ENERGY

Energy is the ability to do work.
(that is to make something move)

Since energy is the ability to do work, it is also measured in Joules.

Example, a plane uses energy to carry passengers.

When electricity turns a motor, the motor is using energy to make the blade move.

When water is changed into steam it uses energy to move the train.

A piece of buttered toast contains about 315 kilojoules (315,000 joules) of energy. With that energy you could:

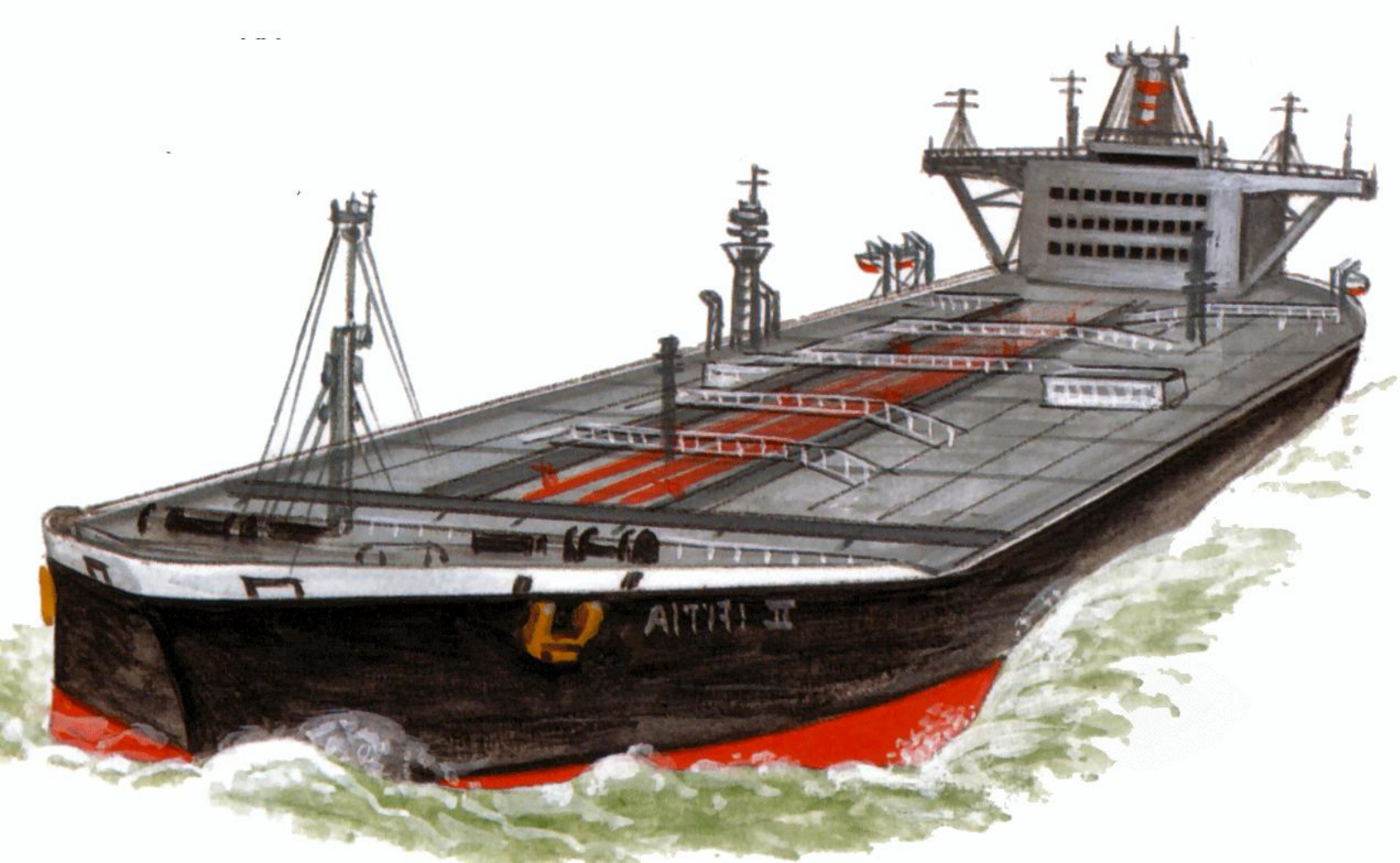
- Jog for 6 minutes
- Bicycle for 10 minutes
- Walk briskly for 15 minutes
- Sleep for 1-1/2 hours
- Run a car for 7 seconds at 80 kilometers per hour
- Light a 60-watt light bulb for 1-1/2 hours
- lift a sack of sugar from the floor to the counter 21,000 times!

There are Two types of Energy

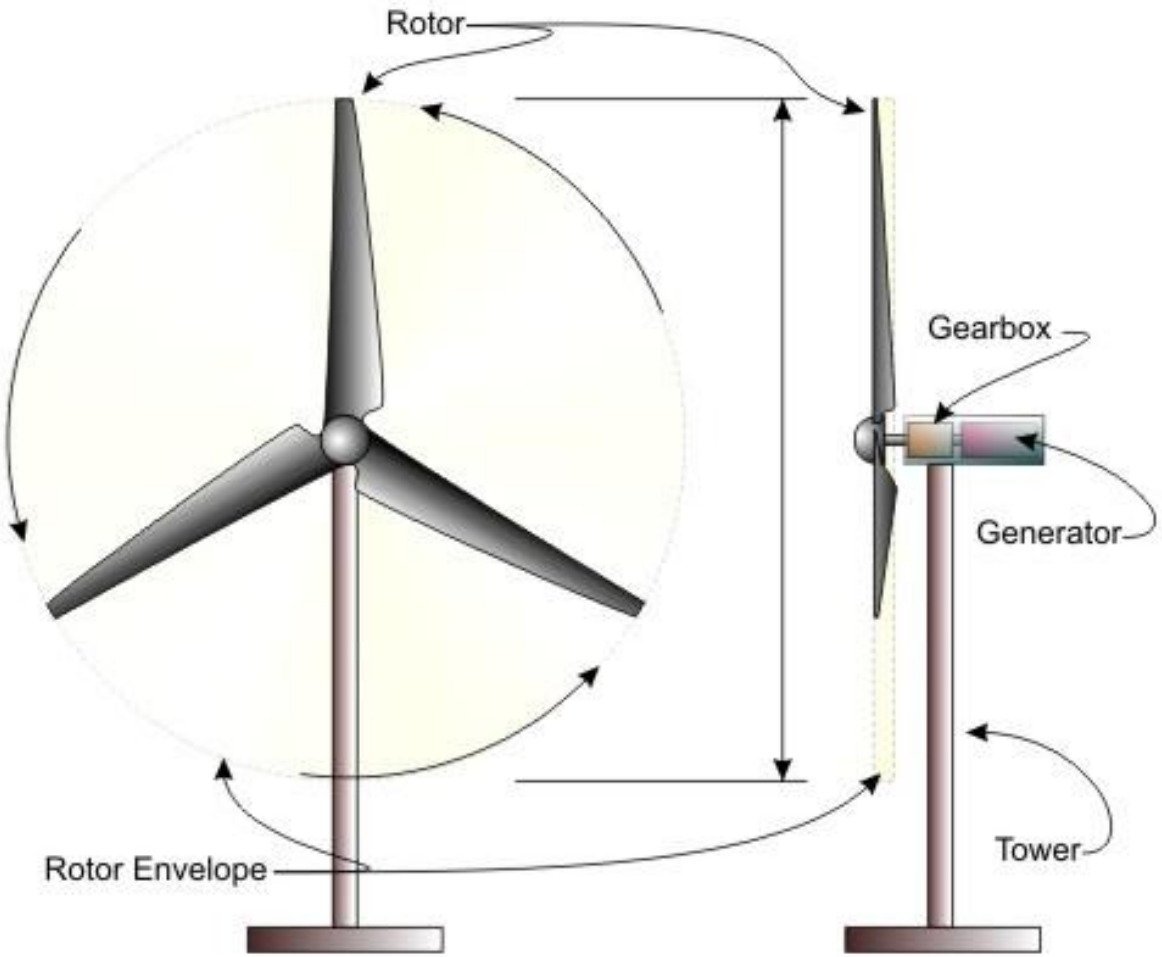
1. Kinetic Energy

Kinetic energy is energy of a mass in motion.

An example of kinetic energy would be a loaded oil tanker coming up Placentia Bay. This vessel would need miles to stop simply because it has a tremendous amount of kinetic energy.



The energy of the wind and motion of the turbine blades has been used for centuries to pump water or to drive millwheels to grind grain.

