



Conservation of Energy

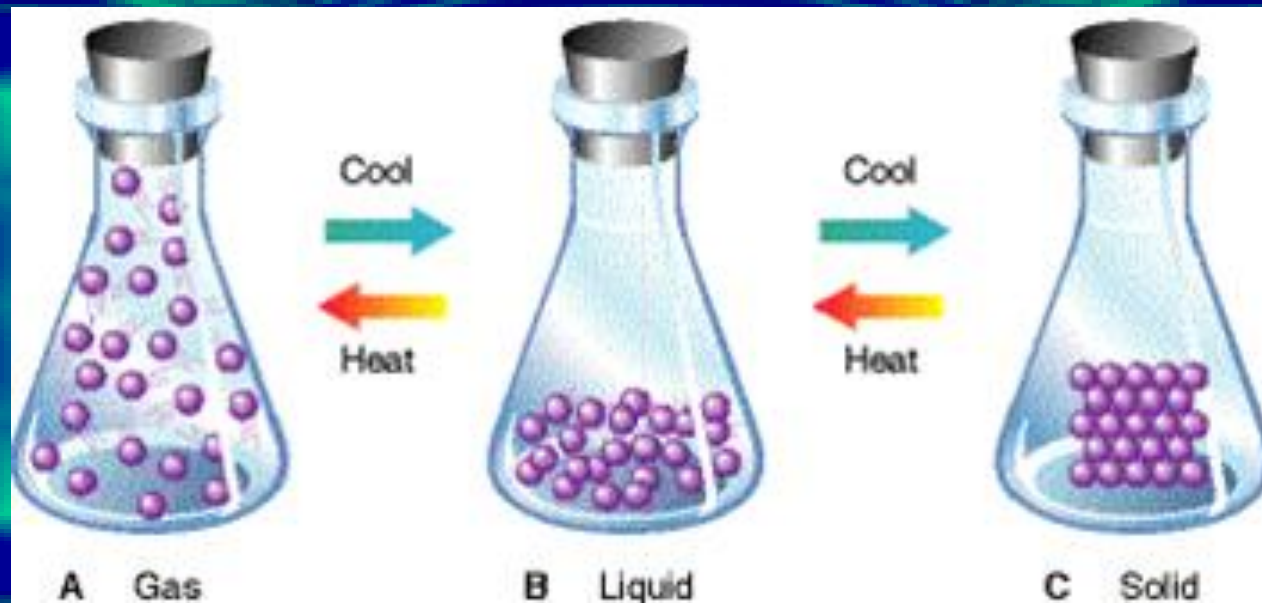
Menu

- Types of Energy
 - The Law of Conservation of Energy
- Magnetism & Electricity
- Conservation of Energy
- Types of Energy Transfer
- Energy & Work
- Simple Machines

Types of Energy

Heat energy

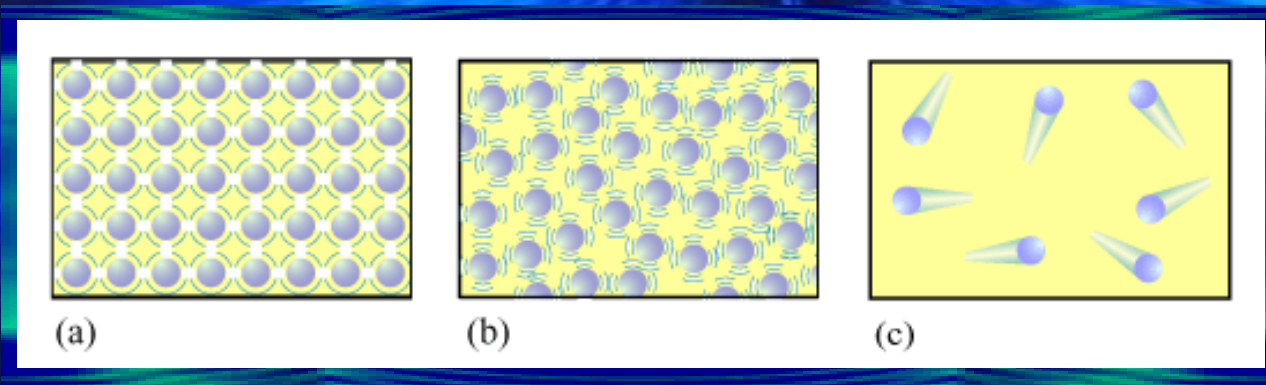
- Heat energy is the transfer of thermal energy (associated with the motion)
- All matter is made up of particles too small to be seen.



Types of Energy

Heat energy

- As heat energy is added to a substance, the temperature goes up indicating that the particles are moving faster. The faster the particles move, the higher the temperature.
- Sources of heat energy: burning material, the sun, and electricity



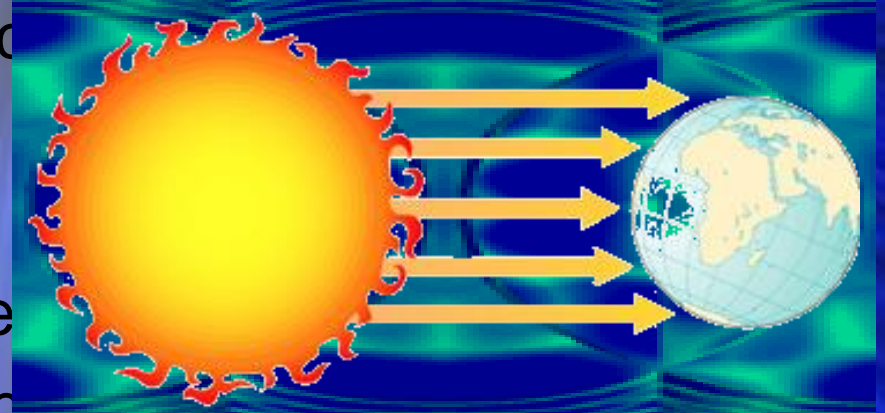
Heated Solid Animation

Types of Energy

Solar energy

- *Solar energy* is the energy from the Sun, which provides heat and light energy for Earth.
- Solar cells can be used to convert solar energy to electrical energy.

- Green plants use solar energy during photosynthesis to produce sugar, which contains stored chemical energy.
- Most of the energy that we use on Earth originally came from the Sun.



Types of Energy

Chemical energy

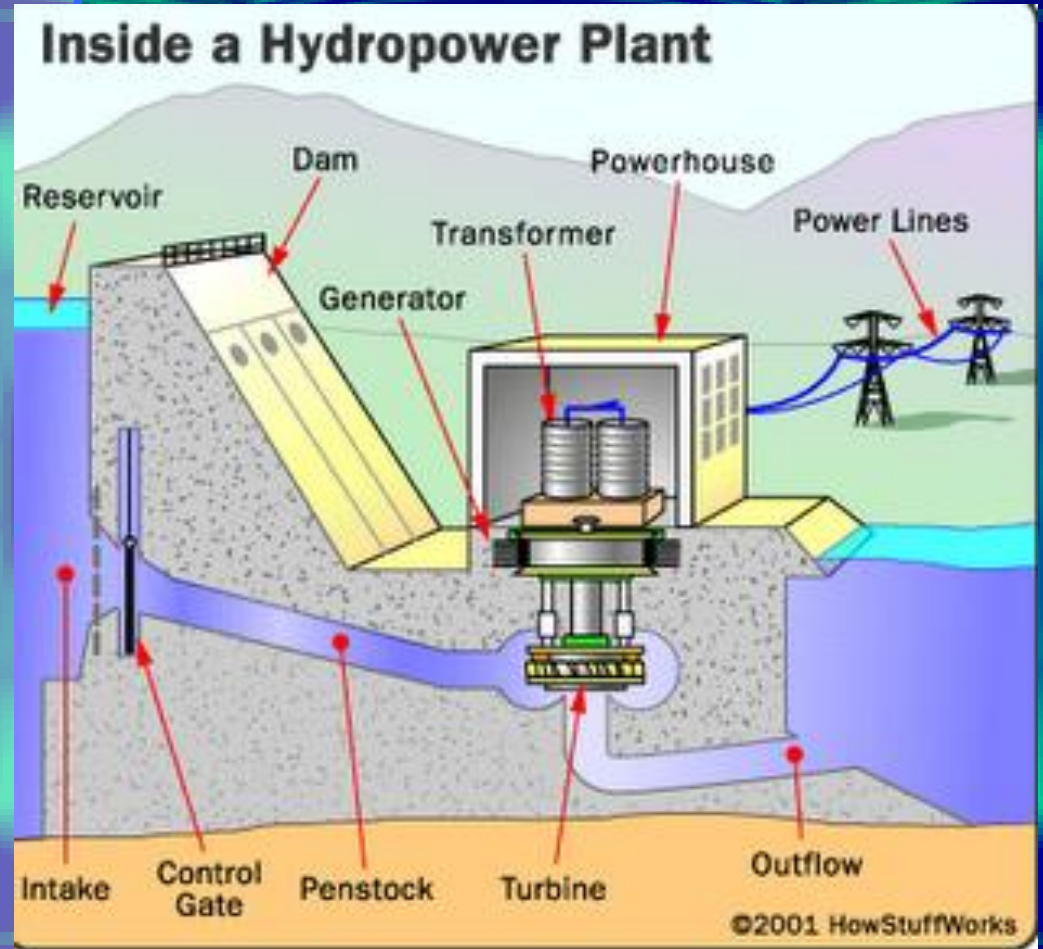
- *Chemical energy* is energy stored in particles of matter.
- Chemical energy can be released, for example in batteries or sugar/food, when these particles react to form new substances.



Types of Energy

Electrical energy

- *Electrical energy* is the energy flowing in an electric circuit.
- Sources of electrical energy include: stored chemical energy in batteries; solar energy in solar cells; fuels or hydroelectric energy in generators.

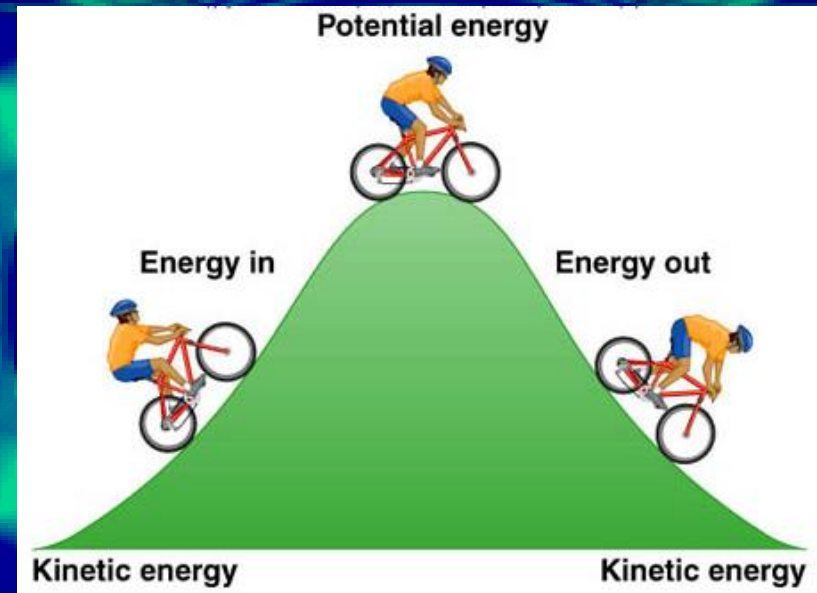


Types of Energy

Mechanical energy

• Mechanical energy is the energy due to the motion (kinetic) and position (potential) of an object.

