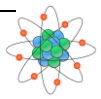
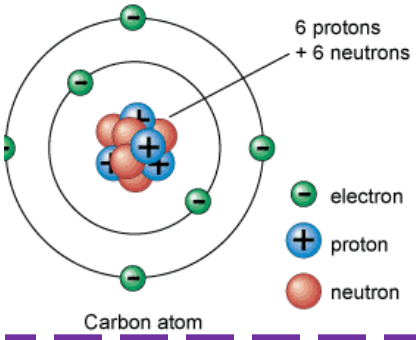
MATTER, ENERGY, Waves, and Forces of Nature



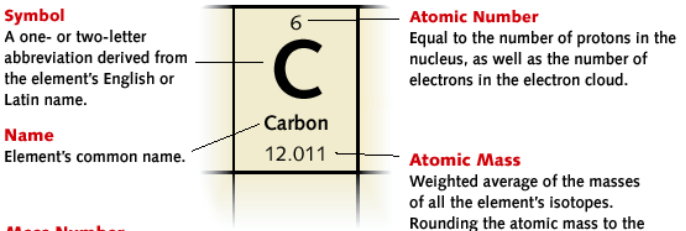
First Area of Focus: Matter

Matter: Anything that has mass and takes up space.

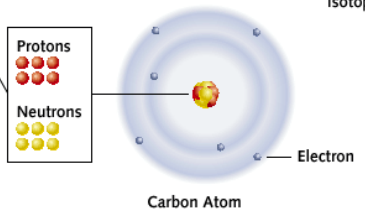
Atom: A basic unit of matter consisting of a dense, central nucleus surrounded by a cloud of negatively charged electrons.



The element square contains all of the information about the unique qualities of different atoms for each element.



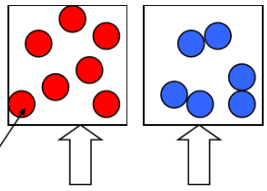
Atoms are the smallest unique particles of matter. Protons, Neutrons, and Electrons are sub-atomic particles that are found in ALL atoms.



Element – A substance that is made entirely from one type of atom

Compound – Made up of two or more elements bonded together.

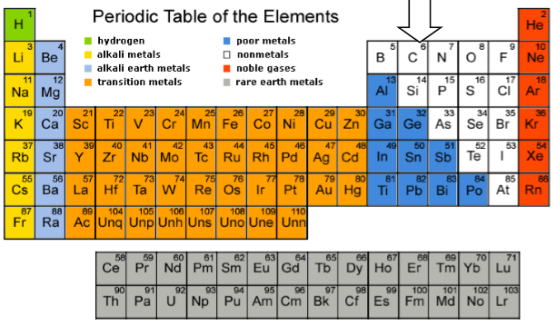
They have different properties



ELEMENTS are made up of only one type of atom. There are only about 100 elements.

The symbols for the elements can be found in the Period Table

Examples of elements: Oxygen, Copper, Gold, Nitrogen, &Titanium



All substances are made of

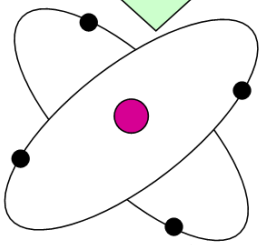
Atoms, Elements Molecules, & Compounds

The elements are arranged in vertical columns, called GROUPS. Each group contains elements with similar chemical properties

Mass number = number of protons + neutrons

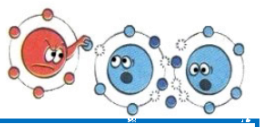
Atomic number = number of protons

Structure of the atom



Made up of protons (charge is +ve) and neutrons (charge is 0)

Charge is -



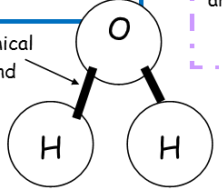
Sometimes atoms react together by transferring electrons to form chemical bonds. Sometimes they share these electrons.

COMPOUNDS are when you have more than one different type of atom joined together

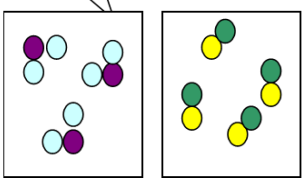
Examples of compounds:

Methane (CH_4), Carbon dioxide (CO_2), Sodium chloride (NaCl).

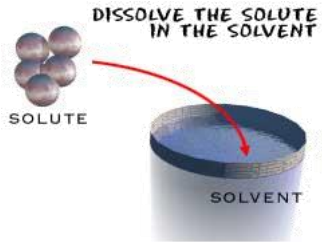
Two or more atoms bonded together are called a molecule



e.g. H_2O



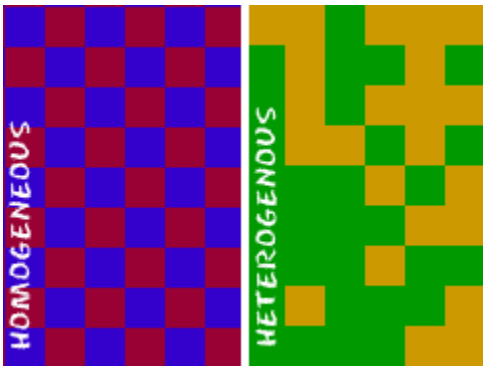
Universal Solvent: Liquid water is able to dissolve a large number of different chemical compounds.

