Physical Science

Study guide

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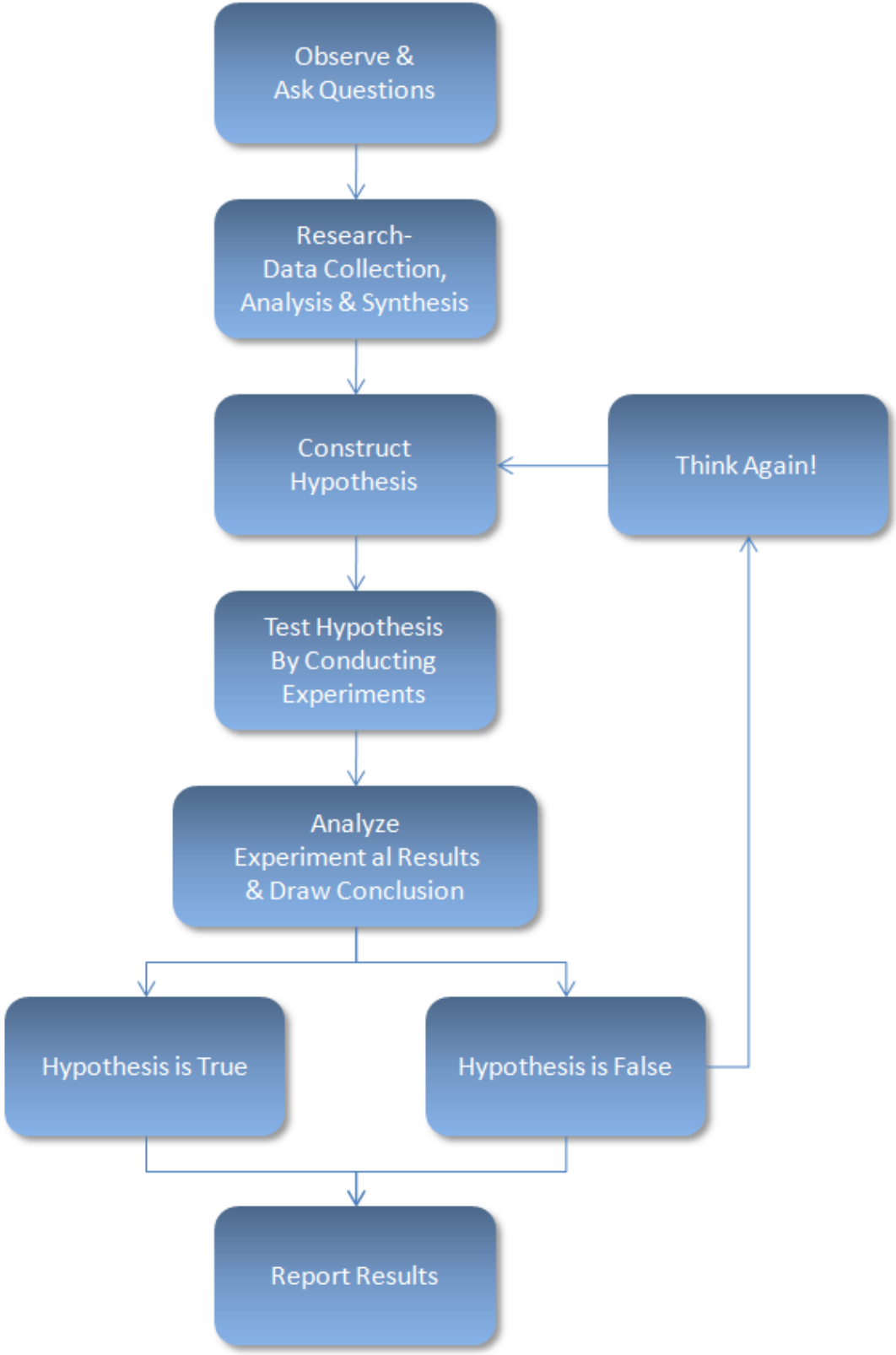
Unit VIII

Scientific Method

A formal procedure in which the researcher can acquire new knowledge in an organized fashion.

scientific method
noun

Principles and procedures for the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of hypotheses.



Independent Variable

The variable in an experiment

Dependent Variable

What you measure in the experiment and what is affected during the experiment. The dependent variable responds to the independent variable.