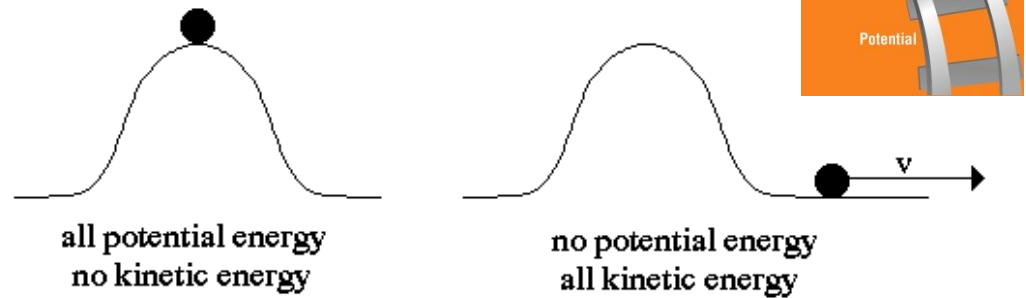
When objects are set in motion or are in a position where they can be set in motion, they have mechanical energy.



Kinetic energy versus Potential energy

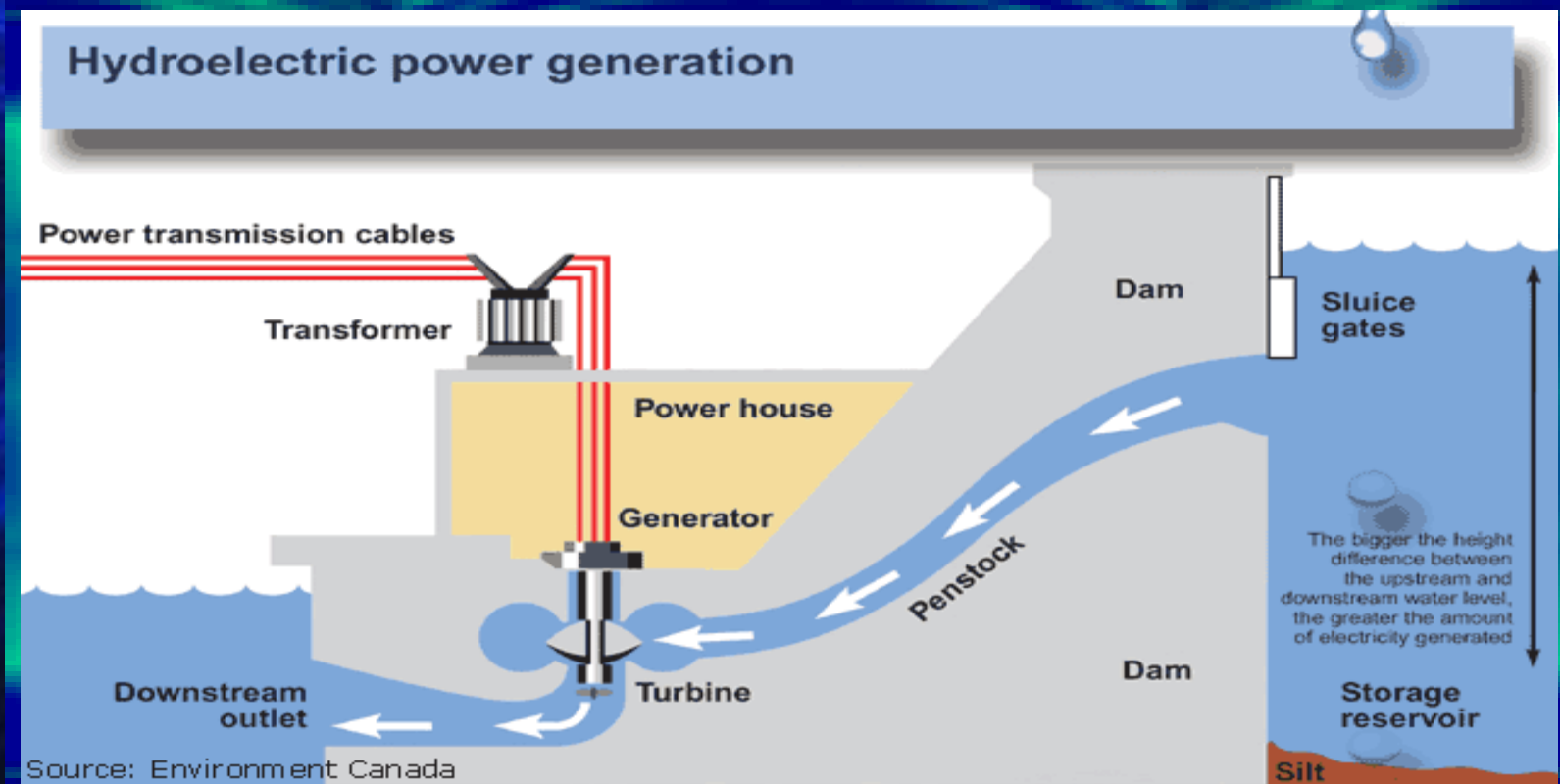
kinetic energy = energy of motion/momentum

potential energy = stored energy/energy from gravity



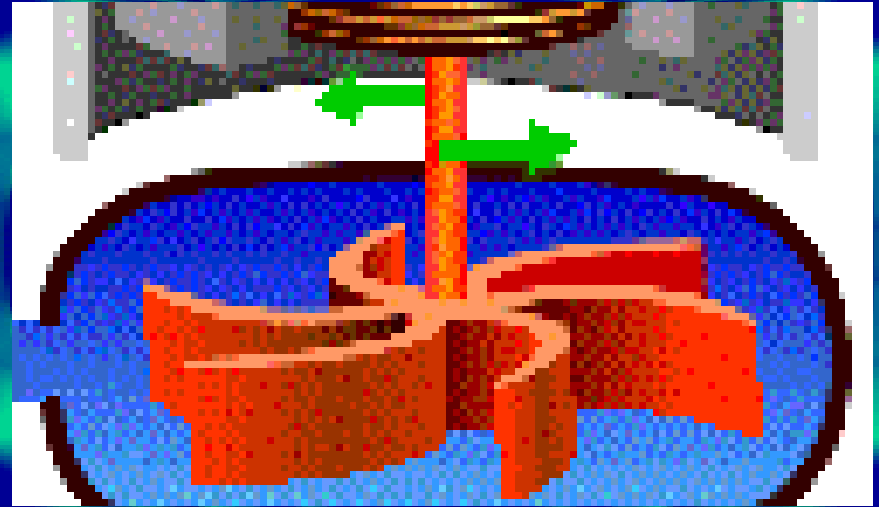
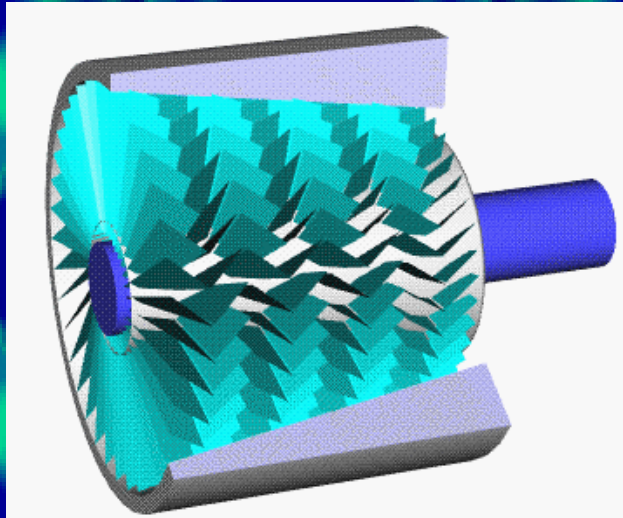
Types of Energy

- Mechanical Potential energy: Potential energy is stored energy. Mechanical potential energy is related to the position of an object. Examples: A stretched rubber band, and water behind a dam



Types of Energy

- Mechanical Kinetic energy: Kinetic energy is the energy an object has due to its motion. Mechanical kinetic energy increases as an object moves faster. Example: a moving car









The Law of Conservation of Energy

- States that energy cannot be created or destroyed. It may be transformed from one form into another, but the total amount of energy never changes.
- Examples of potential → kinetic mechanical transformations might include:

Potential Energy	Kinetic Energy
Water behind a dam	Water flowing over a dam
Stretched rubber band	Released rubber band
Book resting on shelf (position)	Book falling from shelf

The Law of Conservation of Energy

Energy transformations may involve other kinds of energy.

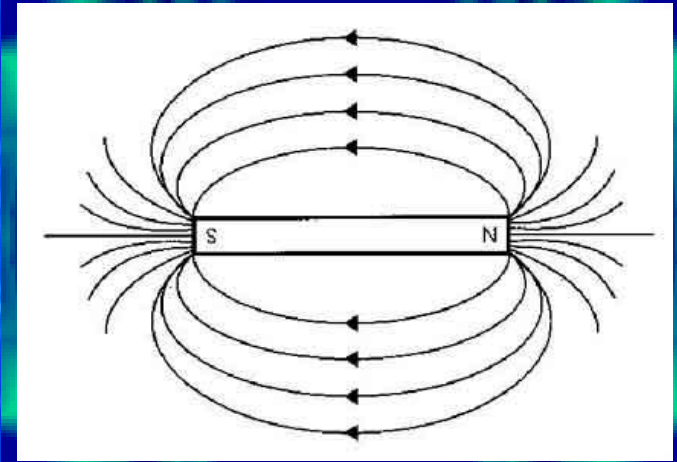
Example	Energy Transformations		
Book falling	Kinetic		sound, heat
Water moving over dam	Kinetic		electrical (via generator)
Green plants	Solar		stored chemical (sugar)
Animals eating food	Chemical		kinetic (moving)
Burning carbon-based fuel	Chemical		heat energy, electrical
Electrical circuit (using an outlet)	electrical		mechanical, heat, sound, and light

The total amount of energy is conserved.

Magnetism & Electricity

Magnetism is the force of attraction or repulsion of magnetic materials.

- Surrounding a magnet is a **magnetic field** that applies a force, a push or pull, without actually touching an object.
- An electric current flowing through a wire wrapped around an iron core forms a **magnet**.