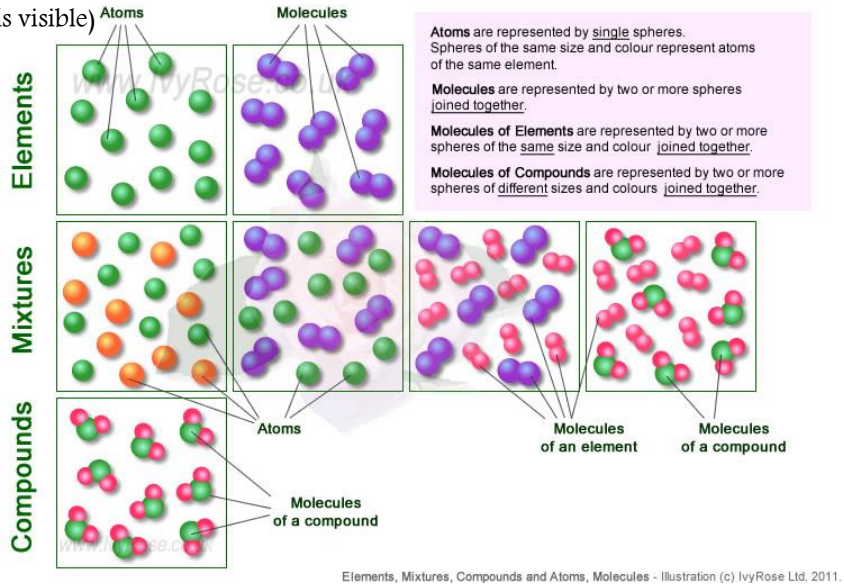


Solvent – The substance that does the dissolving (usually larger amount) –Water is the universal solvent.
Solute – The substance that gets dissolved (usually lesser amount)

Solubility - How much solute can dissolve in a substance before it becomes saturated.

Supersaturated: When no more solute will dissolve. (crystals visible)
Homogeneous mixture – Same throughout.
Heterogeneous – A mixture of two or more compounds.





Kinetic Molecular Theory:

- The molecules are in constant motion.
- This motion is different for the 3 states of matter.

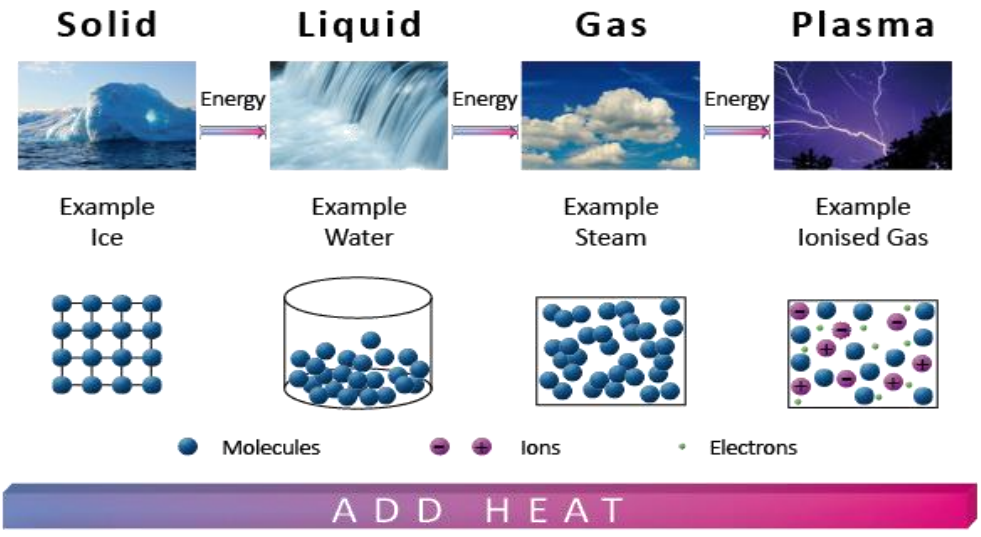
States of Matter

Solid (s) has a definite shape and volume

Liquid (l) Definite volume but not shape

Gas (g) No definite shape or volume

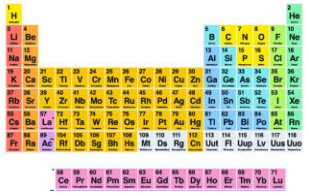
Plasma (p) Ionized gas that emits electrons.



Dark Matter – A hypothetical form of matter that is believed to make up 90% of the universe; it is invisible (does not absorb or emit light)
Dark Energy – A hypothetical form of energy that permeates space and exerts a negative pressure, which would have gravitational effects to account for the differences between the theoretical and observational results of gravitational effects on visible matter.

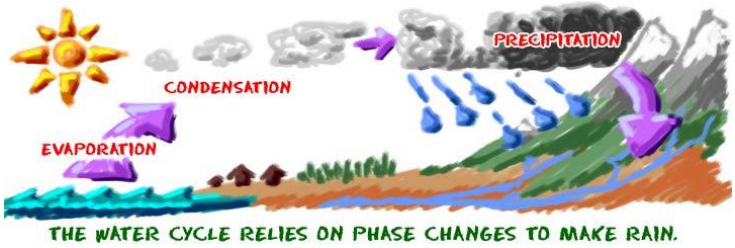
Physical Properties of Matter: Observable using by the 5 senses. Color, temperature, texture, size, density, etc.

Chemical Properties of Matter: Properties that describe the ability of a substance to participate in a reaction with another substance.
Examples of Chemical Properties: Flammability (ability to burn), reactivity with- water, oxygen, and acid.
Not visible by looking at a substance but reactivity can be determined by an element's location on the periodic table



Law Conservation of Matter

- In any physical or chemical change, matter is neither created nor destroyed but merely changed from one form to another.



THE WATER CYCLE RELIES ON PHASE CHANGES TO MAKE RAIN.

The matter TRANSFORMS into different phases of matter (physical changes) never "disappearing" in the system.