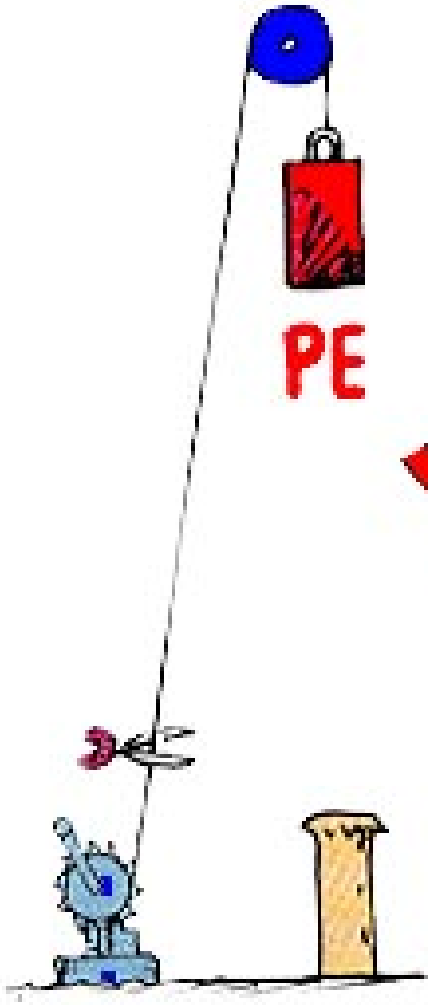


2. Potential energy

Potential Energy (PE) is Stored Energy.

There are many ways to store energy, each resulting in a different name for potential energy.

For example, the energy stored in the large weight of a pile driver can force a post into the ground when it falls.



More examples of potential energy would be

- sunlight, coal, or oil being pumped out of Hibernia

- water in a dam above a power plant, etc.

Power

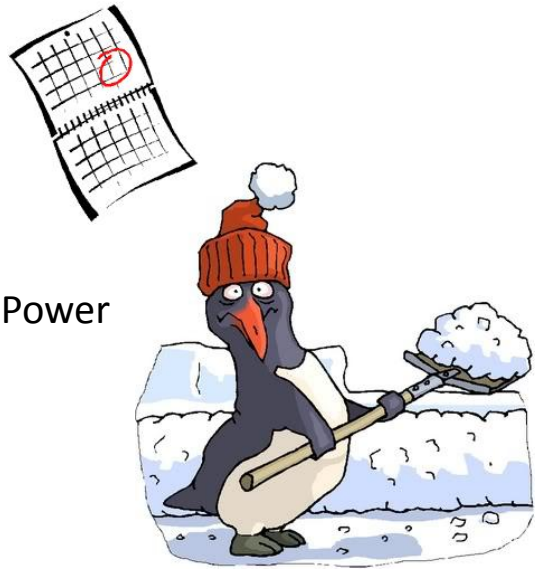
Power is the amount of energy expended in a unit of time or the amount of work done in a unit of time.

The unit of power is the Watt which is a Joule per second.

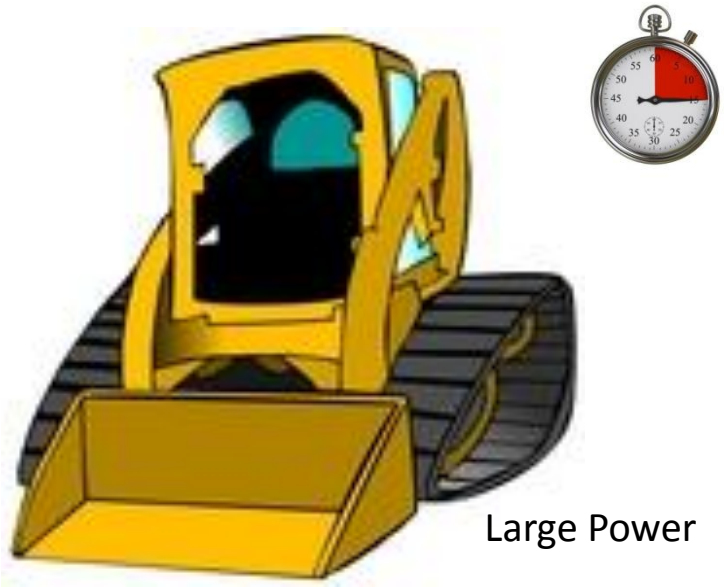
Power

Example, shoveling a mound of snow by hand may take all day whereas a loader can come in and do that in a few minutes.

The loader does the same amount of work in a shorter period of time and therefore has more power.



Small Power



Large Power

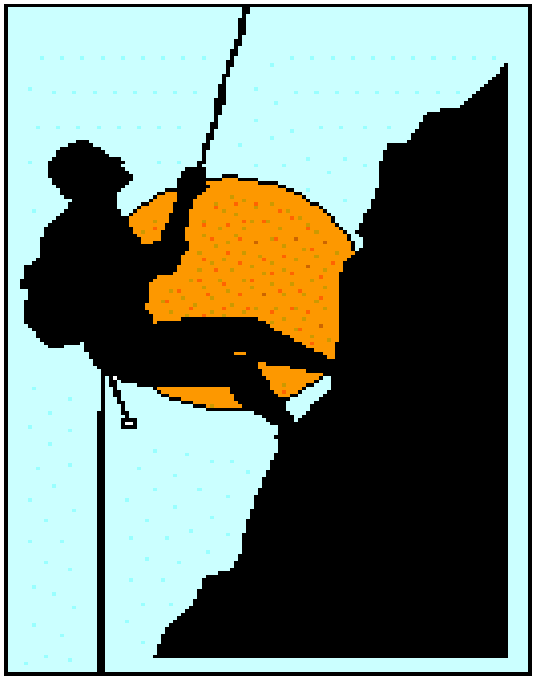
Power

1 Watt is defined as 1 joule of energy expended in 1 second.

Since energy applied over a distance is work done on the object,

1 watt of power = 1 joule of work completed in 1 second

- **Sometimes, work is done very quickly and other times work is done rather slowly.**



Rock climbers do a lot of work at a slow rate; their power is small.

Video - Energy 55 mins

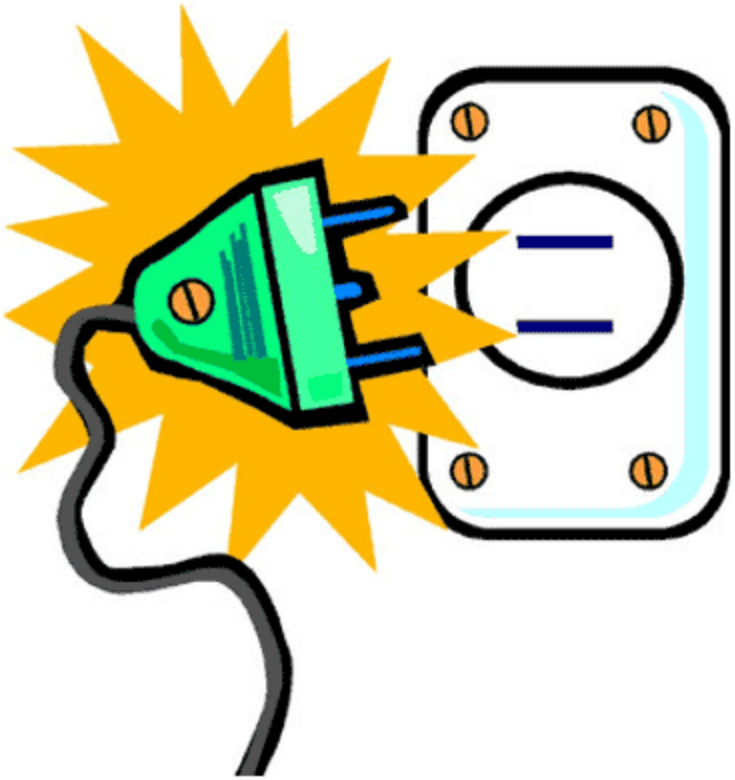
Activity: Poster design

Create a poster that would illustrate one or all of the following concepts: mass, force, kinetic energy, potential energy, and power.

For example, you could use a ping pong ball, pool ball, or puck, etc to illustrate each

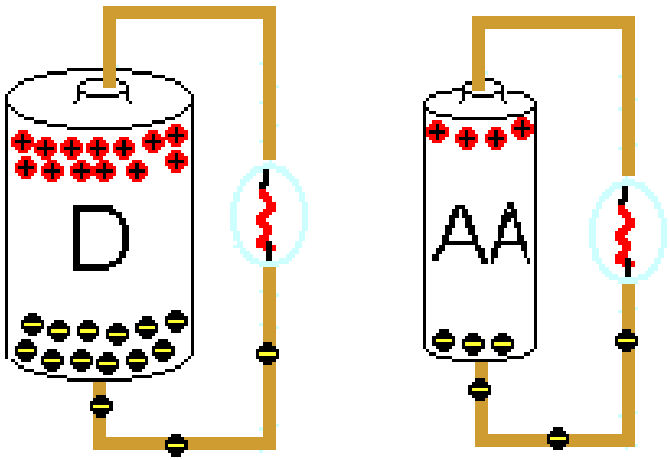
concept.