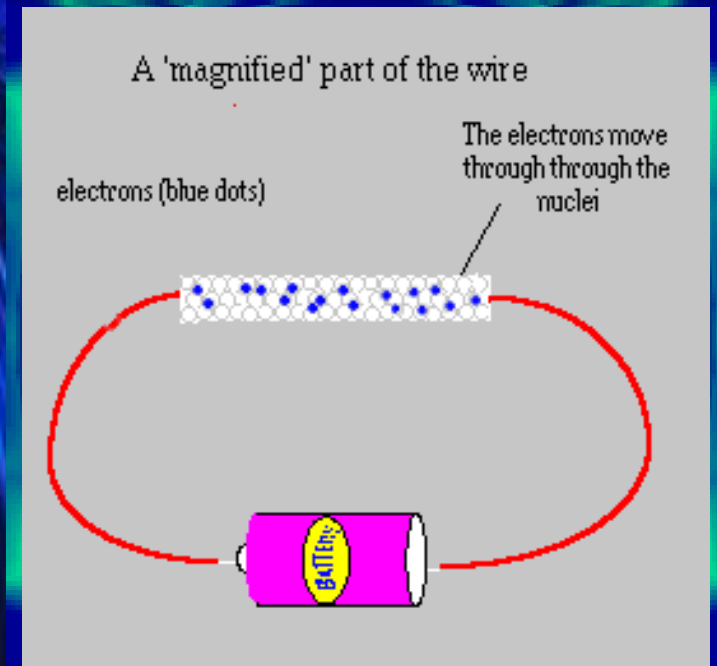
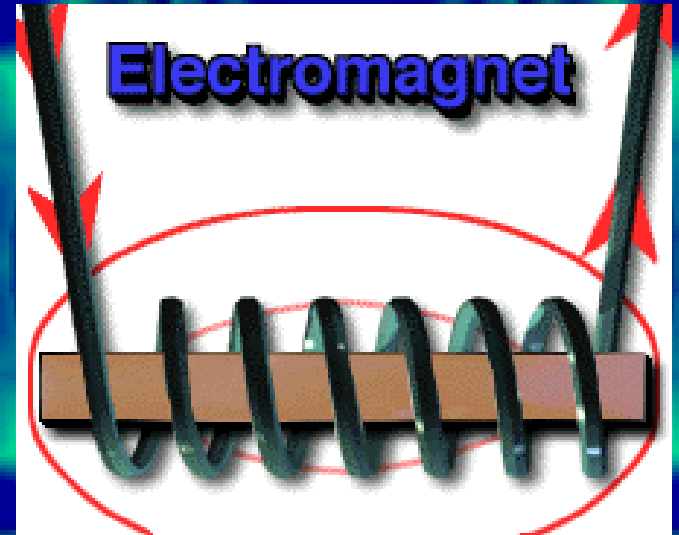


MENU

Magnetism & Electricity

Electromagnets

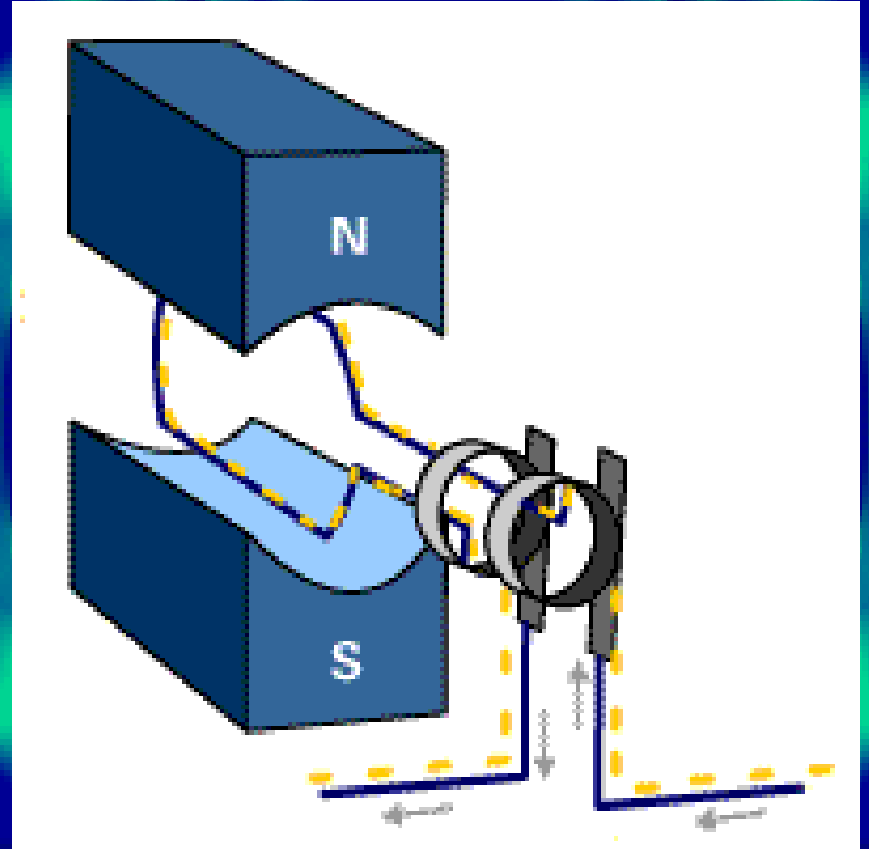
- An electromagnet is formed when a wire in an electric circuit is wrapped around an iron core producing a magnetic field.
- The magnet that results loses its magnetism if the electric current stops flowing.



Magnetism & Electricity

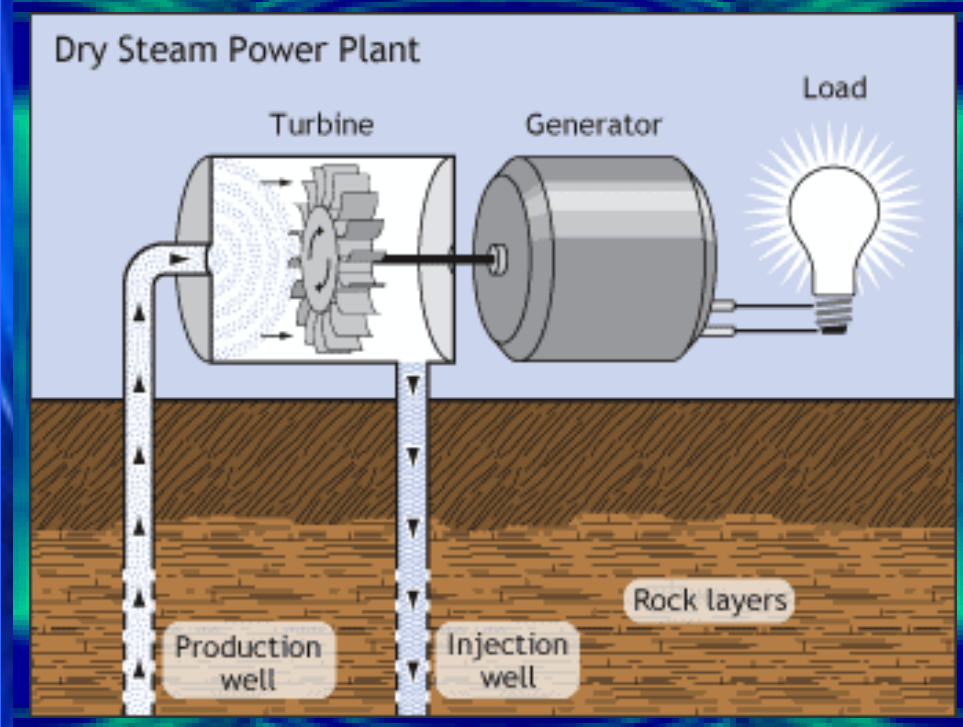
Generators

- A generator produces an electric current when a coil of wire wrapped around an iron core is rotated near a magnet.
- Generators at power plants produce electric energy for our homes.



Magnetism & Electricity

- A generator contains coils of wire that are stationary, and rotating magnets are rotated by turbines. Turbines are huge wheels that rotate when pushed by water, wind, or steam.

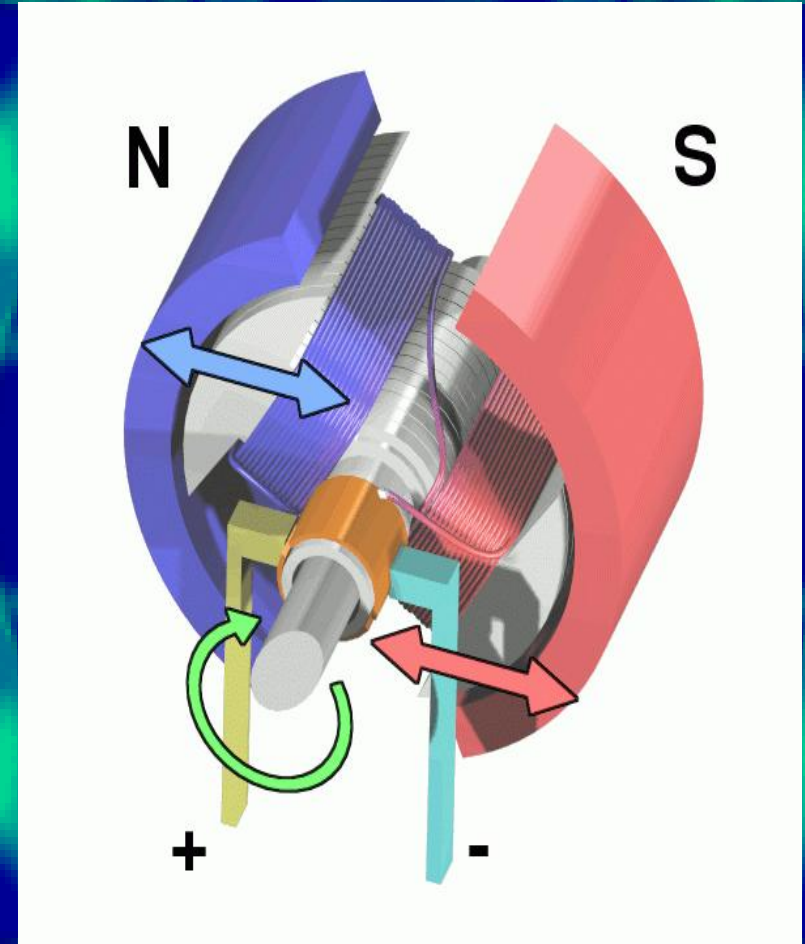


- Thus mechanical energy is changed to electrical energy by a generator. Smaller generators may be powered by gasoline.

Magnetism & Electricity

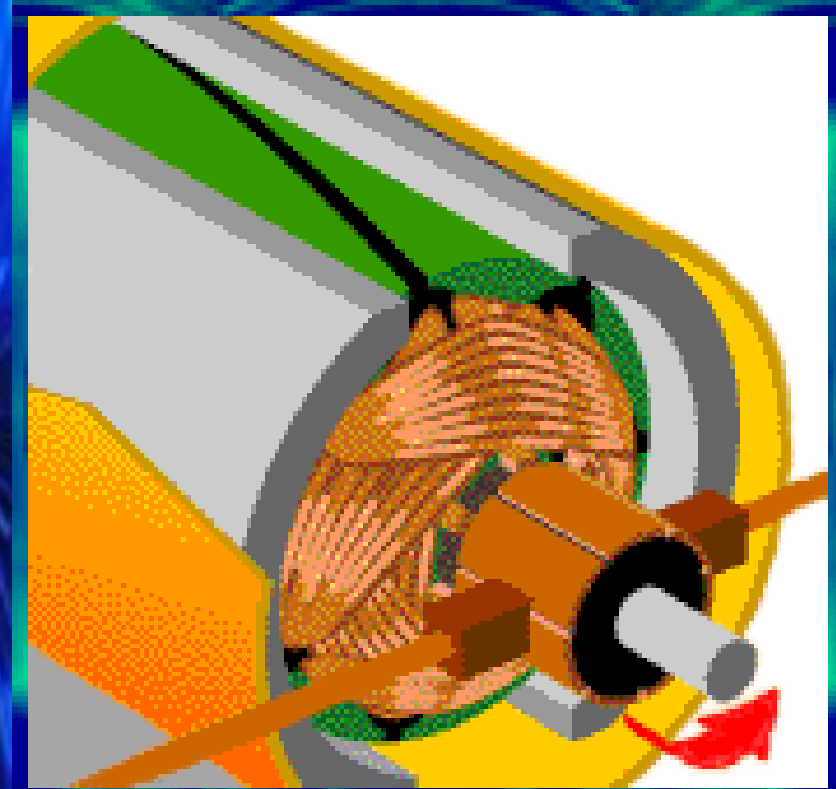
Simple electric motors

- An electric motor changes electrical energy to mechanical energy.
- It contains an electromagnet that rotates between the poles of a magnet.
- The coil of the electromagnet is connected to a battery or other source of electric current.