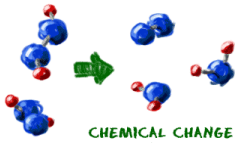
Physical Change

- Changes form solid > liquid > gas > plasma
- Doesn't change identity

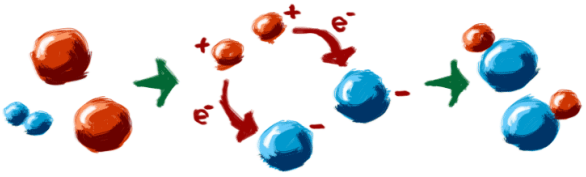

ENERGY FROM A STOVE HEATS UP LIQUID WATER AND CREATES STEAM

A PHYSICAL CHANGE does not change the chemical attributes of a substance.


PHYSICAL CHANGE OF WATER INTO ICE

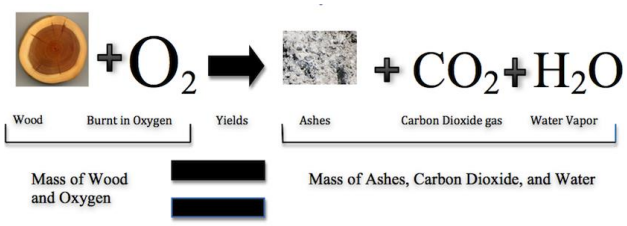

CHEMICAL CHANGE OF HYDROGEN PEROXIDE INTO WATER

Chemical Change: The change of substances into other substances through a reorganization of the atoms.

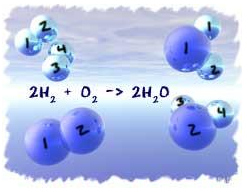

REACTIONS INVOLVE THE CHEMICAL CHANGE OF ATOMS AND MOLECULES.

The Six Types of Chemical Reactions

- Combustion: When oxygen combines with another compound to form water and carbon dioxide.
  - $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$



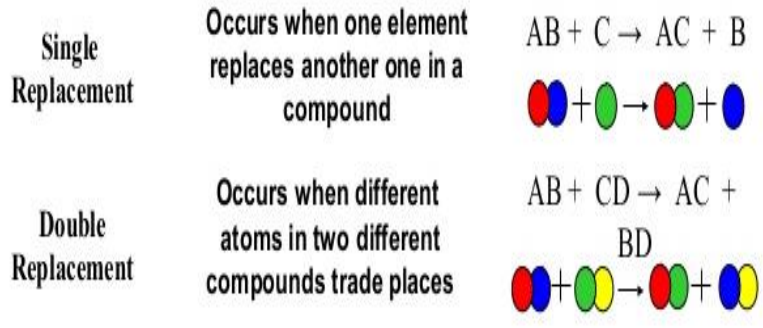
- Synthesis Reaction: When two or more simple compounds combine to form a more complicated one. A + B = AB
  - $Zn + 2\,HCl \rightarrow ZnCl_2 + H_{2\,(g)}$



YOU NEED TWO HYDROGEN MOLECULES FOR EVERY OXYGEN MOLECULE

- Decomposition Reaction: A complex molecule breaks down to make simpler ones.
  - Opposite of Synthesis Reaction. AB → A + B
  - $2\,H_2O$ ---> $2\,H_2 + O_2$ (Electrolysis of Water)

- Single Displacement: When one element trades places with another element in a compound. BC + A → AC + B
- Double Displacement: When the anions and cations of two different molecules switch places, forming two entirely different compounds.
  - AB + CD → AD + CB
    - $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
- Acid / Base: When an acid and base react with each other.

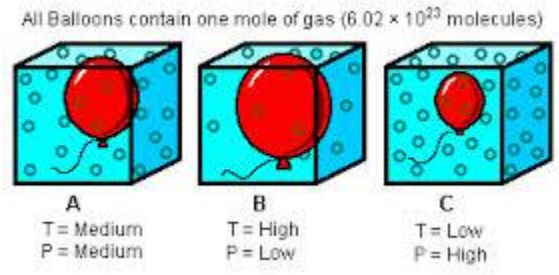


Special Laws for Gases

Charles Law – As temperature changes so does the volume of gasses.
Volume of a gas increases with an increase in temperature.
Volume of a gas decreases with a decrease in temperature.

- Below is an illustration of Charles' Law.
- As a balloon is cooled from room temperature with liquid nitrogen (–196°C), the volume decreases.

Boyle's Law– Volume of gas decreases with increased pressure.
Volume of gas increases with decreased pressure.



Avogadro's Law – Equal volumes of gases, at the same temperature and pressure, contain the same number of particles, or molecules.

Therefore because of Avogadro's Law if these three gases have the same number of particles and are at the same temperature and pressure, they must take up the same volume.

The ideal gas Law: PV = nRT (pressure times volume equals the number of molecules times the gas constant times temperature).

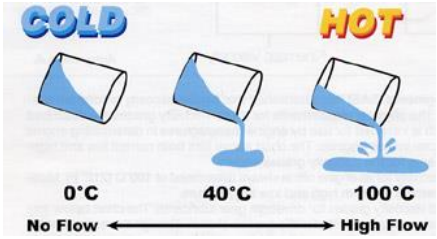
- P=Pressure
- V=Volume
- T=temperature
- n=number of molecules
- R=gas constant

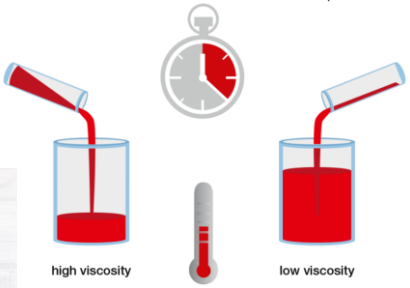
Special Laws for Liquids

Pascal's Law states that if you apply pressure to fluids that are *confined* (or *can't flow to anywhere*), the fluids will then *transmit* (or *send out*) that same pressure in all directions at the *same rate*.