Electricity

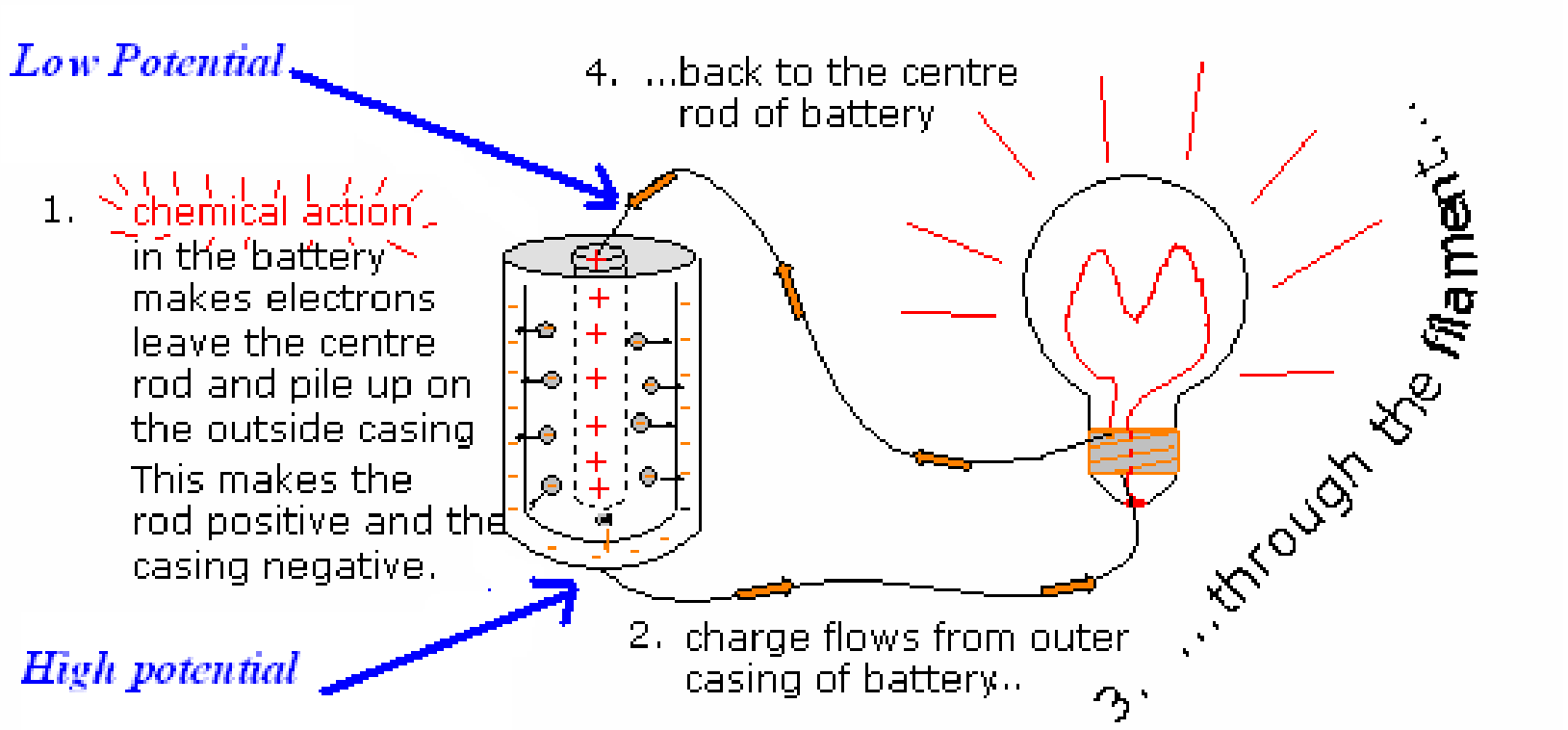


Electric Current

Electric current: is the movement of electrons from a negative terminal back to the positive terminal of a battery .

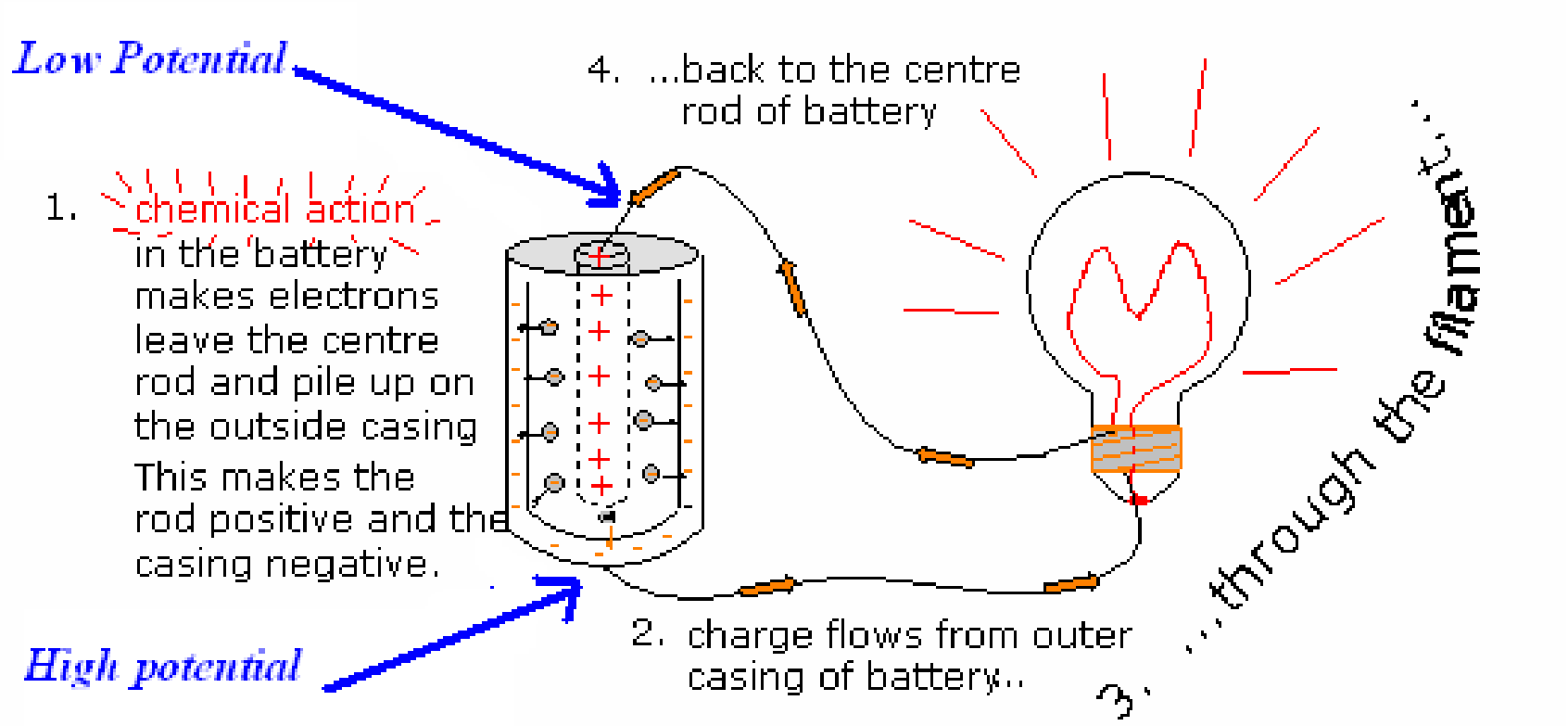


Electric Current



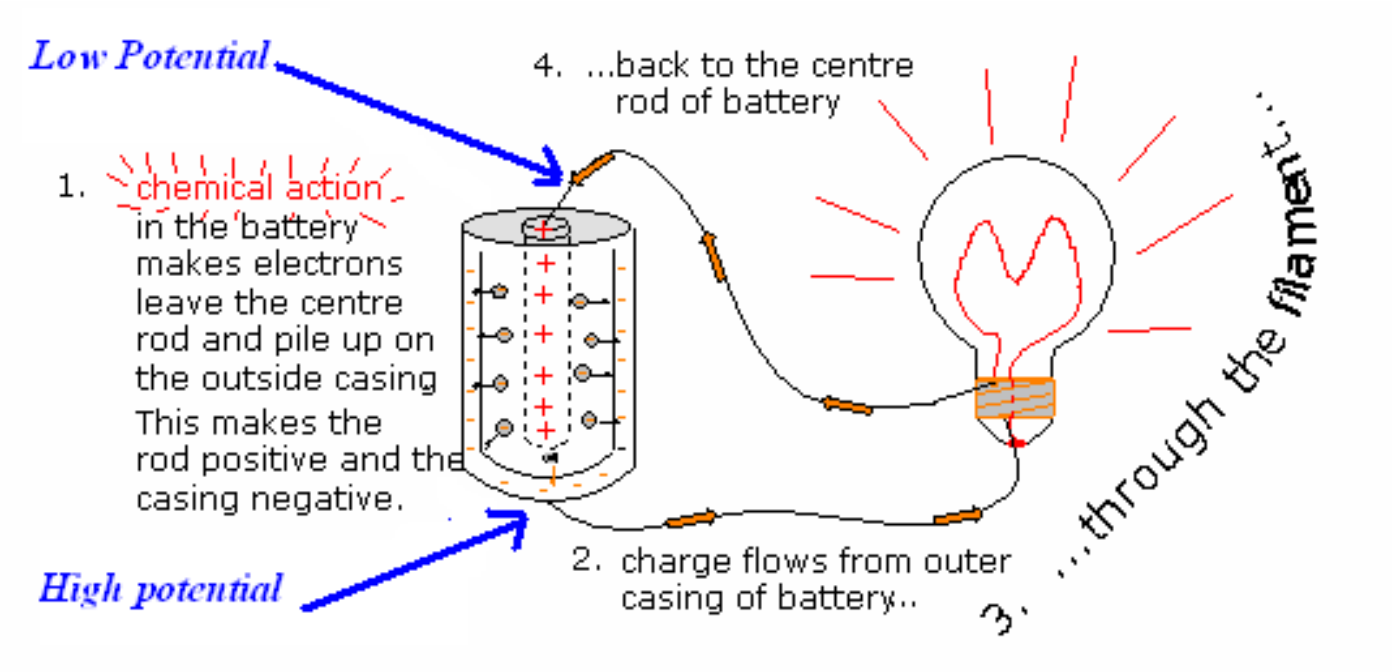
Electrons flow from regions of high Potential Energy to regions of low Potential Energy (something like the pile driver falling in the Potential Energy slide earlier)

In the diagram electrons loose energy because of friction in the wires and the filament of the lamp.