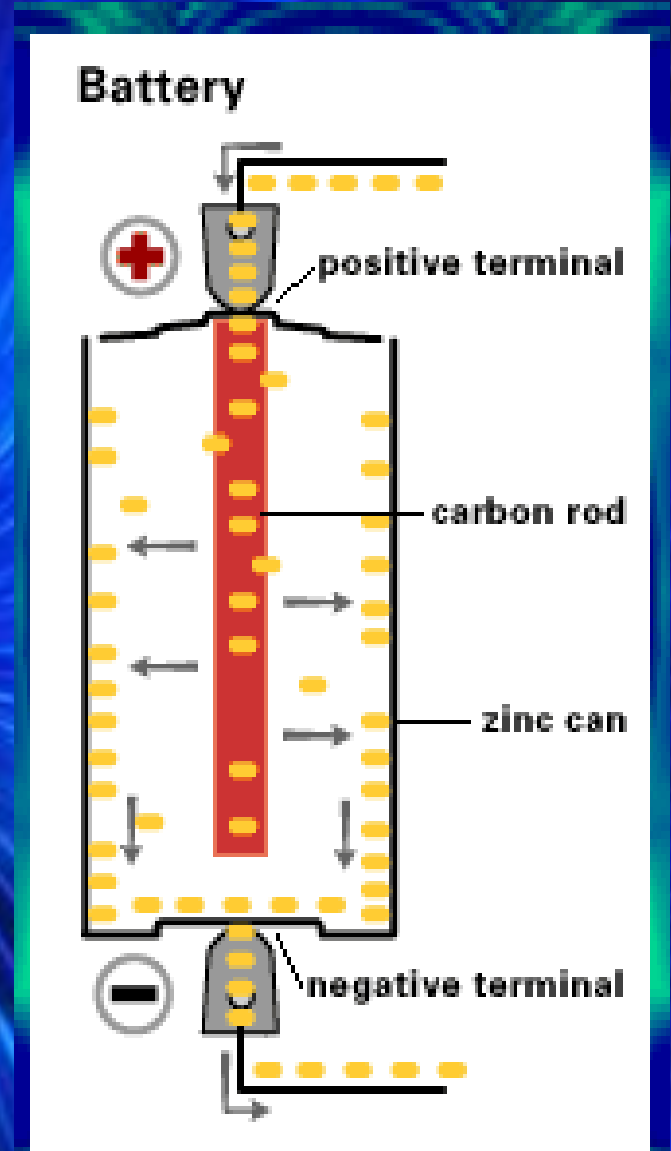
Magnetism & Electricity

- When an electric current flows through the wire in the electromagnet, a magnetic field is produced in the coil.
- Like poles of the magnets repel and unlike poles of the magnets attract.
- This causes the coil to rotate and thus changes electrical energy to mechanical energy.
- This rotating coil of wire can be attached to a shaft and a blade in an electric fan.



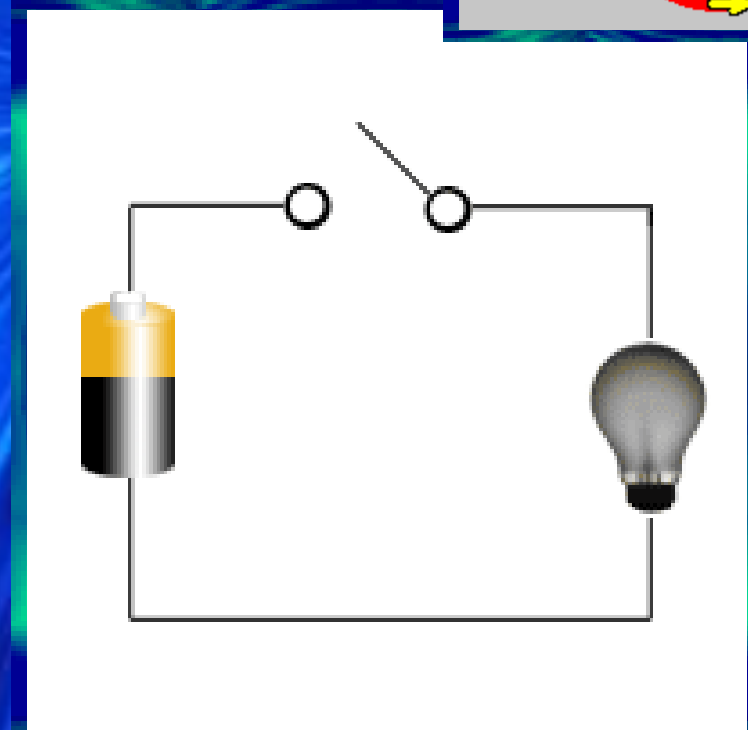
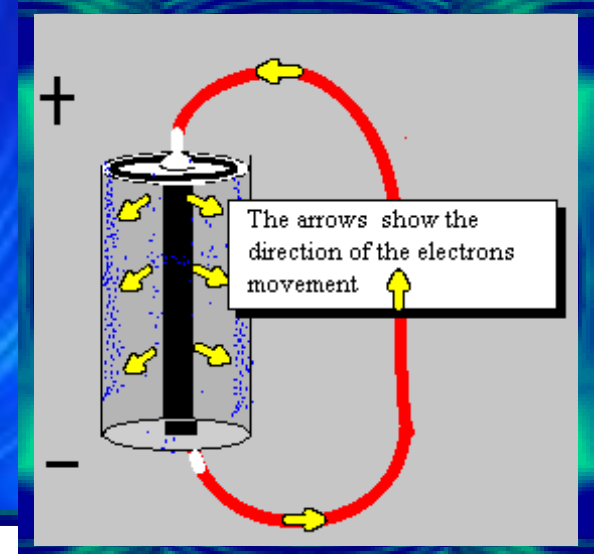
Conservation of Energy

- electrical energy can be transformed to light, sound, heat, and mechanical motion in an electric circuit.
- An electric circuit contains a source of electrical energy, a conductor of the electrical energy (wire) connected to the energy source, and a device that uses and transforms the electrical energy.



Conservation of Energy

•All these components must be connected in a complete, unbroken path in order for energy transformations to occur.



Conservation of Energy

The electrical energy in circuits may come from many sources including:

Source	Energy comes from...
Battery	Stored chemical energy
Solar cell	Light energy from sun
Electrical outlets	Chemical energy (burning fuels)

Most electricity is produced by coal-burning power plants but can also be provided by using nuclear energy, hydroelectric energy, and geothermal power plants.

Conservation of Energy

Electrical energy can be transformed to other forms of energy in a circuit.

Devices used in electrical circuit	Energy Transformations
<u>Light</u> : Light bulb	chemical (battery) → electrical → light & heat
<u>Sound</u> : buzzer, radio, tv	chemical (battery) → electrical → sound
<u>Heat</u> : toaster, stove, or heater	Chemical (fuel) → heat → mechanical (to turn a generator) → electrical → heat (used in device)
<u>Mechanical (kinetic)</u> : fan, motor	Chemical (battery) → electrical → mechanical

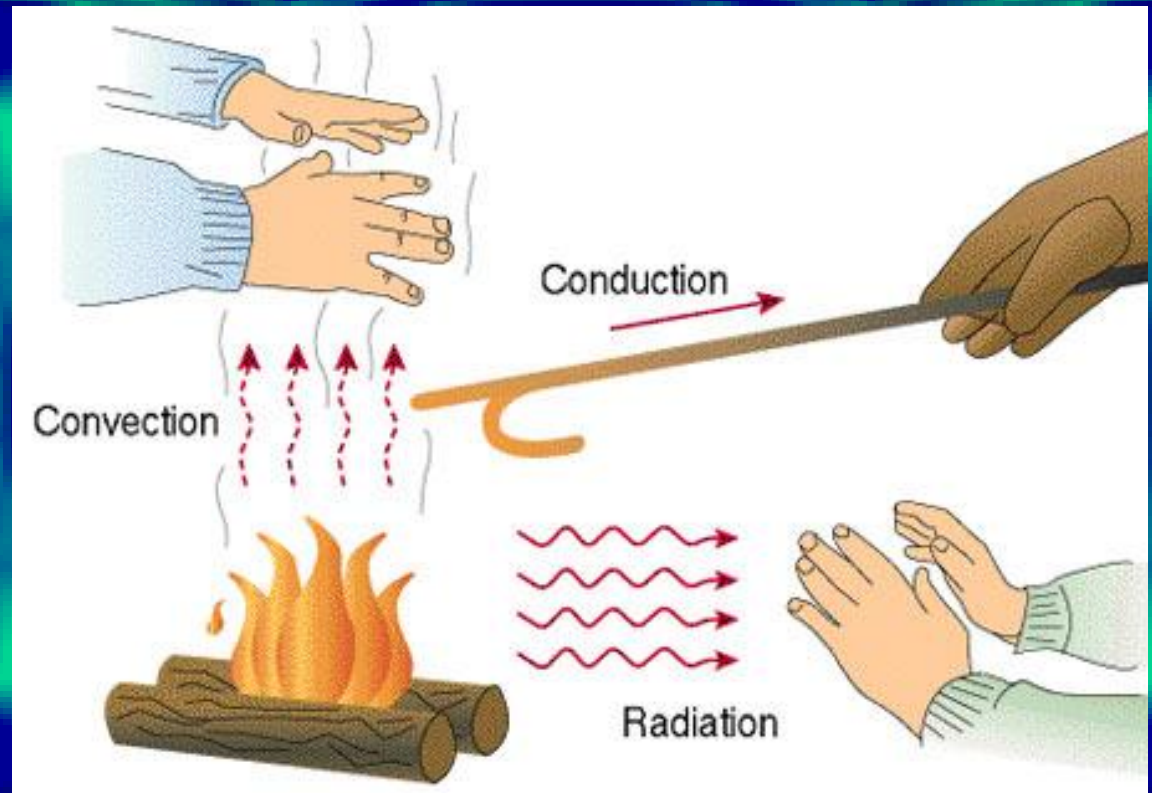
Types of Energy Transfer

Conduction, Convection & Radiation

Conduction

involves objects in direct contact.

- The transfer of energy as heat occurs between particles as they collide within a substance or between two objects in contact.



Types of Energy Transfer

Conduction, Convection & Radiation

- All materials do not conduct heat energy equally well.
- Poor conductors of heat are called insulators.
- The energy transfers from an area of higher temperature to an area of lower temperature.



polystyrene



wood



water



stone



aluminium



Types of Energy Transfer

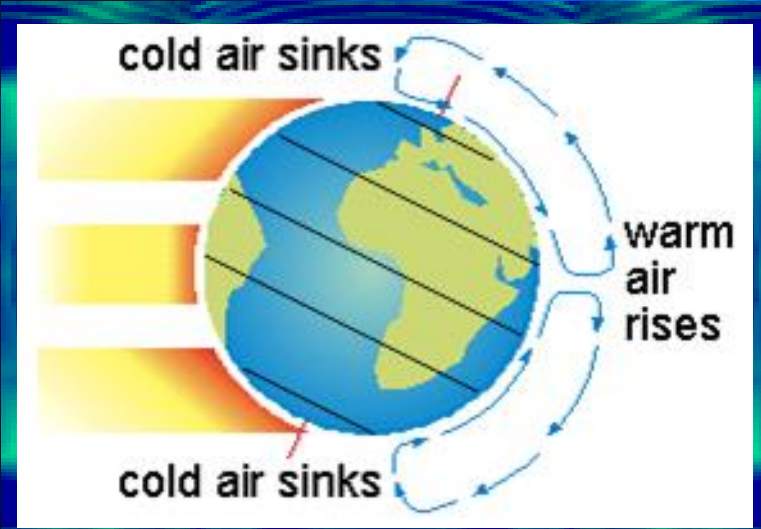
For example, if a plastic spoon and a metal spoon are placed into a hot liquid, the handle of the metal spoon will get hot quicker than the handle of the plastic spoon because the heat is conducted through the metal spoon better than through the plastic spoon.