- **Viscosity**: Resistance of liquid to flow.
  High viscosity = Travels slow because of high resistance.
  Low viscosity = Travels fast because low resistance.

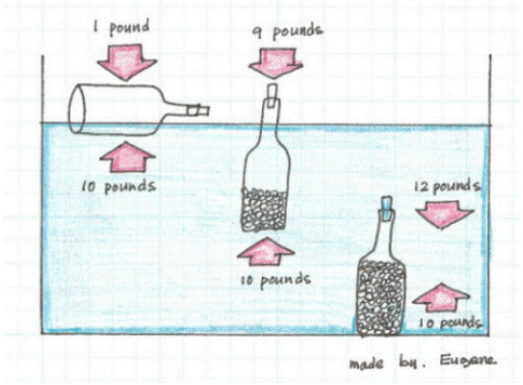
ALSO as temperature increases the viscosity of a liquid decreases. For example if you heat up honey it will be less viscous and flow quickly.

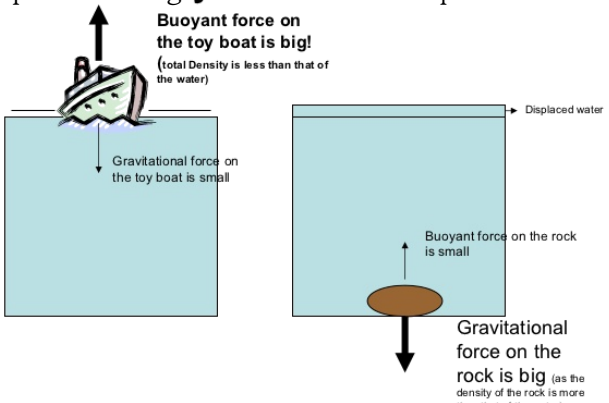




Archimedes Principle: A body that is submerged in a fluid is buoyed up by a force equal to the weight of the fluid that is displaced.

Buoyancy: Buoyancy force is equal to the weight of fluid displaced by the body.





New Area of Focus: Energy

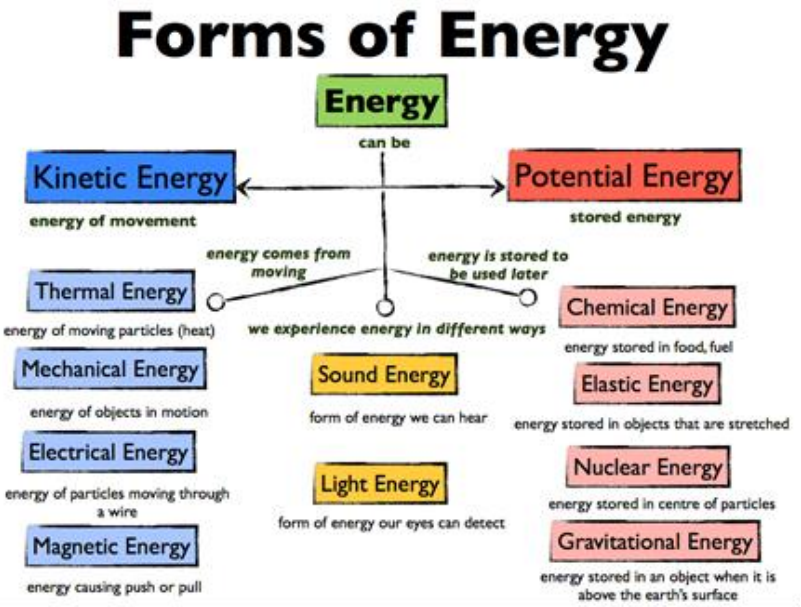
Energy comes from somewhere – Our energy originates from the SUN.

Law Conservation of Energy: Energy cannot be created or destroyed but can diminish in quality from useful to less useful.

The forms of energy: **KE** Mechanical, Radiant, Sound, Friction, Electrical, and Thermal; **PE** Gravitational, Elastic (*mechanical*), Nuclear, and Chemical.

REMEMBER

KE (Mrs.Fet is FIT & in constant motion)	PE (Generation Computer not in motion)
M- Mechanical	G- Gravitational
R- Radiant	E- Elastic
S- Sound	N- Nuclear
F- Friction	C- Chemical
E- Electrical	
T- Thermal/Heat	



Nuclear Energy– The energy that deals with the changes in the nucleus of an atom. Nuclear energy is produced when the nuclei of two atoms join together (*fusion think V-8 Fusion FUSES vegetable + fruit flavors*) or when the nucleus of an atom splits apart (*fission think DIVISION).*

1st Law of Thermodynamics

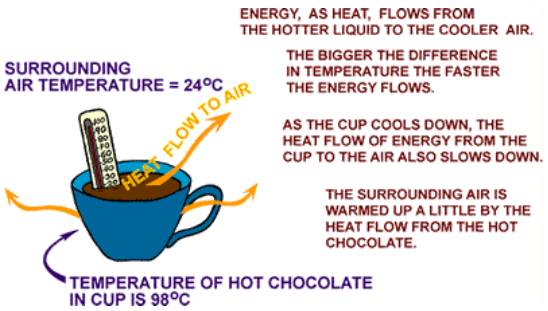
- Change in energy of a system is equal to the heat added to the system minus the work done.
- You can't get something for nothing.