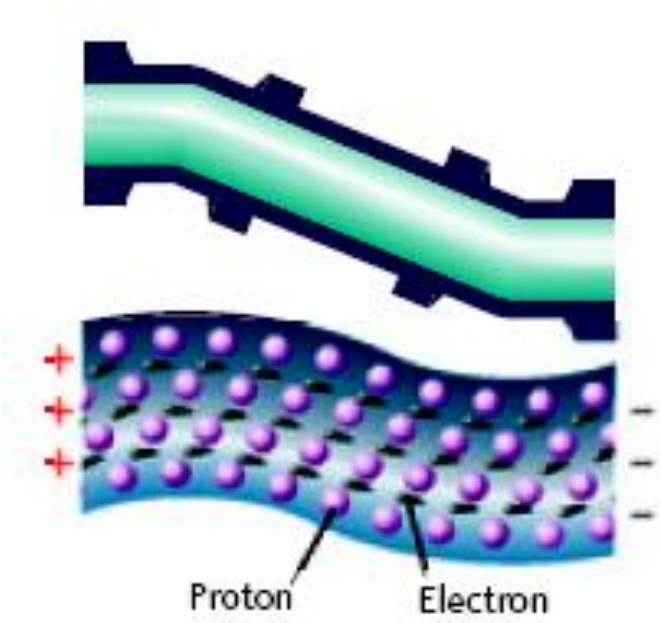
Another name for these obstacles is **resistance**.

In the battery energy comes from the chemical energy in the battery which "pumps them up to the top of the hill (casing of battery).



Current

Current is the rate at which the electric charges move through the conductor and is given the symbol (I).

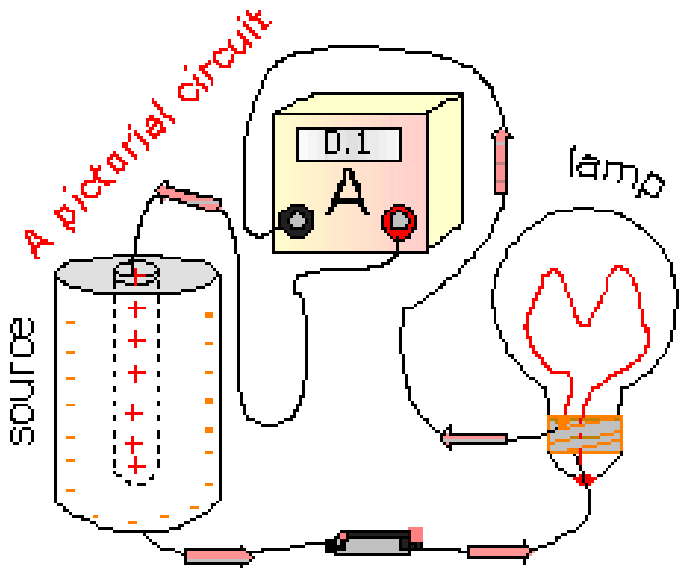


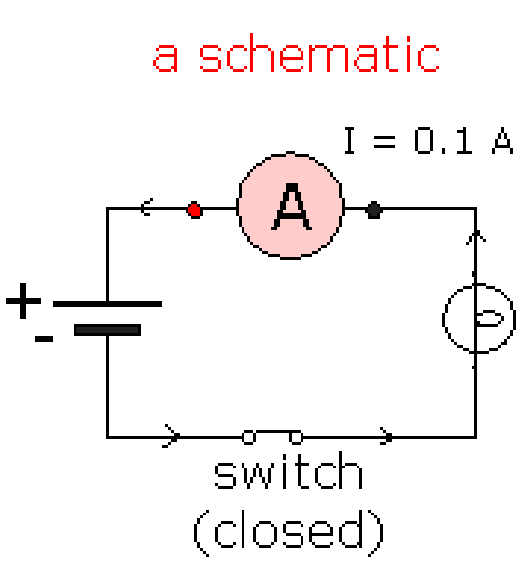
Units: C/s or Amperes, A

MEASURING CURRENT

Current is measured with an instrument called an ammeter.

- An ammeter typically has a red terminal and a black terminal. Connect the red terminal to the positive terminal of the battery.

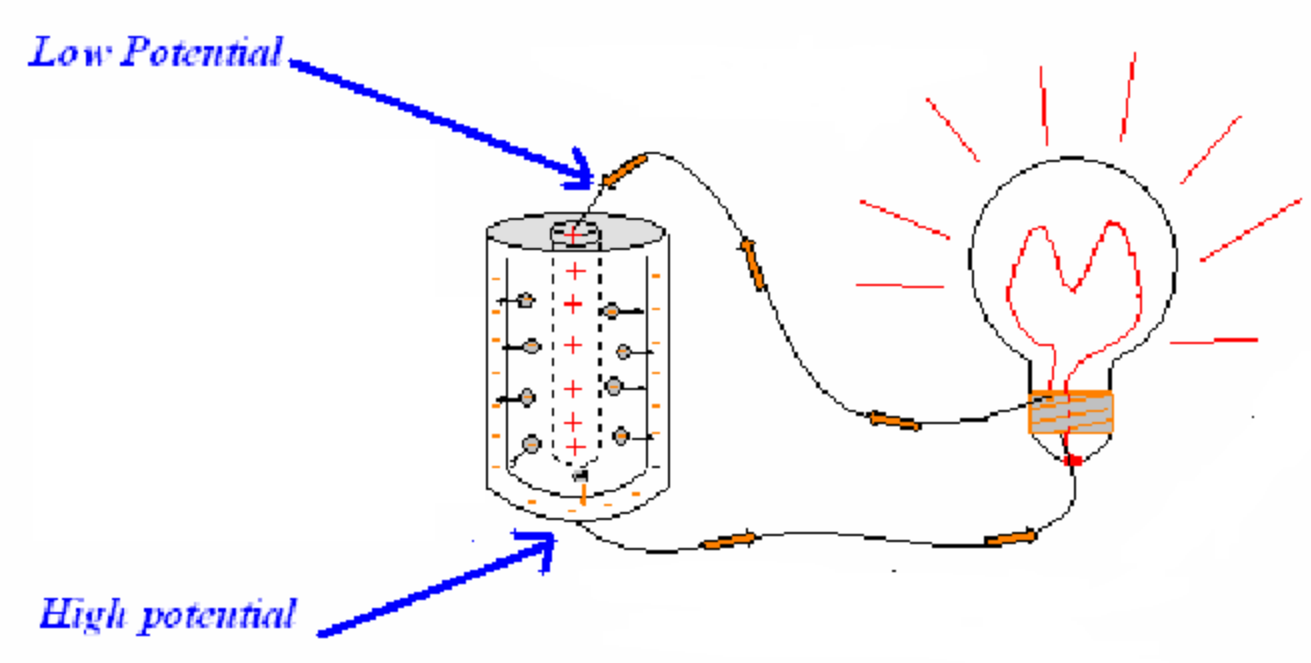




Electric Potential Difference (VOLTAGE)

Charge does not flow on its own.