Types of Energy Transfer

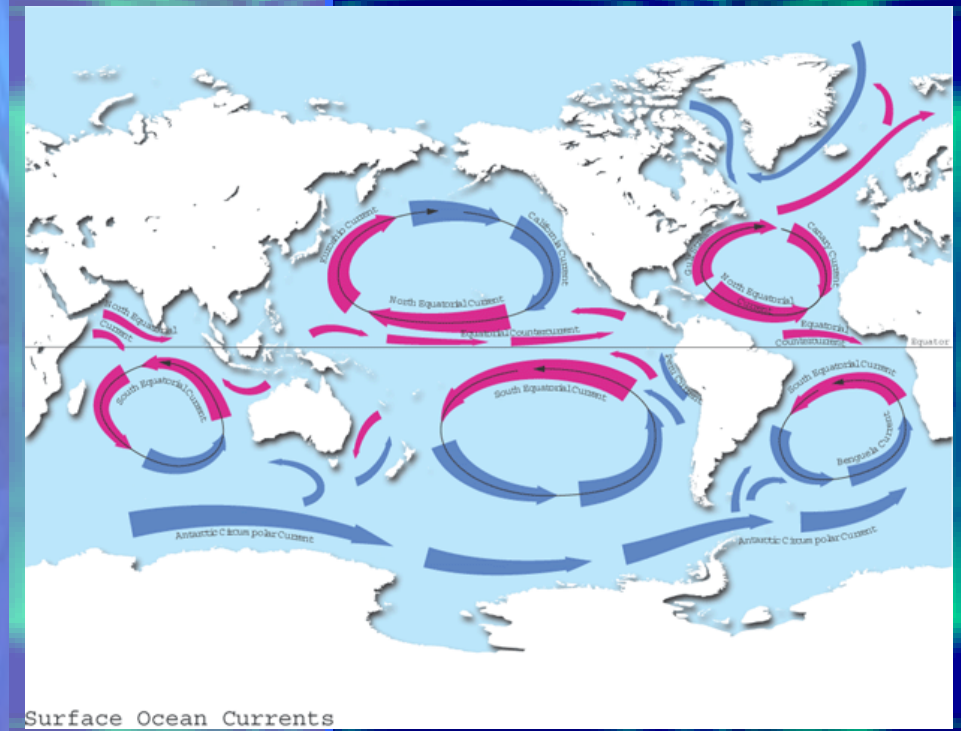
Convection is the transfer of energy as heat by movement of the heated substance itself, as currents in fluids (liquids and gases).

- In convection, particles with higher energy move from one location to another carrying their energy with them.

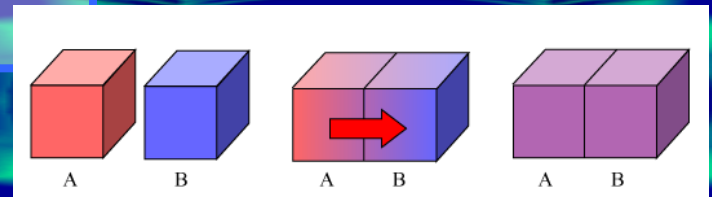


Types of Energy Transfer

- Heat transfer occurs when particles with higher energy move from warmer to cooler parts of the fluid.
- Uneven heating can result in convection, both in the air and in water. This causes currents in the atmosphere (wind) and in bodies of water on earth which are important factors in weather and climate.



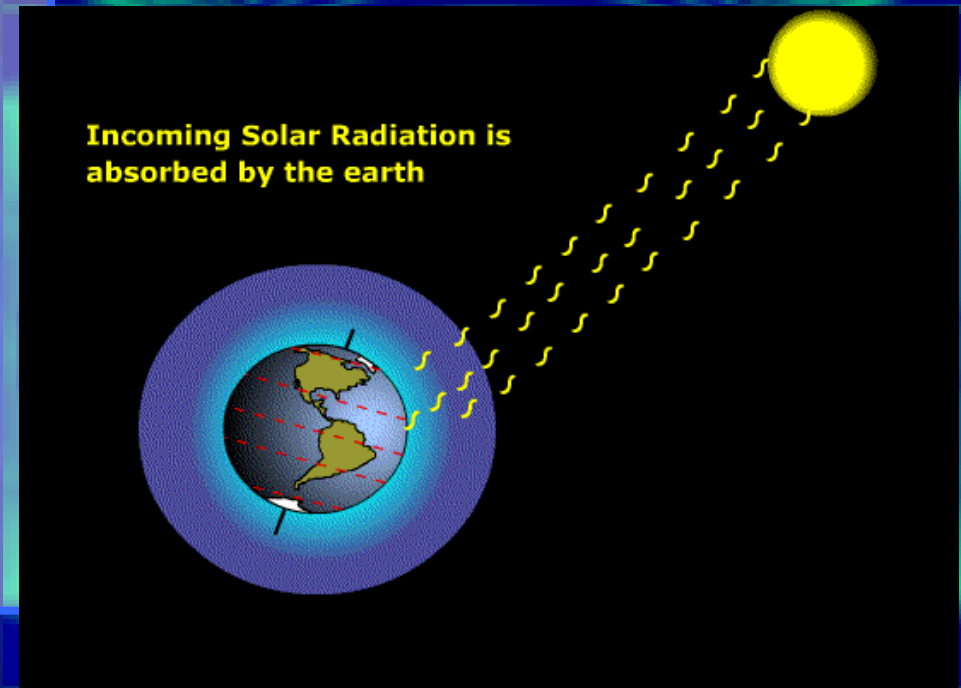
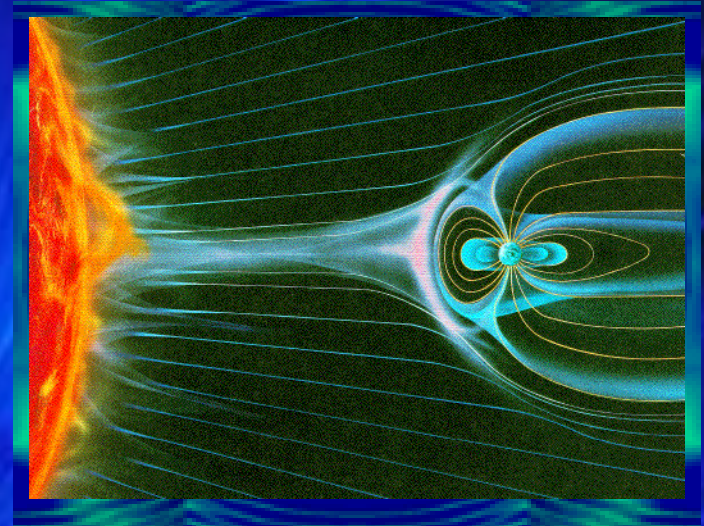
Surface Ocean Currents



Types of Energy Transfer

Radiation is the transfer of energy through space without particles of matter colliding or moving to transfer the energy.

- This radiated energy warms an object when it is absorbed.
- Radiant heat energy moves from an area of higher temperature to an area of cooler temperature.



Energy & Work

Energy is a property that enables something to do work.

- Work means to (1) apply a force to an object over a distance, and (2) the object moves in response to the force.
- If something has the ability to cause a change in motion, it has energy.
- Energy can cause work to be done, so when we see work done, we see evidence of energy.

Energy & Work

Evidence of energy is when work is being done.

For example:

- When a toy car at rest is pushed, work is done on the car if it moves. This work (or movement) is evidence of energy.
- When a fan is connected to an electric circuit, it moves, so work was done on the fan. This work (or movement) is evidence of energy.
- When an object is lifted, it moves, so work is done on the object. This work (or movement) is evidence of energy.

Energy & Work

A spring scale is used to measure force. Force (including weight) is measured in SI units called newtons (N).



Simple Machines

A simple machine is a device that helps reduce the amount of force required to do work. Work is done when a force (*effort force*) is applied over a distance.

- A simple machine allows the user to apply a smaller force over a larger distance to move an object.
- Simple machines can also change the direction of the force applied.
- If the distance over which the effort force is exerted is increased, the same amount of work can be done with a smaller effort force.

Simple Machines

Lever- is a rigid bar or board that is free to move around a fixed point called a fulcrum.

- The fulcrum may be placed at different locations along the bar.
- A lever can reduce the amount of force required to lift a weight in two ways:

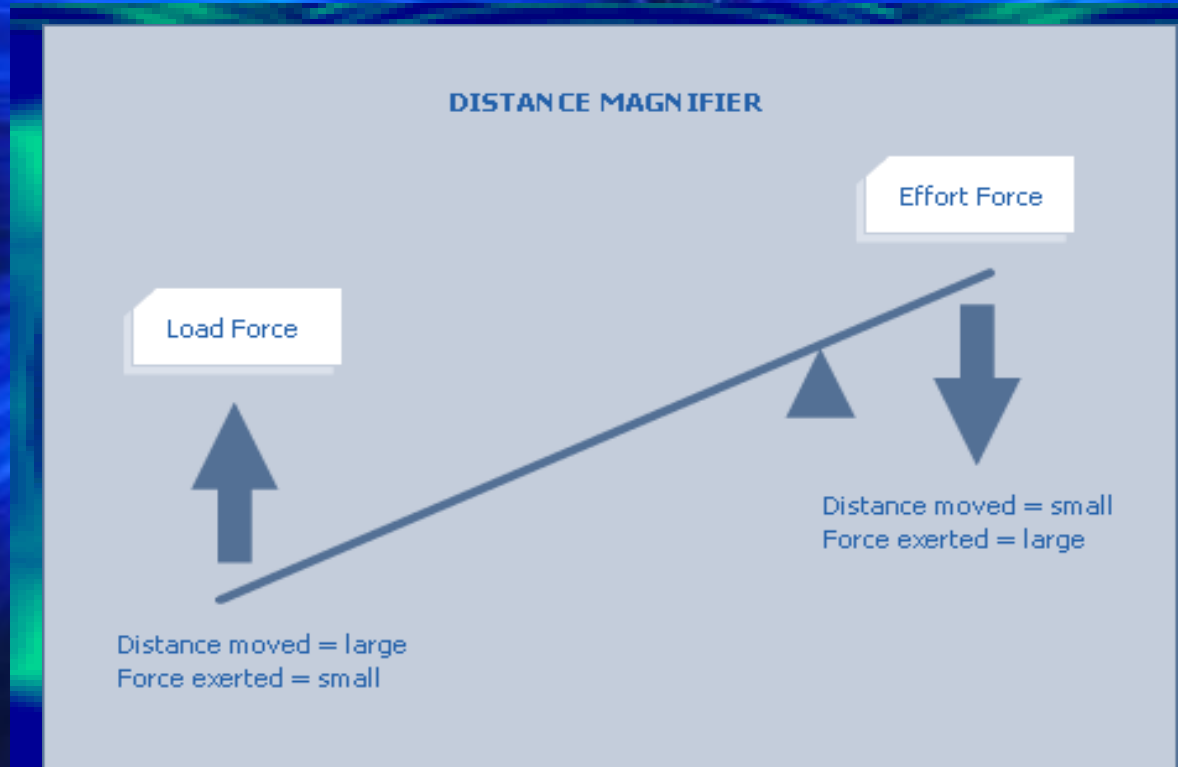


[Lever Animations](#)