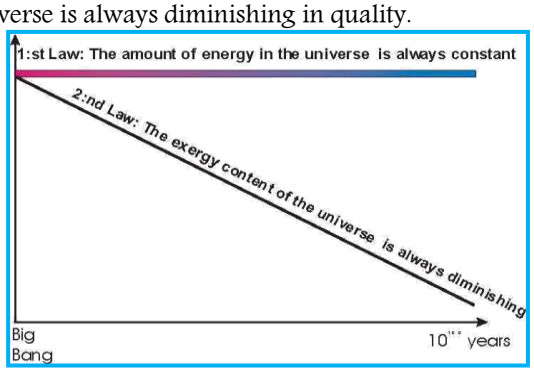
$\Delta U = Q - W$

ΔU: Change in Energy; Q: Heat Added; W: Work Done

2nd Law of Thermodynamics: The energy content of the universe is always diminishing in quality.

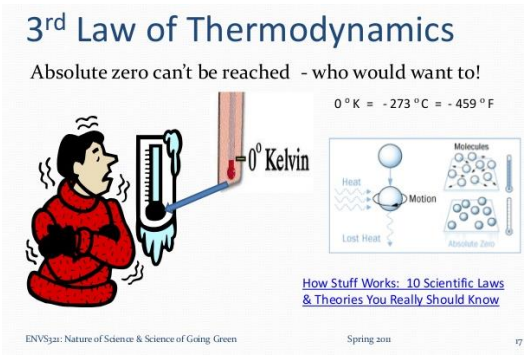
- Heat Flow -> Warm to cold.



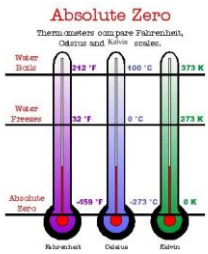


The 3rd law of Thermodynamics: All molecular movement stops at absolute zero.

- Temperature: The degree of hotness or coldness of a body or environment.
- Corresponds to its molecular activity.



Absolute zero (0 Kelvin) cannot be reached.
Kelvin measures molecular movement.

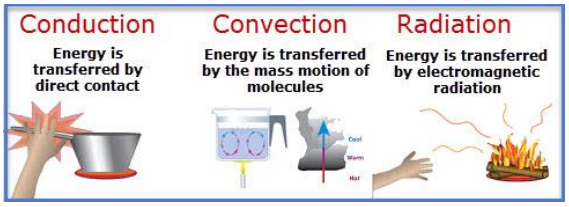


METHODS OF ENERGY/HEAT TRANSFER

Convection: Vertical circulation in which warm rises and cool sinks. Flow of heat by this circulation.

Conduction: The movement of heat from one molecule to another.

Radiation: Energy that is radiated or transmitted in the form of rays, waves, or particles.



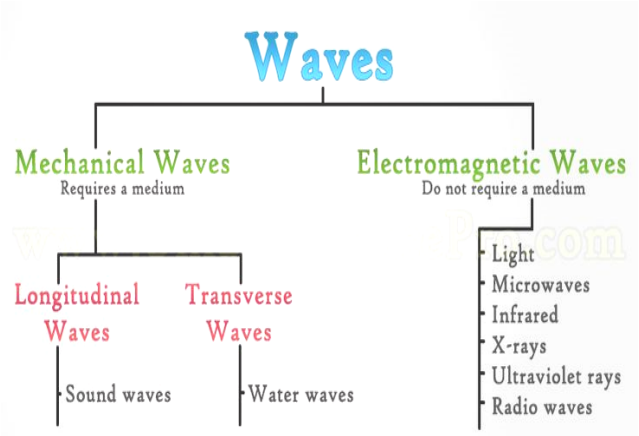
New Area of Focus: Waves

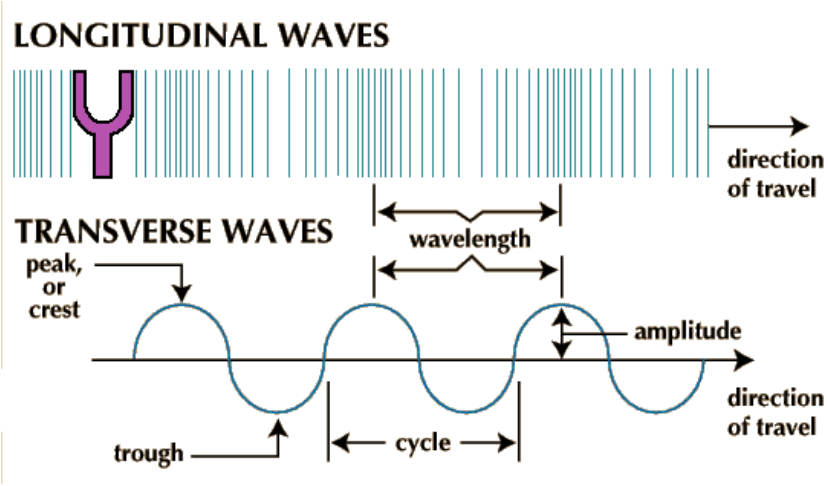
A wave: In physics – A wave is the movement up and down or back and forth.

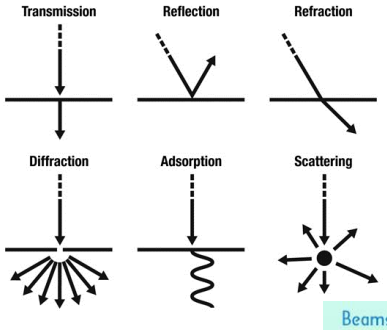
The types of waves:

Mechanical Wave: Moves through a medium. *Water, Solid, Gas,*

Electromagnetic Waves: Do not require a medium to move through.