D-Dependent
R-Responding
Y-Y Axis

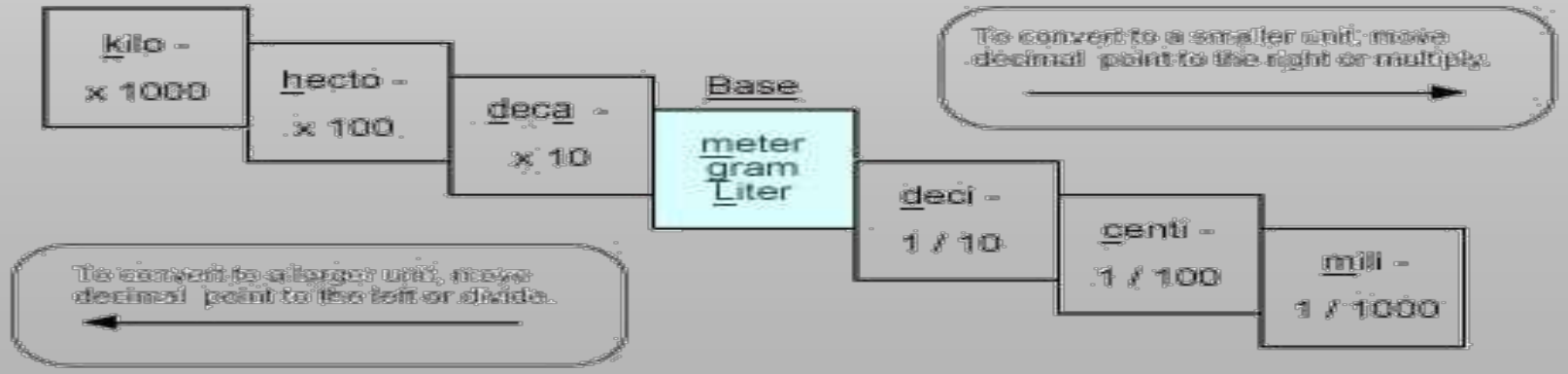
M-Manipulated
I-Independent
X-X Axis

Controlled Variable

A variable which is not allowed to change

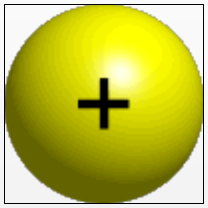
Hypothesis

A educated guess.



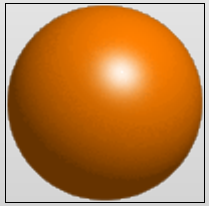
Protons

Protons are positively charged particles found within atomic nuclei.



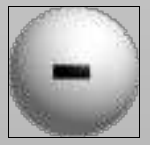
Neutrons

Neutrons are uncharged particles found within atomic nuclei.



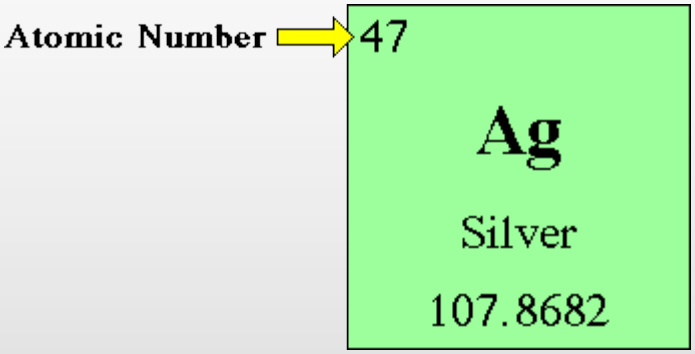
Electron

Electrons are negatively charged particles that surround the atom's nucleus.



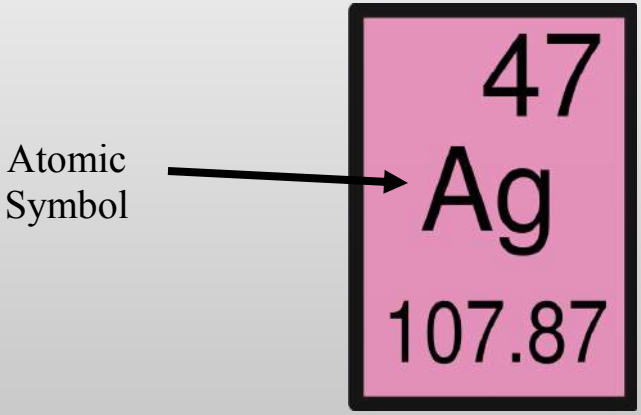
Atomic Number

The amount of protons and electrons in an atom.