[The Lever Story](#)

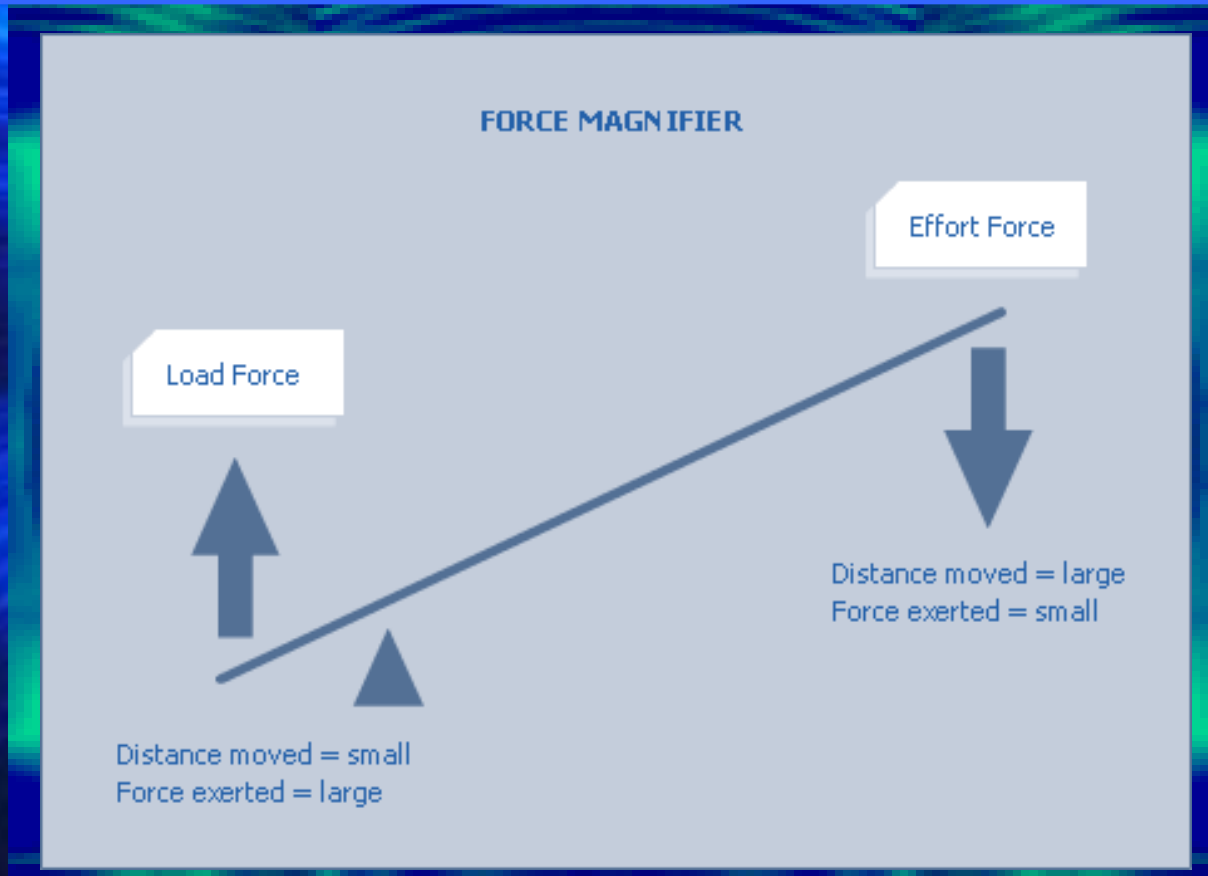
Simple Machines

1. By increasing the distance from the fulcrum to the point where the effort force is applied, or by decreasing the distance the weight is from the fulcrum.



Simple Machines

2. By increasing the distance the effort force moves relative to the distance the weight moves, a lever can reduce the effort force needed.

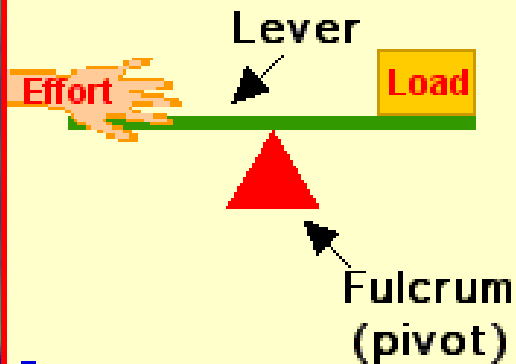


Simple Machines

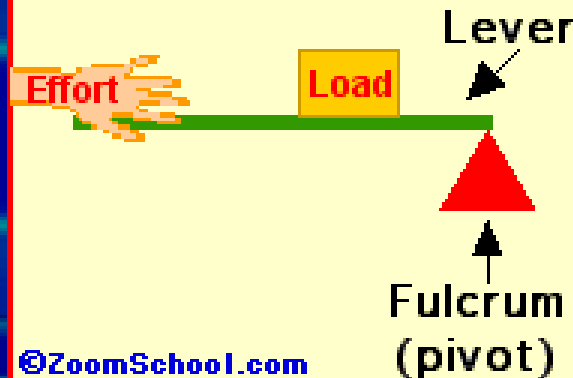
ARCHIMEDES

Archimedes (287-212 BC) was an ancient Greek mathematician. Among his many accomplishments was the first description of the lever (around 260 BC). Levers are one of the basic tools. Many of our basic tools use levers: including scissors (two class-1 levers), pliers (two class-1 levers), hammer claws (one class-1 lever), nutcrackers (two class-2 levers), and tongs (two class-3 levers).

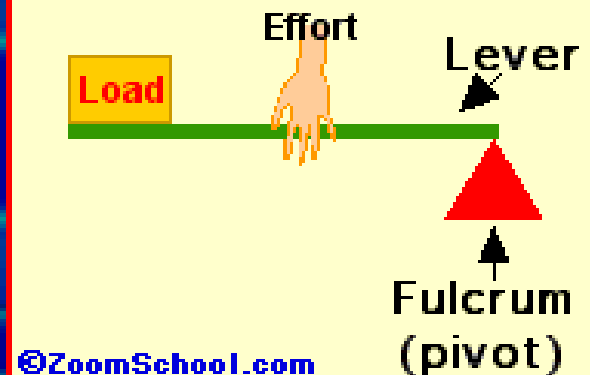
First Class Lever



Second Class Lever



Third Class Lever



Simple Machines

Pulley- has a grooved wheel with a rope running along the groove.

- change the amount and/or the direction of the effort force.
- if you increase the distance that the effort force moves relative to the distance the weight moves, a pulley can reduce the effort force needed.
- movable pulleys reduce the effort force.
- a single fixed pulley changes only the direction of the force (you pull down and the weight goes up.)

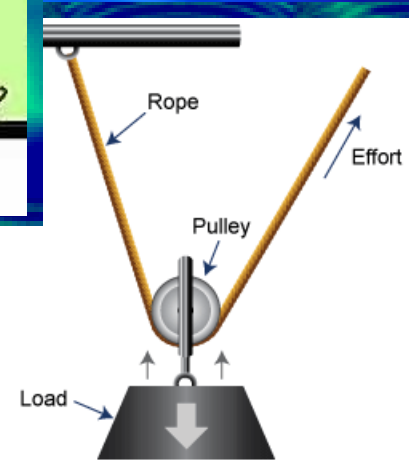
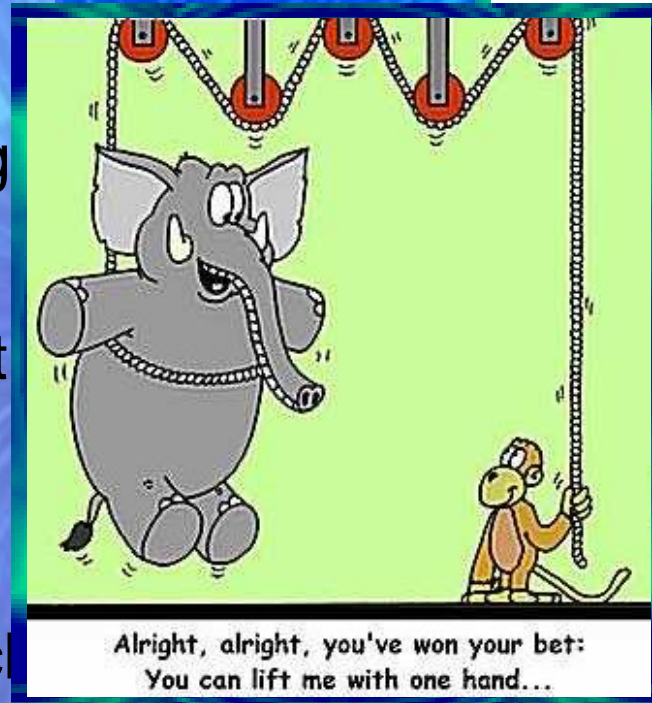
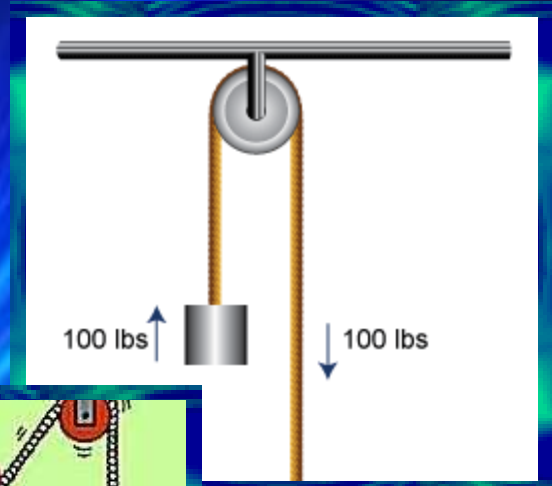


[Pulley Animations](#)

Simple Machines

Pulleys

Fixed pulleys, those attached to a structure, can be found on the top of a flag pole and on window blinds. Moveable pulleys, those not attached to a structure, can be found on construction cranes and as part of a block and tackle system.



[Pulley System Interactive](#)

[The Pulley Story](#)

Simple Machines

Inclined plane- is a sloping surface, like a ramp, that reduces the amount of force required to lift an object.

- An inclined plane can reduce the force needed to lift a weight in two ways:

(1) increase the length of the ramp or (2) decrease the height of the ramp.

- By increasing the distance the effort force moves (length of the ramp) relative to the distance the weight is lifted (height of the ramp), an inclined plane can reduce the effort force needed.

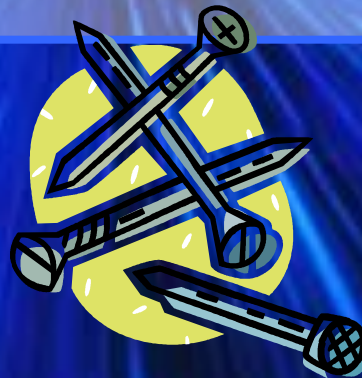


Simple Machines

Inclined planes- with a sloping surface can be found as *ramps* on a truck or wheelchair ramp and stairs.

Inclined planes that are wedges, one inclined plane or two back-to-back inclined planes that can move are found as knife blades or nails.