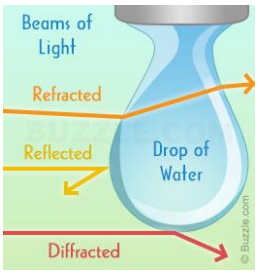
Light is a particle and a wave and goes out in a straight line unless it bumps something.

Refraction: The bending of a wave when it enters a medium where it's speed is different.

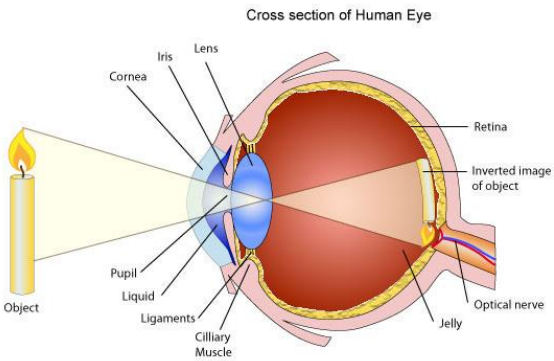
Diffraction: Bending of waves around objects.

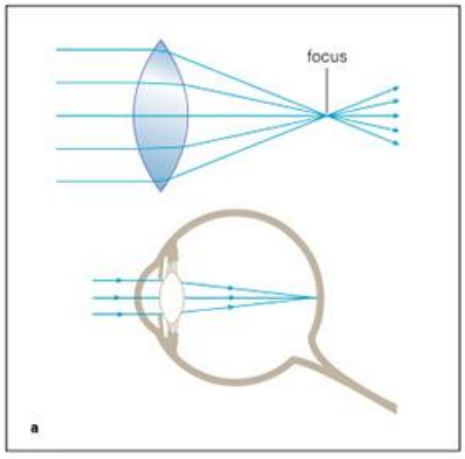
Reflection: Waves bounce off of a hard surface at the same angle as the incident wave.

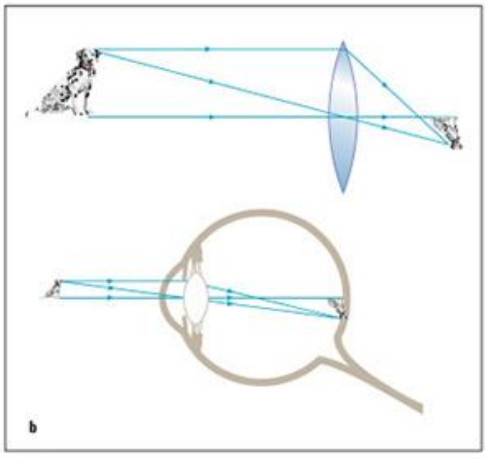
Absorption: None of the frequencies of the incident wave are present in an object so they do not reflect.



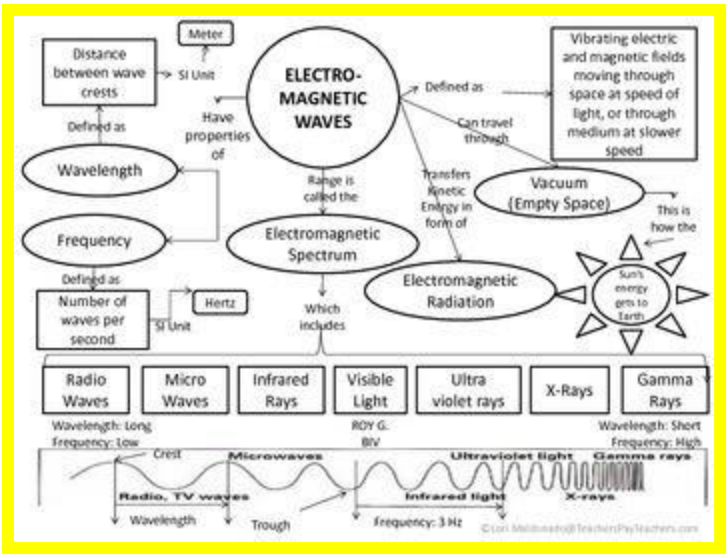
Lens: A transparent optical device used to converge or diverge transmitted light and to form images.



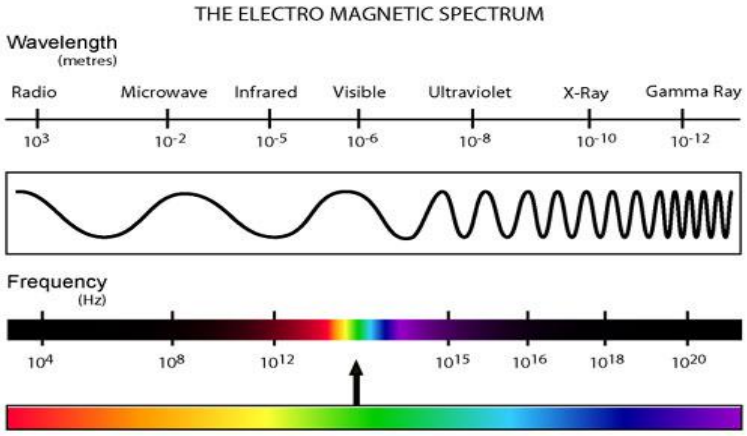




New Area of Focus: The Electromagnetic spectrum

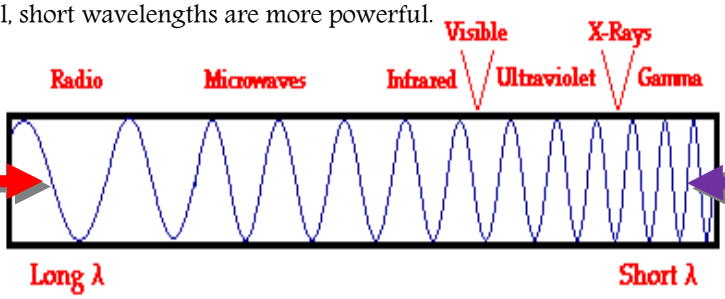


The Electromagnetic spectrum: The entire frequency range of electromagnetic waves.