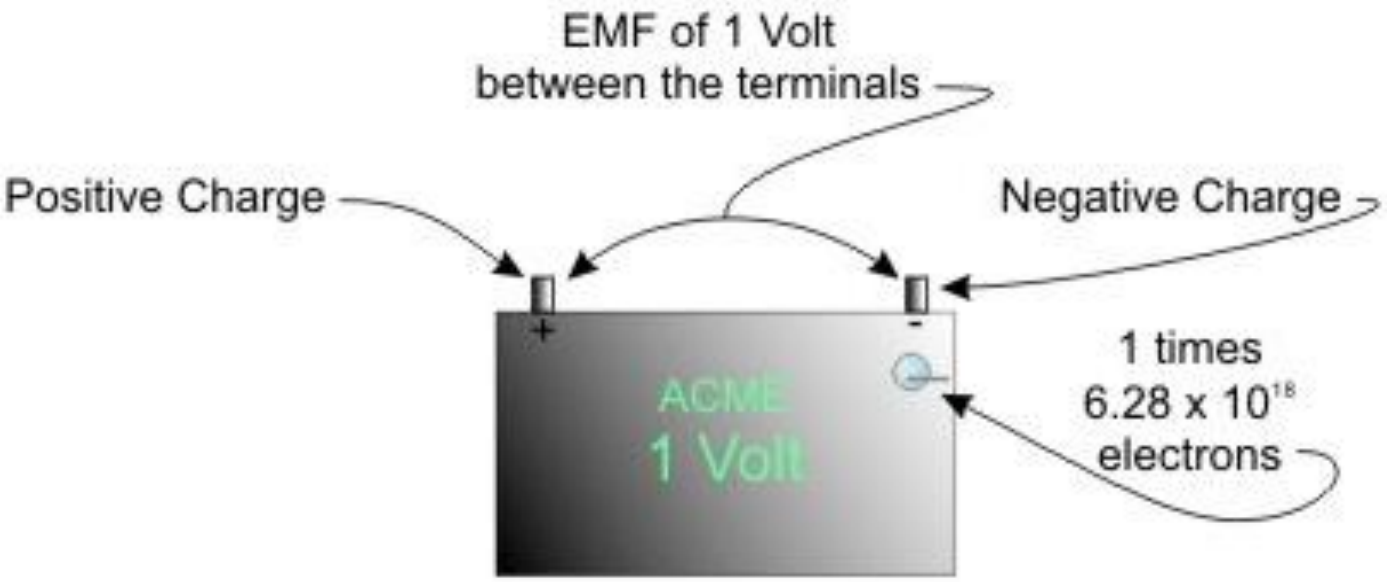
To produce an electric current, a difference in potential Energy is required.



Electric Potential Difference (VOLTAGE)

This electric potential difference is called electromotive force or Voltage.

In the automotive battery shown below, the EMF is the total charge between the two terminals.



Simply put, this means that 1 volt of EMF means there are 6.24 X 10^{18} electrons available to do work.

Sources of Potential Difference (Voltage)

Table 14.2
Sources of Electrical Energy

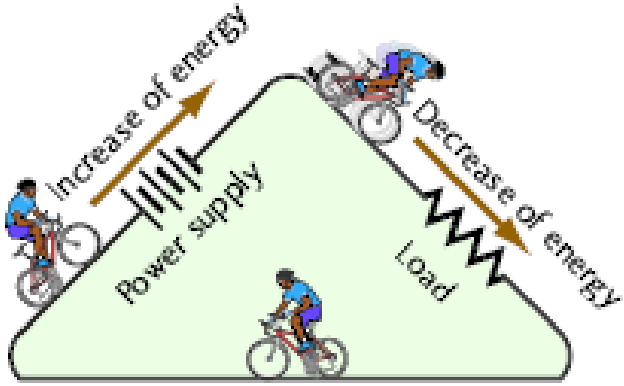
Source process	Common applications
Voltaic cells	Chemical potential energy is released during a reaction as electrons are driven between two different metals (e.g., common dry cell batteries for portable electric devices).
Piezo-electricity	Quartz and Rochelle salt crystals create small electric potential when mechanical force or stress is applied to them (e.g., phonograph cartridges, barbecue spark starters).
Thermoelectricity	Two pieces of different metals joined together and subjected to temperature differentials transfer thermal energy to electric potential energy in what is called a **thermocouple** (e.g., gas appliance pilot light safety system: current keeps gas valve open as long as flame is lit).
Photoelectricity	Light energy absorbed by electrons of certain metals causes charge flow (e.g., satellite and International Space Station power supply, calculator power supply).
Electromagnetic induction in generators (see Chapter 16)	Kinetic energy of water or steam forces conductors to rotate in a magnetic field (e.g., hydro-, nuclear-, fossil-fuel-powered electric generators).

What is Voltage? Confused??

Whatever the source, it helps to picture potential difference or voltage as the force behind the current--the force making the electrons move.

Voltage may be viewed as a hill: the steeper the hill, the faster a bike will roll down. The "current of bikes" will deliver more bikes to the bottom of the hill faster when the hill is steep.

Likewise, when voltage is high, it seems reasonable to predict that a larger current of electrons will roll through the circuit.

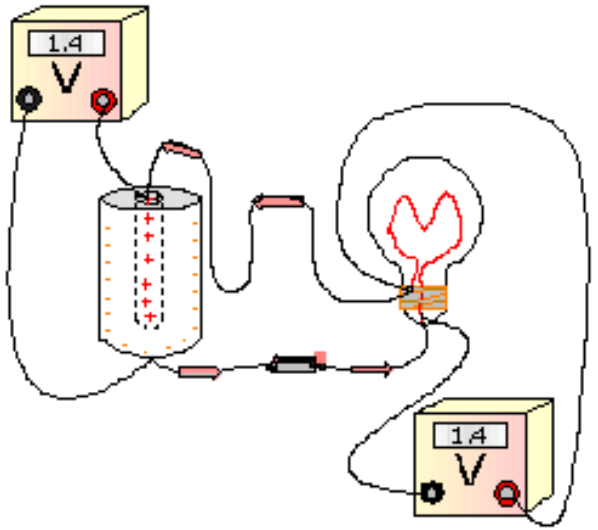


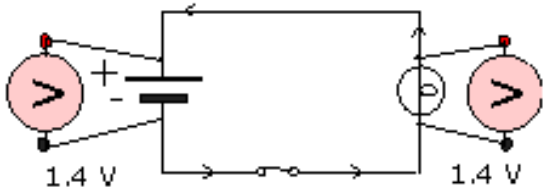
MEASURING VOLTAGE

The instrument used to measure voltage is called a **voltmeter**.

A voltmeter can measure the increase in potential at the terminals of the dry cell, and the decrease in potential as the electrons give up their energy in the lamp.

Voltmeters must be hooked up in parallel

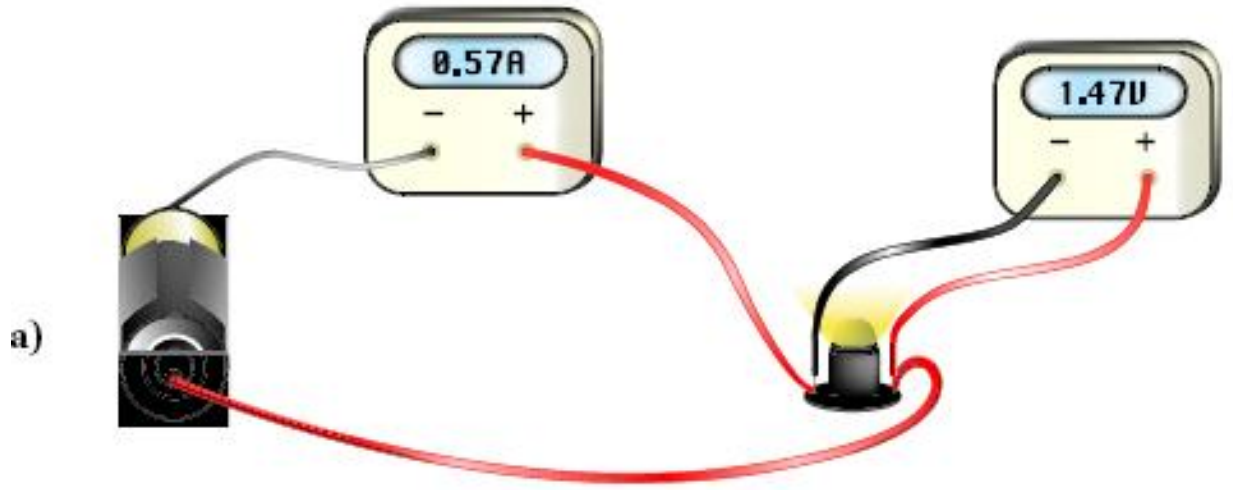




Unlike the ammeter the circuit is not broken to connect a voltmeter.

• The red terminal of the voltmeter is connected to the positive terminal of the cell. (However, the red terminal of the voltmeter must be connected to the terminal of the bulb that is towards the positive terminal of the dry cell.)

• Voltmeters must have an extremely large resistance to discourage electrons from passing through them.



	Current	Voltage
Measured in	Amps, A	Volts, V
Measured with	Ammeter in series	Voltmeter in parallel
Circuit symbol of measuring devise		

Confused?? Look at it this way:
The Mouse Cheese Analogy

Negative charges are attracted to positive charges the same way mice are attracted to cheese. The negative charges (mice) will gladly do work in order to get to the positive charges (cheese).

Voltage:

The amount of work that each charge (mouse) will do as it goes through the circuit. Can also be thought of as the amount of push on the charges or how hungry the mice are.

Current:

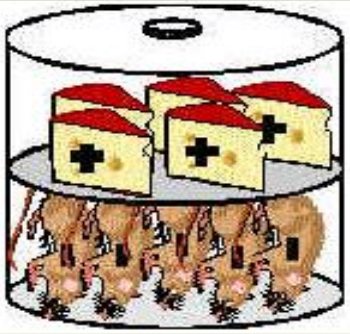
The number of charges (mice) passing a point per second. The rate of flow of charges.

Resistance:

The opposition to the flow of charge. Any appliance that asks the charge (mouse) to do work will slow it down.