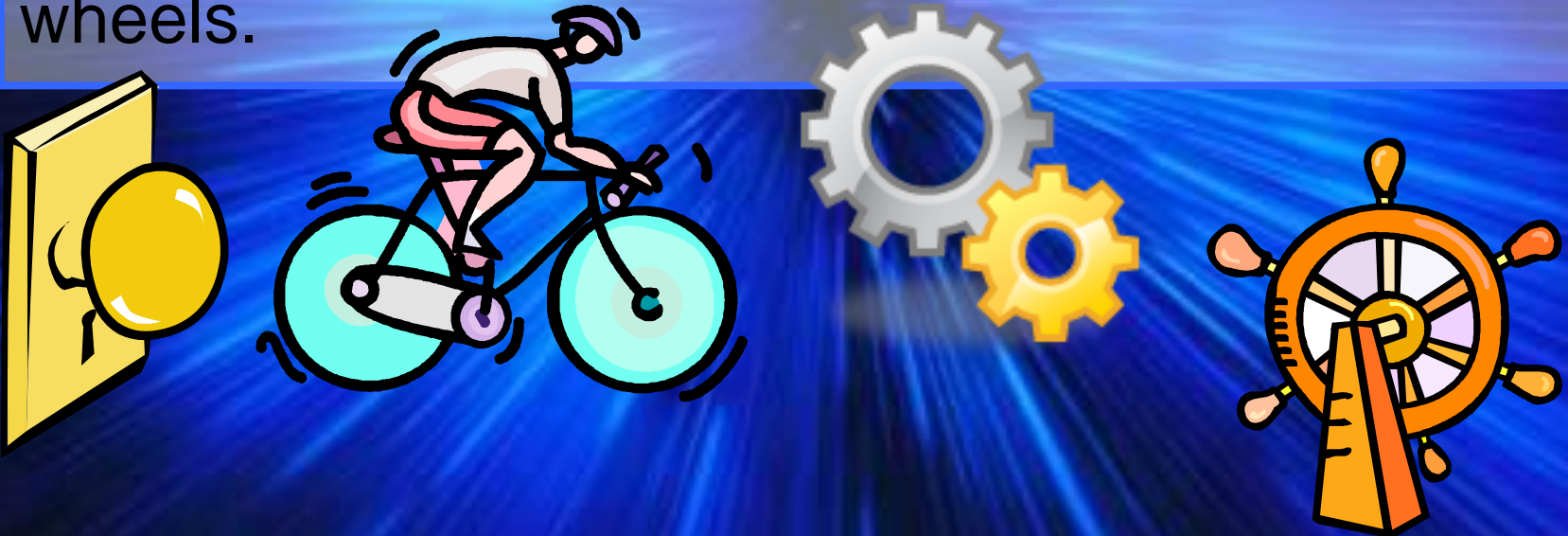
Inclined planes that are wound around a post or cylinder are called screws. Screws can be found in bolts and jar lids.



Simple Machines

Wheel and axles- consist of two circular objects: a central shaft, called an axle, inserted through the middle of a wheel.

Wheel and axles can be found as door knobs, steering wheels, screwdrivers, gears, and bicycles wheels.



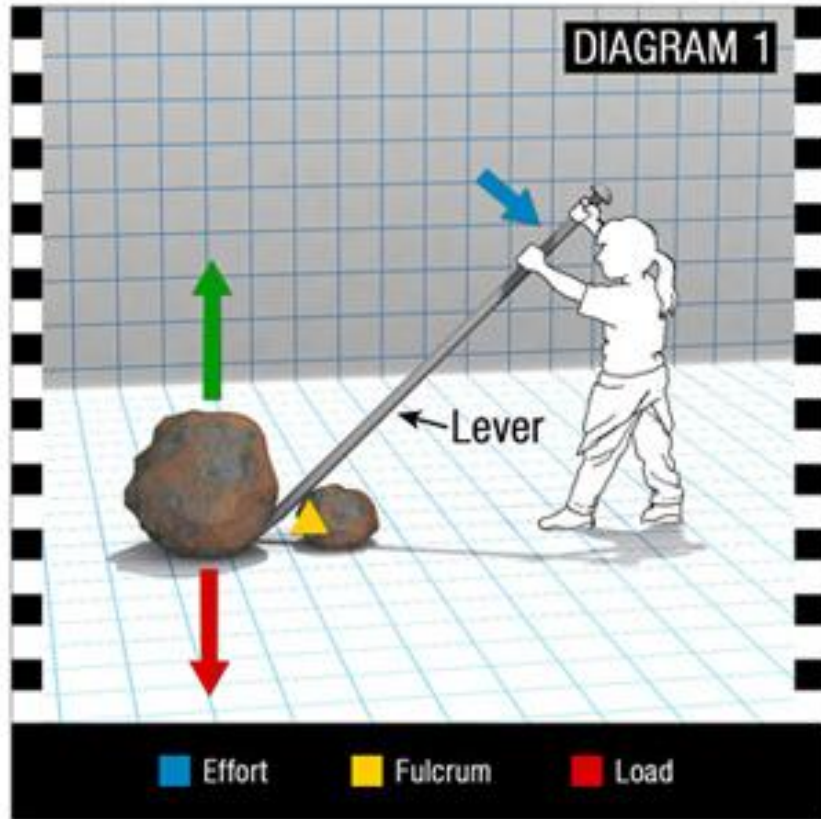
Simple Machines

Complex machines- also known as compound machines consist of two or more simple machines.

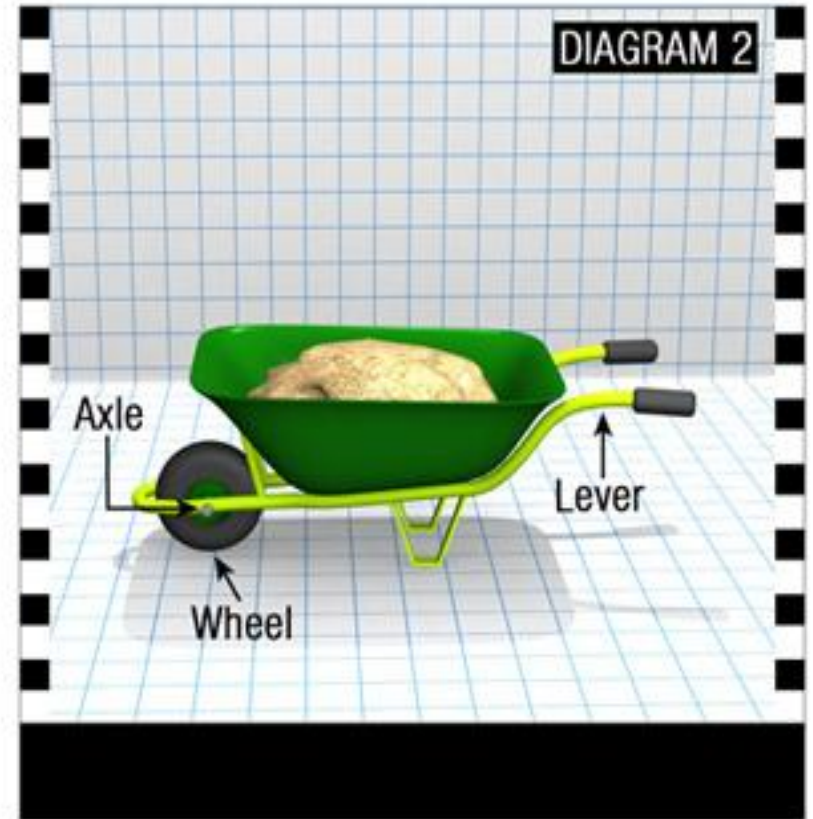
Examples include:

- scissors consisting of two levers and two inclined planes (wedges);
- a fishing pole consisting of a lever, a wheel and axle and a pulley;
- a bicycle consists of levers (handlebars and handbrakes), wheel and axles (gears, wheels, and pedals), and a number of screws.

Review of Simple Machines

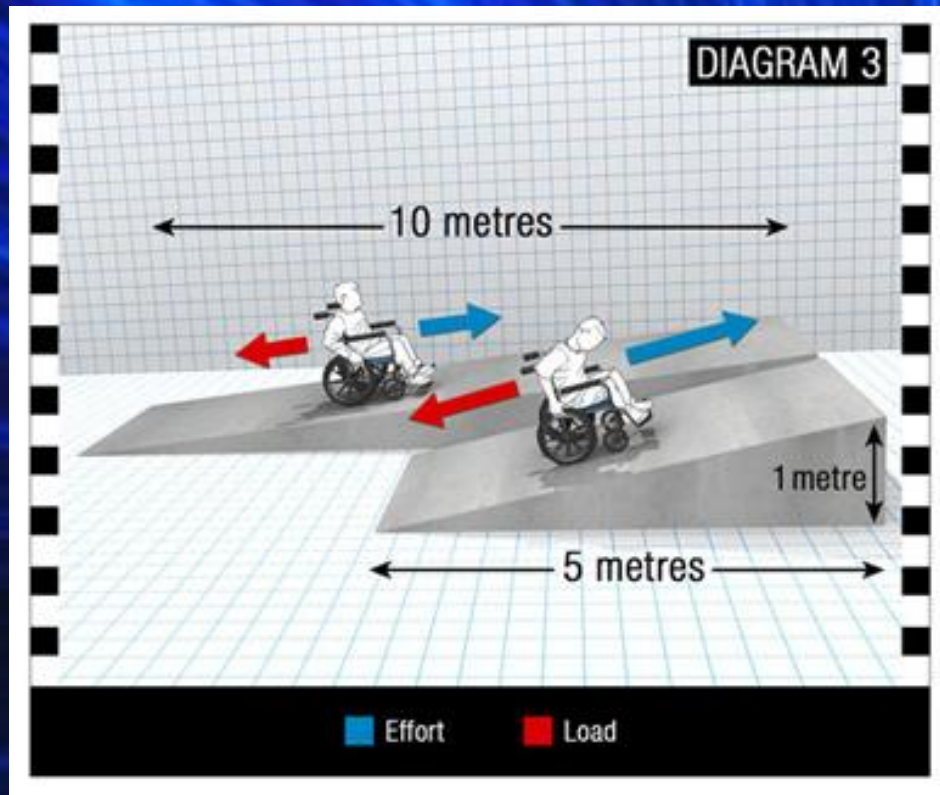


The force applied to the lever (the crowbar) makes the rock move and the work easier to do.

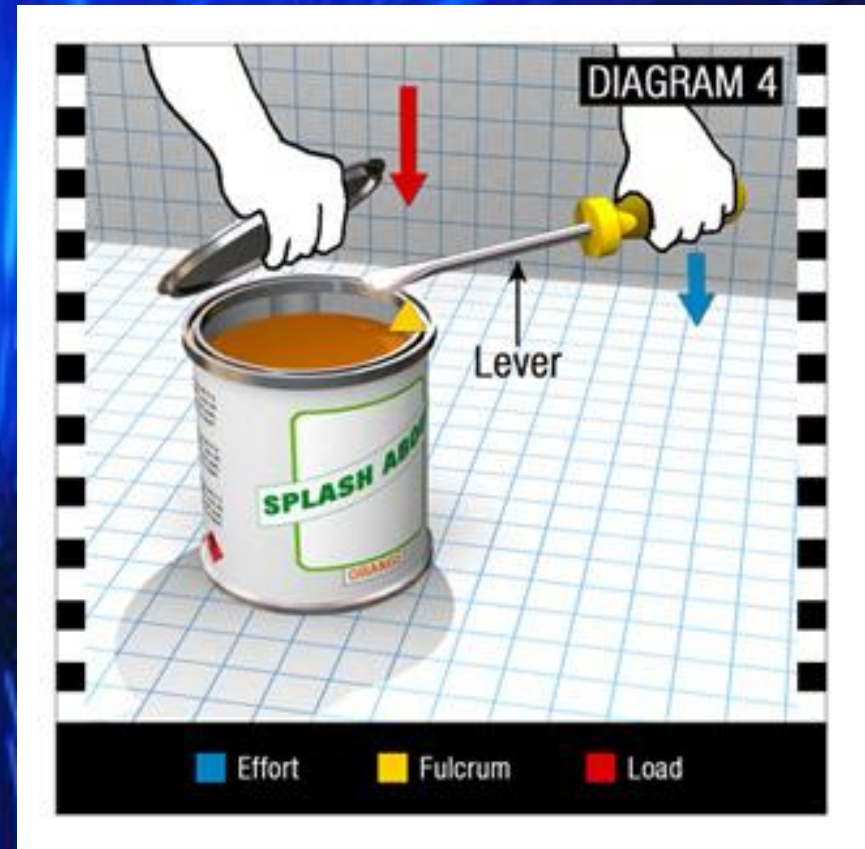


A wheelbarrow is one example of a compound machine. It has two levers (the handles) to help lift the load, and a wheel and axle to make it easier to move the load forward.