Long wavelengths are less powerful, short wavelengths are more powerful.

Radio waves have VERY long wavelengths (football fields long) and are around us all the time.
LOW FREQUENCY



Gamma Rays have wavelengths smaller than the diameter of an atom!! They are dangerous and cause radiation poisoning and are deadly.
HIGH FREQUENCY

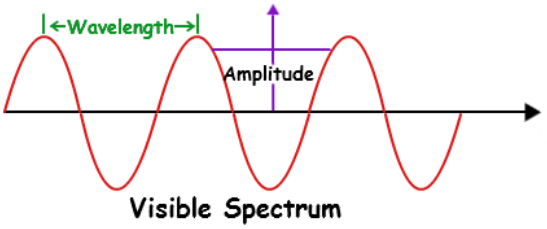
Temperature of an object relates to the amount of radiation released. The hotter, the more radiation released.

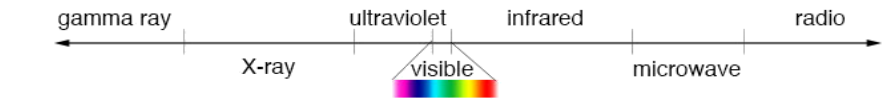
Radio waves: Longest wave in the spectrum, size of a football field. Not very powerful.

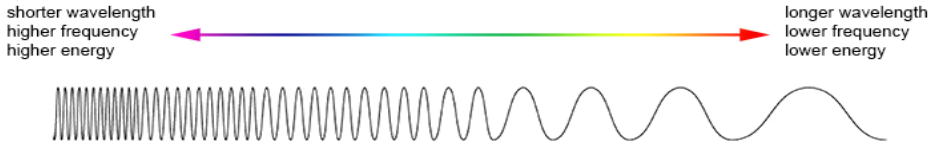
Microwaves: Waves with wavelengths ranging from 1 m down to 1 mm.

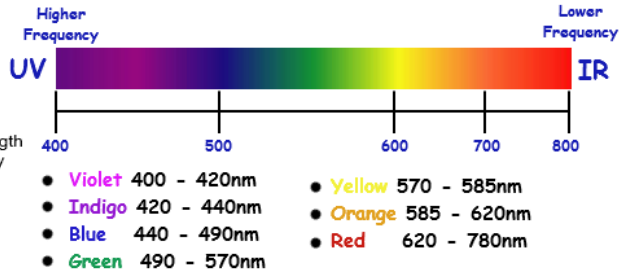
Infrared Radiation: Wavelengths between microwaves and visible light. (heat)

Visible light consists of…









Ultraviolet (UV) – Has shorter wavelengths than visible light. – thus it more powerful than visible light.

UV consists of many wavelengths All of which can cause cancer. UVA, UVB, UVC ~PROTECTION IN SUNSCREEN!!

X-Rays: They have smaller wavelengths and therefore higher energy than ultraviolet waves.

Gamma ray: Highest energy, shortest wavelength. Emitted during radioactive decay of a fission product.

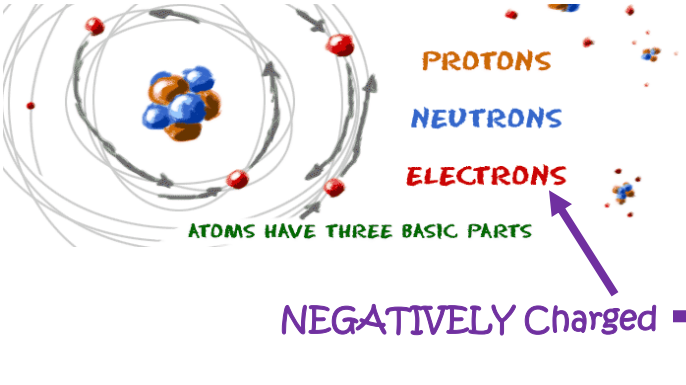
Laser – Light Amplification by Stimulated Emission of Radiation.

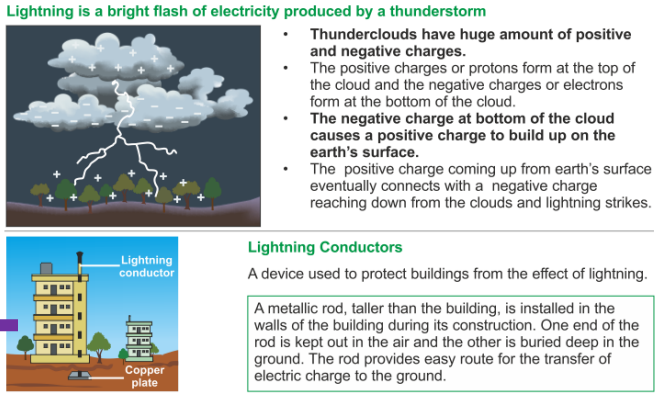
- Lasers cross over many parts of the EM scale.

Waves of the electromagnetic spectrum travel at the speed of light. 186,000 miles per second or 300,000 kilometers per second in a vacuum.

