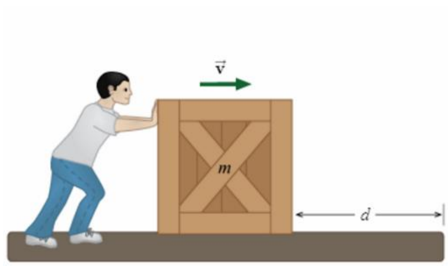
The energy transfer (or work) caused by the ***variable*** force turns out to be:



The **area** under a **force** vs. **displacement graph**

Example:

Imagine the graph below represent the **force** on a box as it is pushed along a floor. How much **work** was done on the box?



POWER and Efficiency NOTES

- *Remember **Work** and **Energy** are the **same** thing!*
- *They have the same units (joules).*
- ***Work** just means **Energy** being put into a system to increase its energy.*

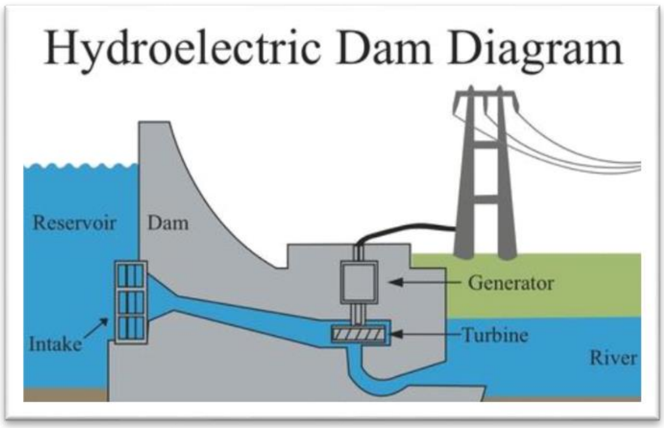
POWER

*Power is **not** the same as energy or work.*

***Power** is the rate at which work is done.*

Or

***Power** is the rate at which energy is converted from one form to another.*



*The units of power are **Watts (W).** 1 watt is equal to using 1 Joule each second*

1 Watt = 1 Joule/1sec.

$$\text{Power} = \frac{\text{Work\_Done}}{\text{Time\_Taken}}$$

Example 1

A cat who cat weighs 40 Newtons climbs a tree that is 15 meters tall in 10 seconds. Calculate the work done by the cat and the cat's power.

Example 2

A 60 Watt light bulb is used for 30 minutes. Determine the energy it used.

Efficiency

*No process is 100% efficient – some energy is always **'lost'** in the process.*

Examples of some energy losses for the following situation:

*Formula to calculate how **efficient** in percent (%) a process is:*

$$\textit{Percentage Efficiency} = \frac{\textit{Power Out}}{\textit{Power In}} \times \frac{100}{1}$$