Review of Simple Machines



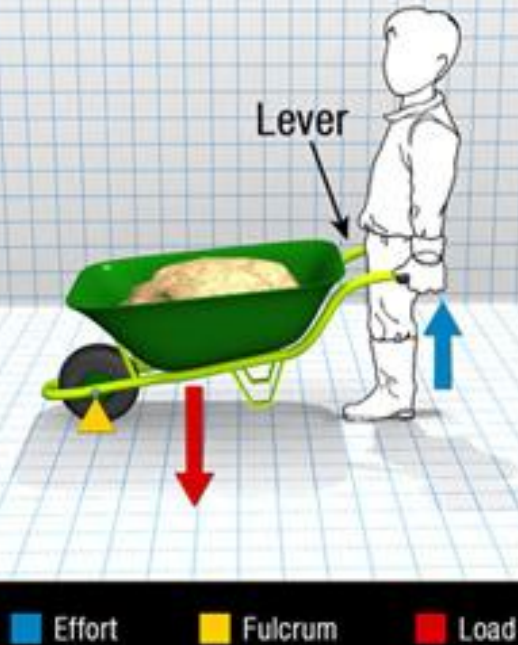
An inclined plane is a flat surface that is at an angle to the load. This type of 'machine' has no parts that move.



The direction of the force is also being changed by the lever. Pushing down on the lever (the screwdriver) raises the load (the paint can lid).

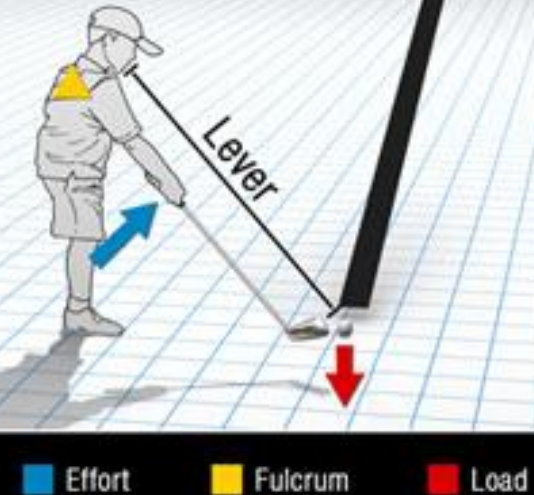
Review of Simple Machines

DIAGRAM 5



The mechanical advantage (remember, this is what makes the load easier to lift) is created by having the load closer to the wheelbarrow axle (the fulcrum) than to the person lifting the handles (the effort).

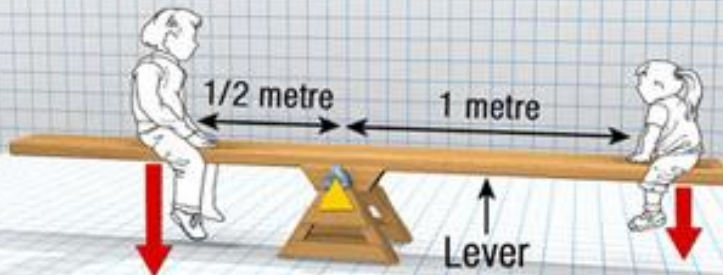
DIAGRAM 6



This type of lever often trades distance for force. You can use a large force for a small distance to move a small load for a larger distance.

Review of Simple Machines

DIAGRAM 7



■ Fulcrum

■ Load

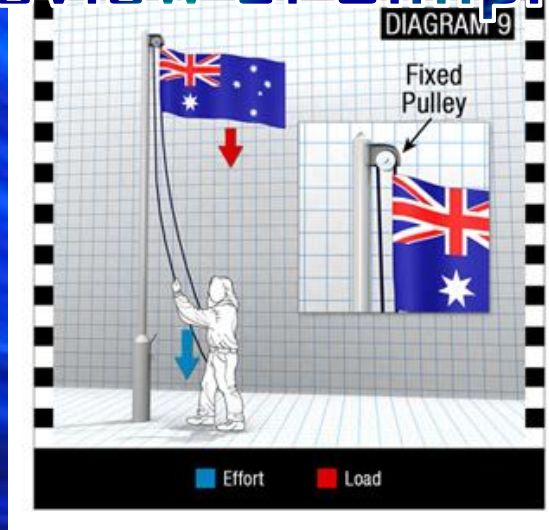
For a lever to be in balance (not moving) the forces trying to turn it in one direction (the turning effect) will be exactly balanced by the forces trying to turn it in the opposite direction.

DIAGRAM 8

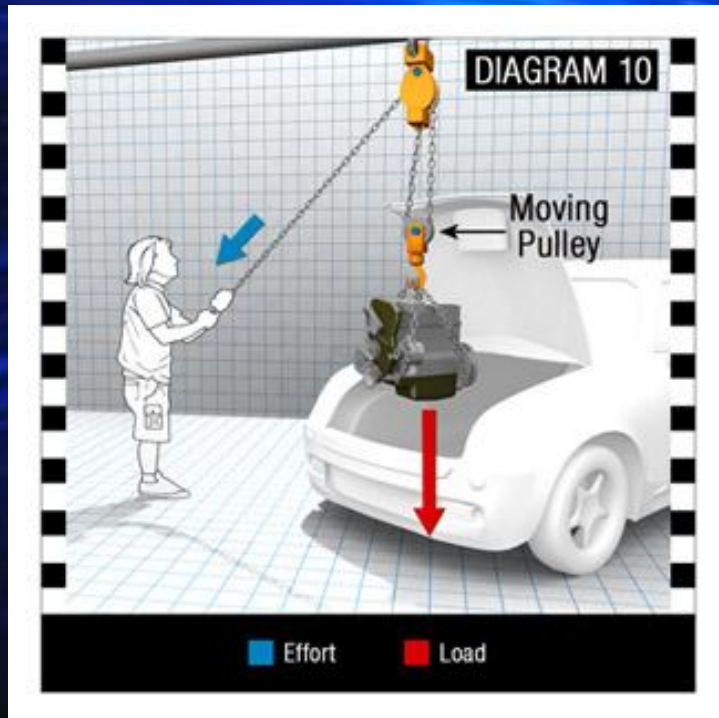


A wheel and axle is a simple machine that is made up of a smaller cylinder (the axle) joined to a larger cylinder (the wheel). To work together, the axle must be connected to the wheel in such a way that it allows the wheel to rotate evenly about its center.

Review of Simple Machines

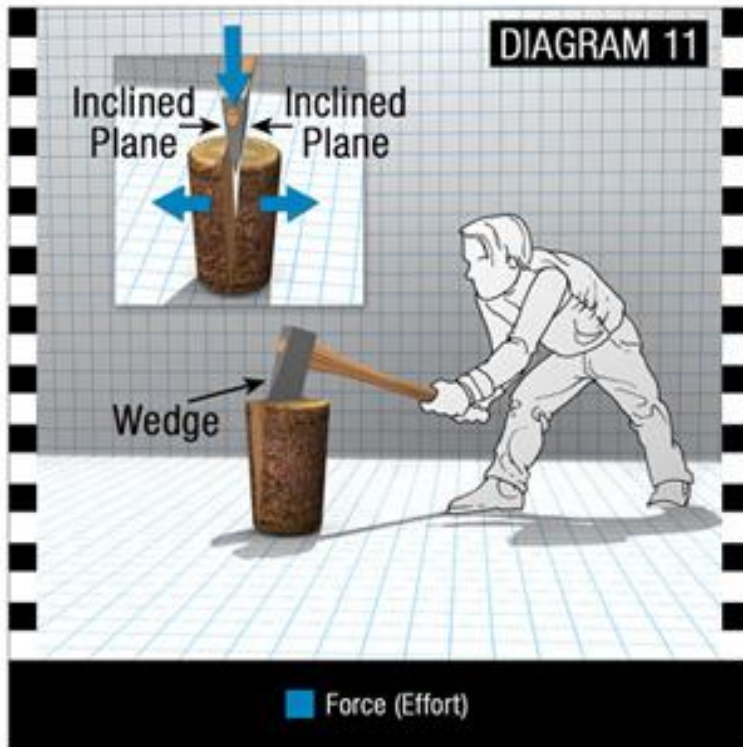


Fixed pulleys do not give a mechanical advantage. The distance that the load moves is exactly the same as the distance moved by the effort

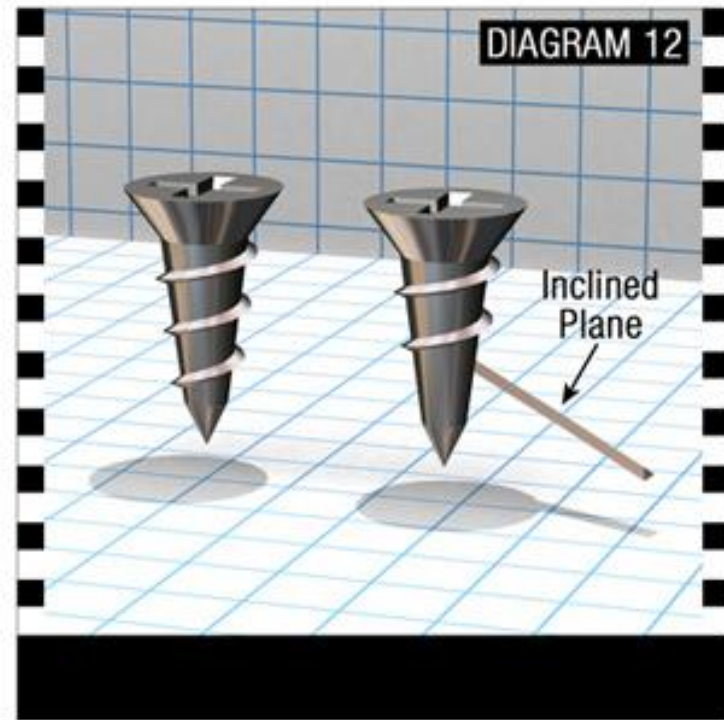


In a pulley system, each moving pulley halves the effort, but means that the effort has to be applied for twice the distance. This is why a person can lift an engine out of a car using only a 'block and tackle'. The mechanical advantage is achieved by pulling the chain over a much longer distance than the distance that the engine is actually lifted.

Review of Simple Machines



The axe is actually being used to change the direction of the force. The force of the axe blow is downwards, but the wedge changes this downward force into two sideways forces, causing the wood to split apart.



A screw is really an inclined plane that is coiled around a shaft (see Diagram 12).

I can't crack the
nut with my teeth?



Why not use a
nutcracker?