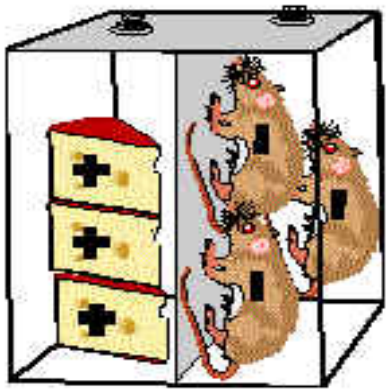
The Mouse Cheese Battery (cell)

The battery goes "dead" when all the negative charges make it through the circuit and get to the positive charges.



D cell
1.5 volts

AA cell
1.5 volts



lantern battery
6 volts
hungrier mice

slightly flawed: the lantern battery would also have many more mice than the D cell, but that is not related to it being 6volts

Forms of Energy

Remember there are Two types of Energy: Potential and Kinetic.

Can you identify some various sources of energy?

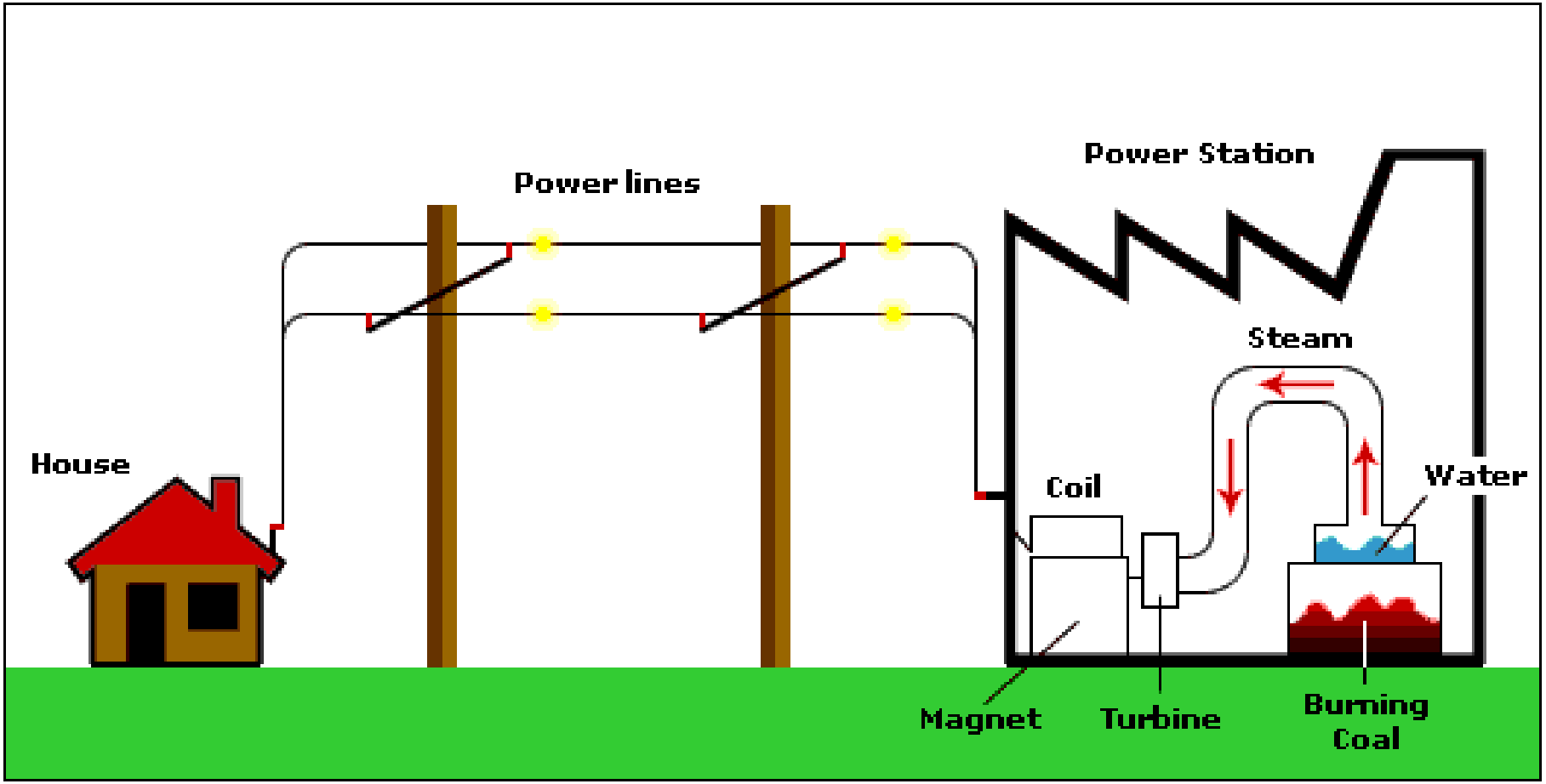
Chemical Energy (Potential)

Chemical energy is the energy stored in the bonds of atoms and molecules.

Biomass, petroleum, natural gas, propane, batteries, and coal are examples of stored chemical energy.

Chemical Energy (Potential)

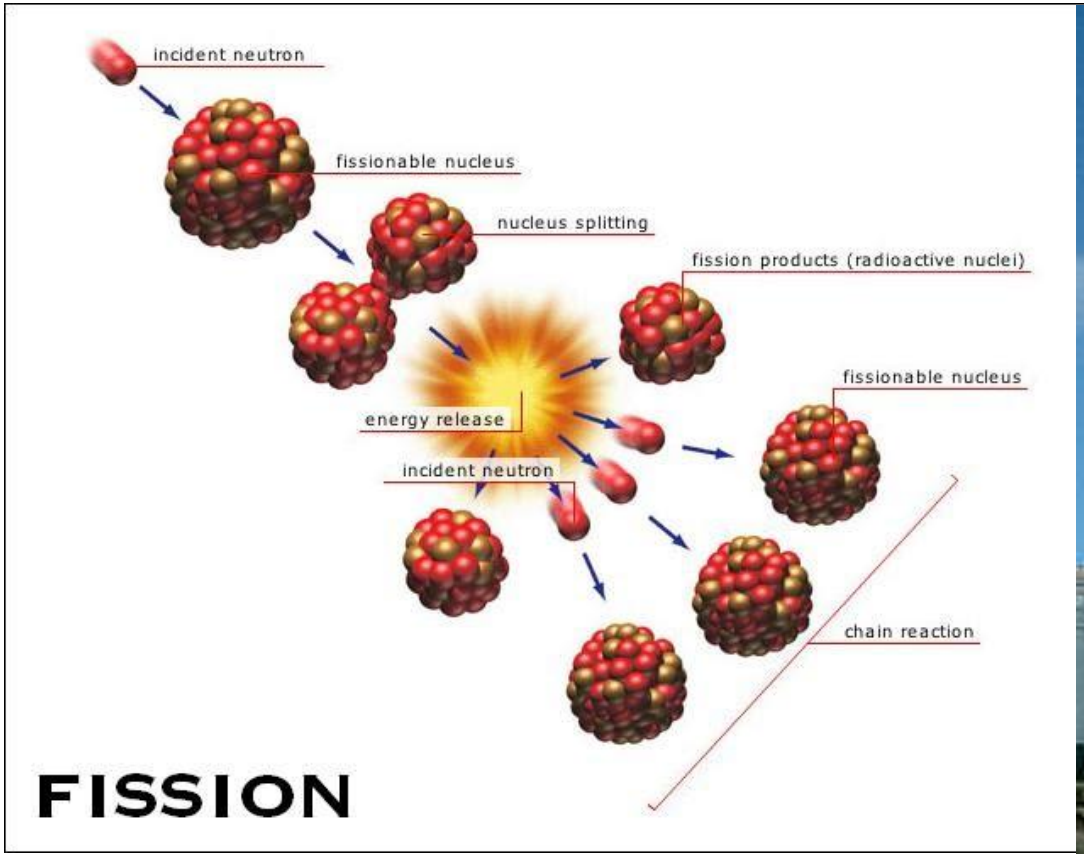
Chemical energy is the energy stored in the bonds of atoms and molecules.



Nuclear Energy (Potential)

Nuclear energy is the energy stored in the nucleus of an atom - the energy that holds the nucleus together.

The nucleus of a uranium atom is an example of nuclear energy.