- Visible light measured in lumens.
- All others are measured in radiation.

Electricity: Electricity is related to charges, and both electrons and protons carry a charge.





Lightning is a big spark that occurs when lots of electrons move from one place to another very quickly. Unequal distribution of electrons.

Static Electricity and Friction

- All solid materials are **charged** by the **transfer** of **electrons**
- When two objects rub together, the force of **friction** can remove electrons from one object and transfer them to the other object

Static Electricity: The imbalance of positive and negative charges.

Magnetism

Electric Fields: The funky area near any electrically-charged object

- replace electrostatic for funky.

Coulombs Law:

- The greater the charges, the greater the force.
- The greater the distance between them, the smaller the force.

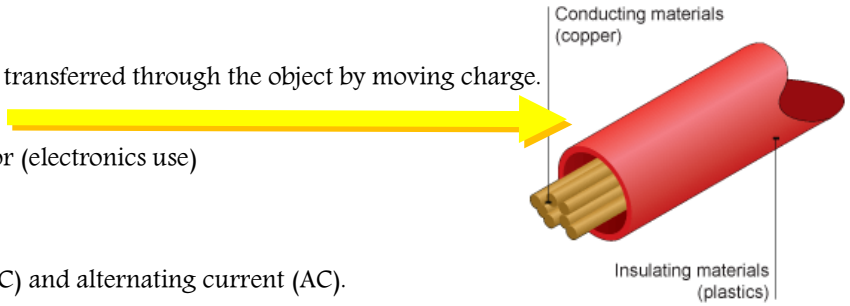
Current is a flow of electrons, or individual negative charges

Conductors, Insulators, Semi-conductors: How easily energy is transferred through the object by moving charge.

Conductor: Electrons flow easily, semi flows in the middle.

Semi-conductor: Conductivity between conductor and insulator (electronics use)

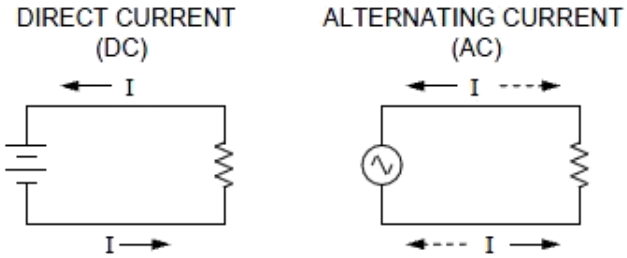
Insulator: Electrons do not flow easily



There are two main kinds of electric current, direct current (DC) and alternating current (AC).

- (DC) Direct current is a flow of charge always in one direction. (Batteries)
- (AC) -Alternating current is a flow of charge back and forth, changing its direction many times in one second. (Plugs and outlets / household)

- Volts are a measure of the force or pressure under which electricity flows.
- Amps are a measurement of the current flow rate of electrons
- Watts is a measurement of electrical power created.
  - 1 watt is equal to one joule of energy per second.



Volt. A measure of the force or pressure under which electricity flows.

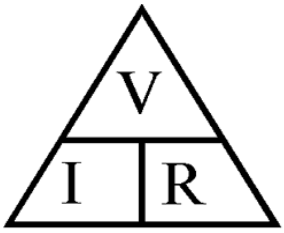
Ampere. How much current moves through a wire in one second is measured in amperes. Basically, the larger the size of wire, the greater the ampere capacity.

Watt. The amount of electricity consumed per second is measured by what are called watts, calculated by multiplying volts times amps. Most household electrical usage is billed in kilowatt hours, or the amount of hours times 1,000 watts.

Resistance. Anything in an electrical circuit that impedes the flow of current is referred to as resistance. (ohms) Ω

Ohms Law

$$I\ (\text{amps}) = \frac{V}{R\ \Omega}$$



V = Volts, R = Resistance Ω , I = Current (amps)

Magnetism

A **magnet** is an object or a device that gives off an external magnetic field.

EXTRAS

Faraday's Law: The changing of a magnetic field can create voltage.

Electromagnets: By running electric current through a wire, you can create a magnetic field.

Compass: A navigational instrument for determining direction relative to the Earth's magnetic poles.

New Area of Focus: Relativity, Einstein, and E=MC2

General Relativity is a theory of the structure of space-time.

- Time slows down with increased velocity.

E=MC2

- E = Energy (Joules)
- M = Mass
- C = Speed of Light in vacuum
  - 300,000,000 meters per second (really 299, 792,458)

New Area of Focus: Connections to Earth Science

Environmental science is the study of interactions among physical, chemical, and biological components of the environment.

Environmental studies is the systematic study of human interaction with their environment.

The 4 R's

1. Reduce: Our stuff becomes harmful waste
2. Reuse: So we can reduce
3. Recycle
4. Rethink: Reinvent everything with the R's in mind.

Fossil fuels are borrowed light: The energy rich organic matter from millions of years ago.

Carrying Capacity: the amount of food that an area of land will yield and, therefore, the number of people that an area of land will support.

Forms of renewable energy

Hydropower: Damless Hydropower, Ocean thermal energy conversion, Wave Energy, Tidal Energy, Wind., Solar Chimney, Solar Thermal.

Liquid Biofuels: Vegetable oils, Ethanol, Biobutanol, Sweet Sorghum (food and fuel)

Solid Biofuels:. Wood, Manure, Crop waste, Biogasification

- Biogas.
  - Digesters that produce flammable gas.
  - Algae as a fuel source.

Nuclear (kind of clean / renewable)

- Nuclear waste needs to stored away forever.
- Nuclear material is not an abundant resource.