Stored mechanical energy (Potential)

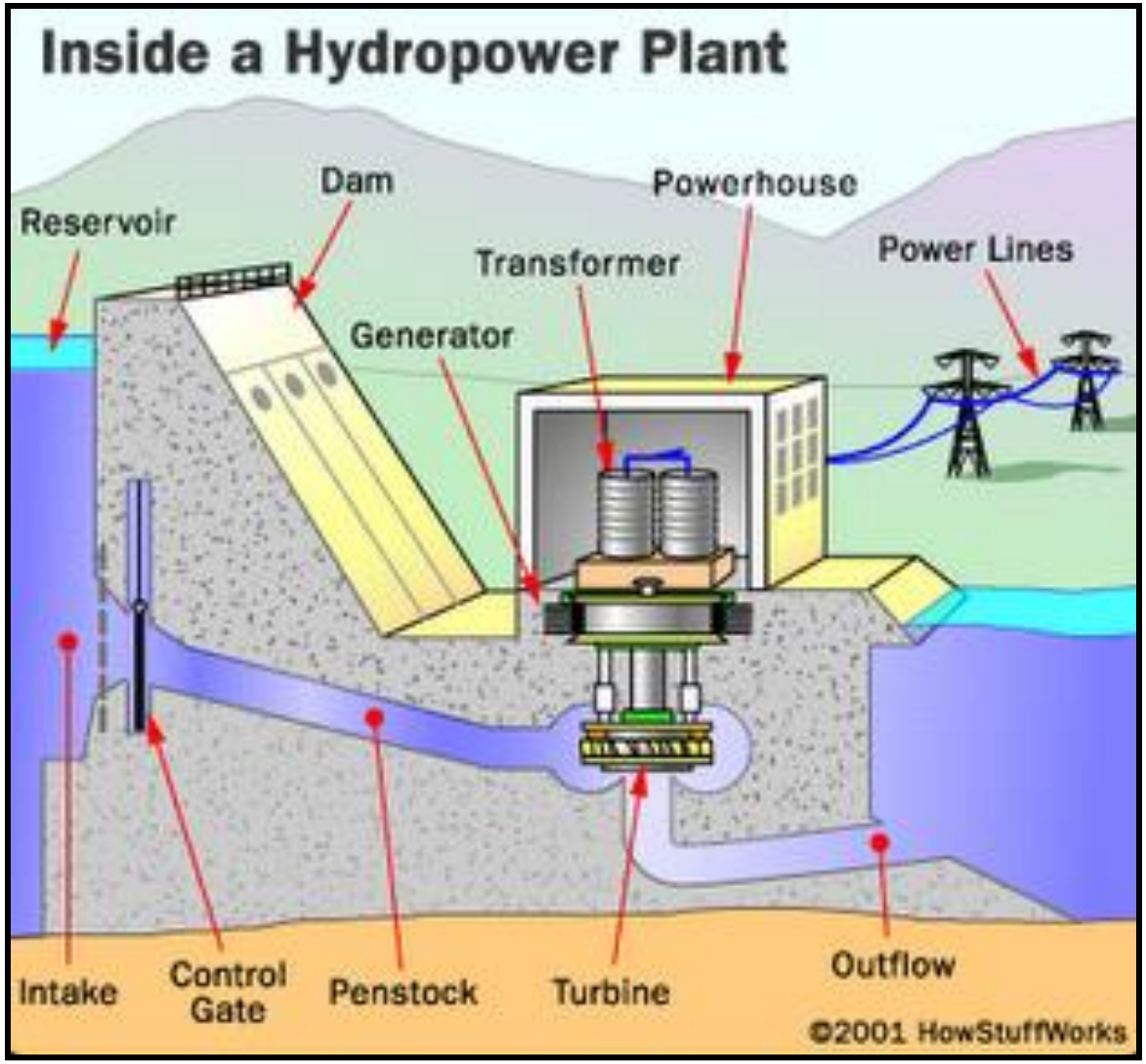
Stored mechanical energy is energy stored in objects by the application of a force.

Compressed springs and stretched rubber bands are examples of stored mechanical energy.

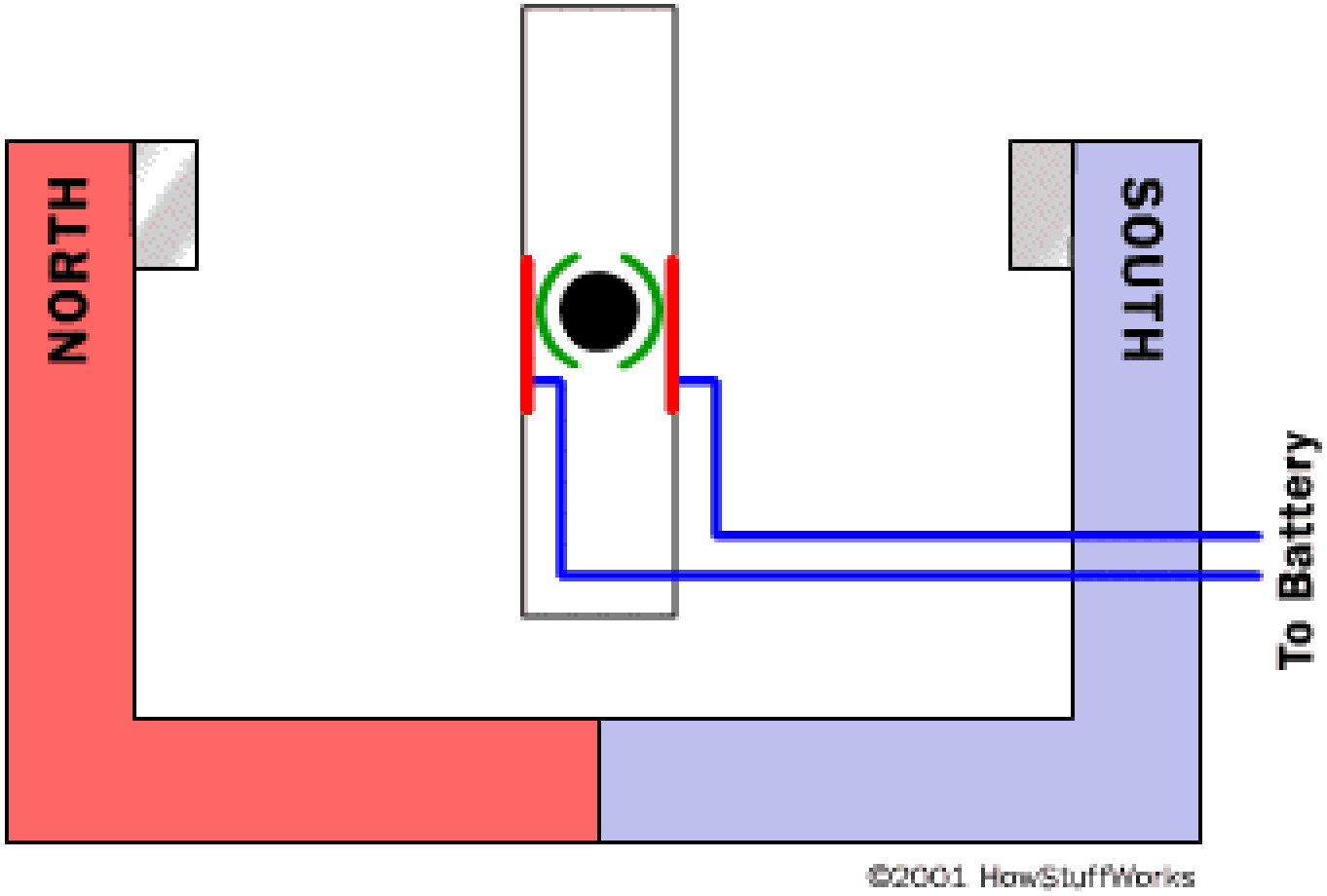
Gravitational Energy (Potential)

Gravitational energy is the energy of place or position.

Water in a reservoir behind a hydropower dam is an example of gravitational potential energy. When the water is released to spin the turbines, it becomes motion energy.



Generating Electricity



Motion Energy (Kinetic)

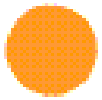
The movement of objects from one place to another is motion.

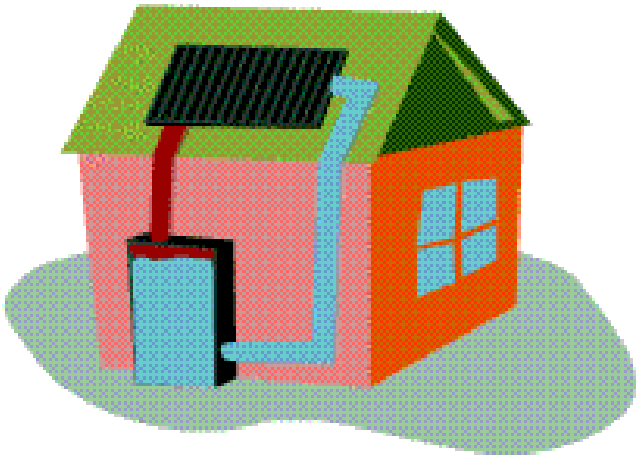
Wind and hydropower are examples of motion.

Radiant Energy (Kinetic)

Radiant energy is electromagnetic energy that travels in transverse waves.

Radiant energy includes visible light, x-rays, gamma rays and radio waves. Solar energy is an example of radiant energy.

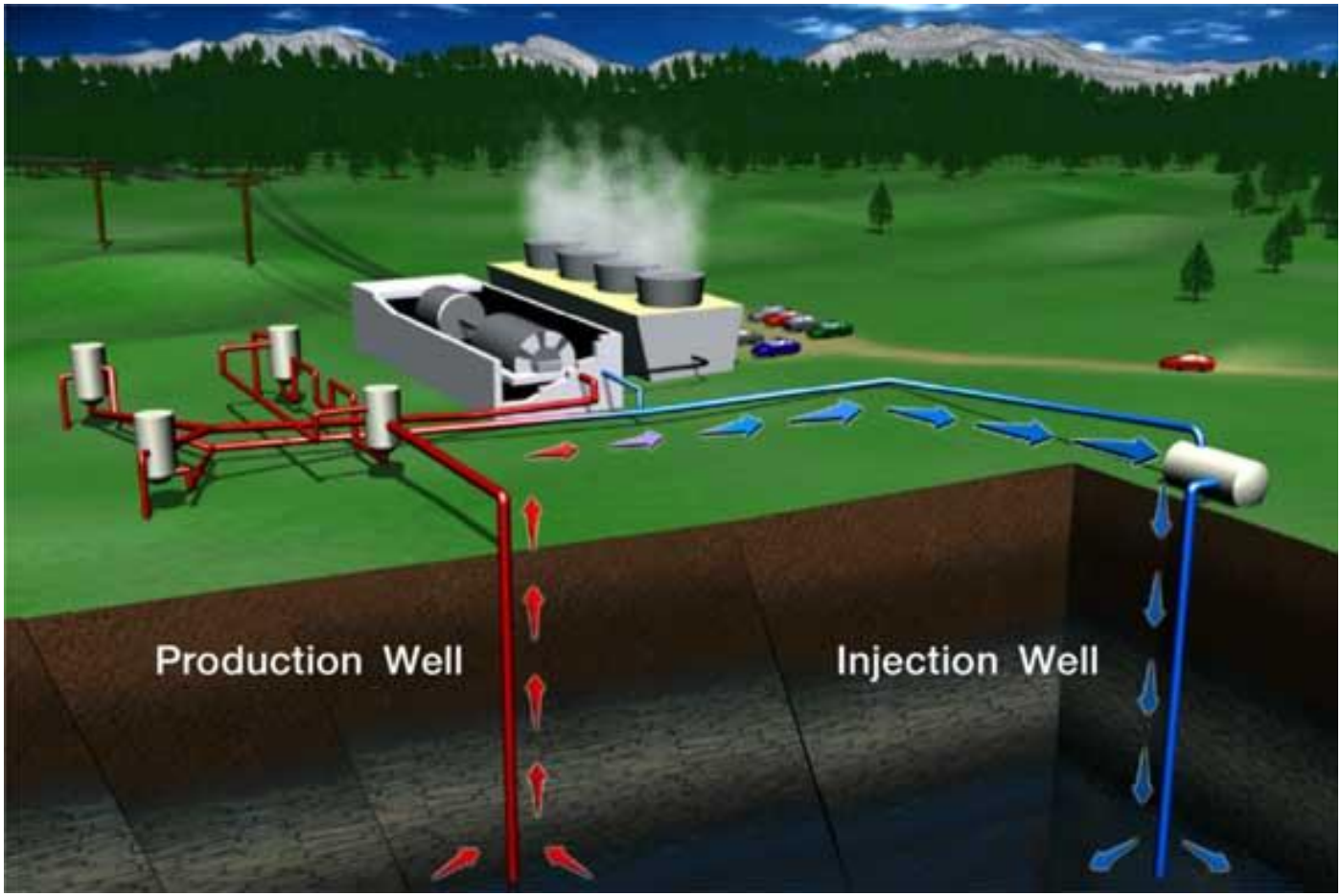




Thermal Energy (Kinetic)

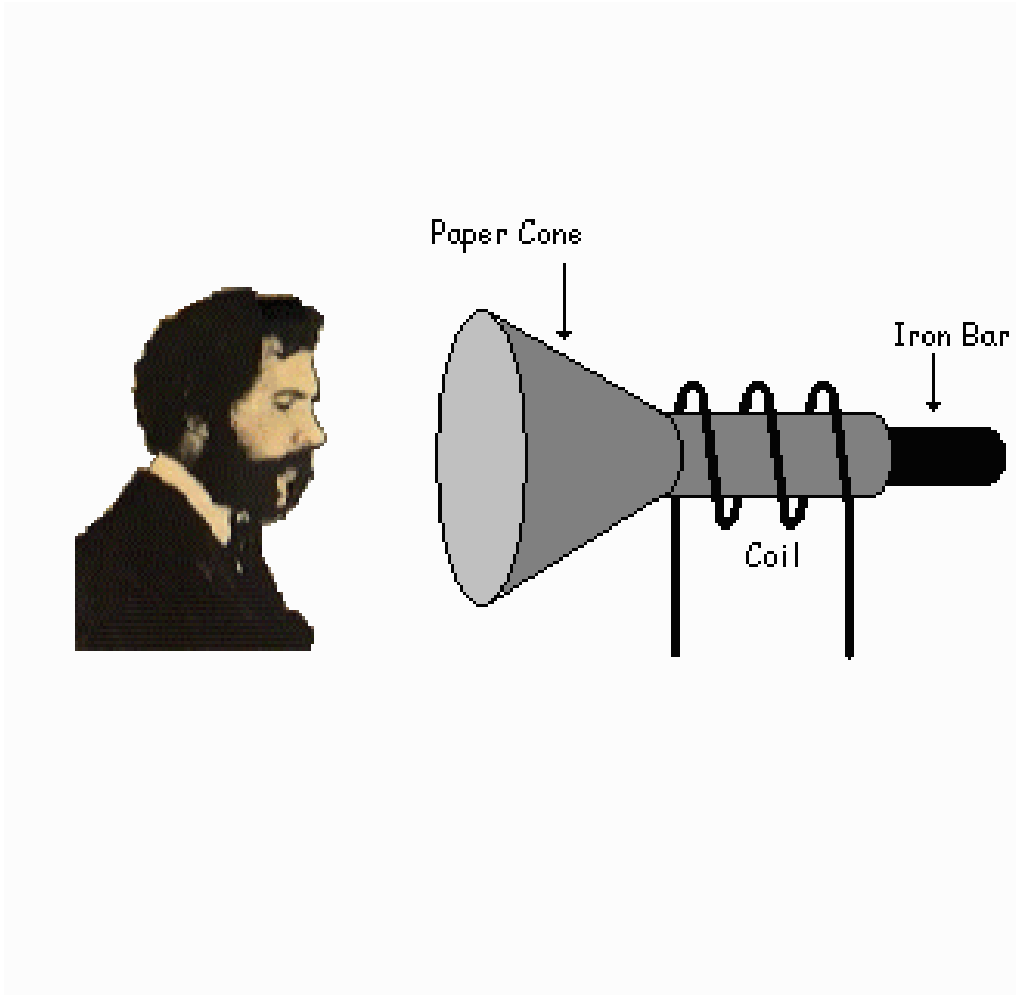
Thermal energy (or heat) is the internal energy in substances - the vibration and movement of atoms and molecules within substances.

Geothermal energy is an example of thermal energy.



Sound Energy (Kinetic)

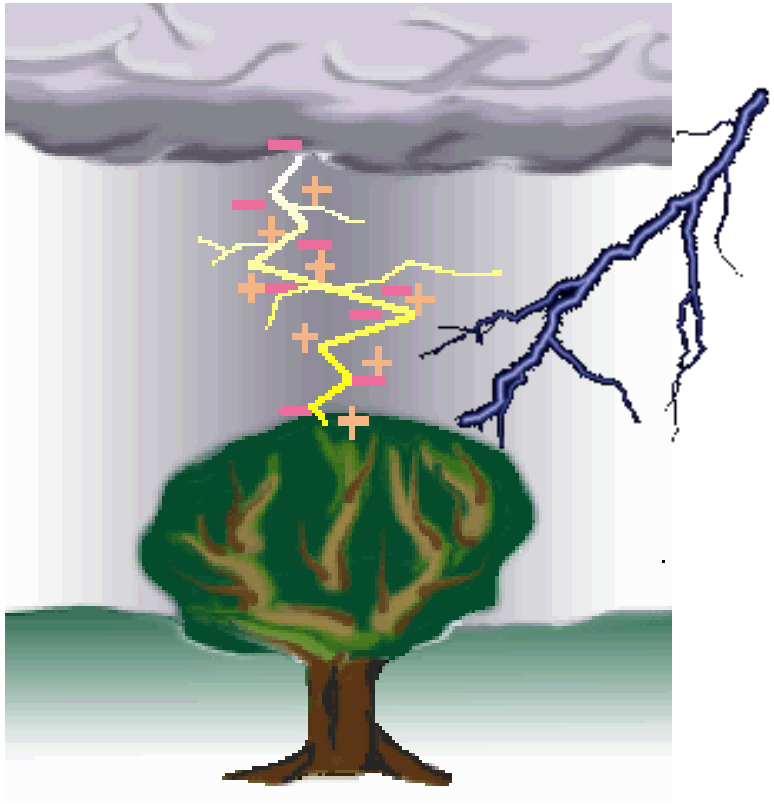
Sound is the movement of energy through substances in longitudinal (compression/ rarefaction) waves.



Electrical Energy (Kinetic)

Electrical energy is the movement of electrons.

Lightning and electricity are examples of electrical energy.



Video - Energy Sources 6 mins

Handout: Forms of Energy

Converting Energy

Energy can be converted from one form to another. There are many methods that can be used.

Look at the following examples and determine which type of energy conversions occurred.

Turn a flashlight on

A tree growing

Pouring water into a glass

Rubbing two sticks together to start a fire

Using a magnifying glass to ignite a piece of paper

Video: Transformation of Energy - 4 mins