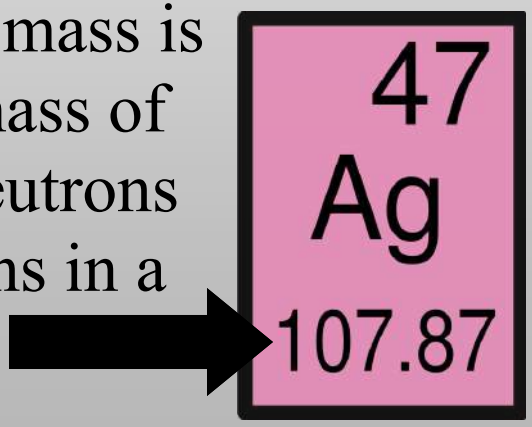
Atomic Symbol

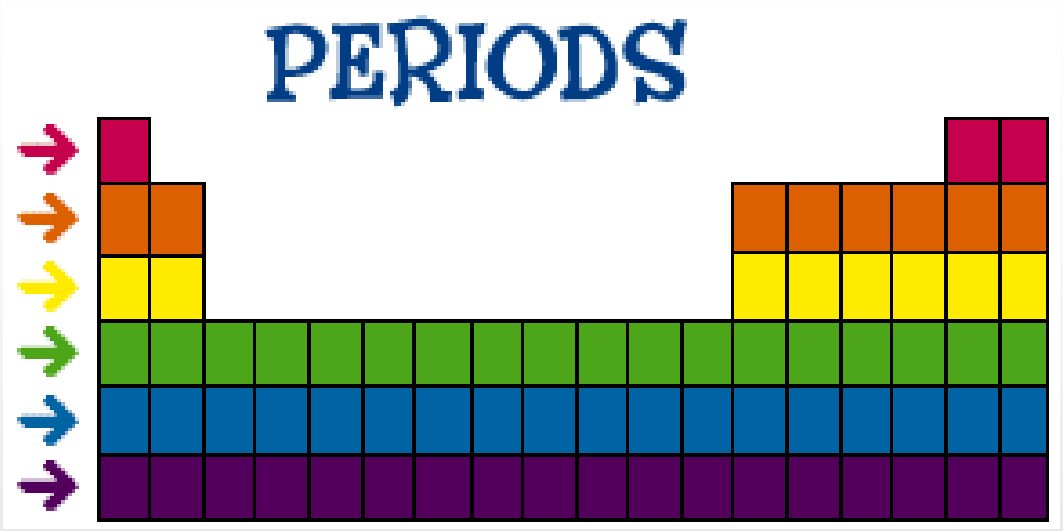
A one or two letter internationally agreed code for an element.



Atomic Mass

The atomic mass is the total mass of protons, neutrons and electrons in a single atom.





Rows of elements are called periods. The number of energy levels is equal to the period number.

Columns of elements are called groups. The number of valence electrons are equal to the group number.

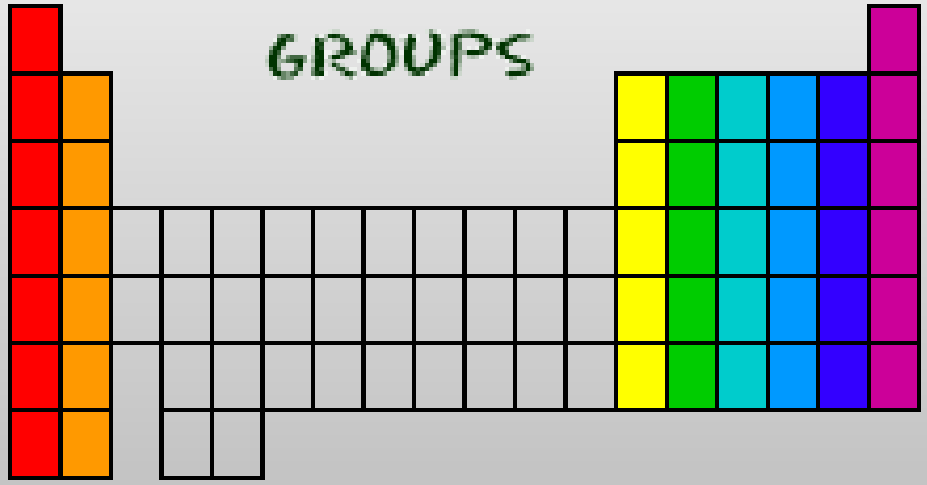
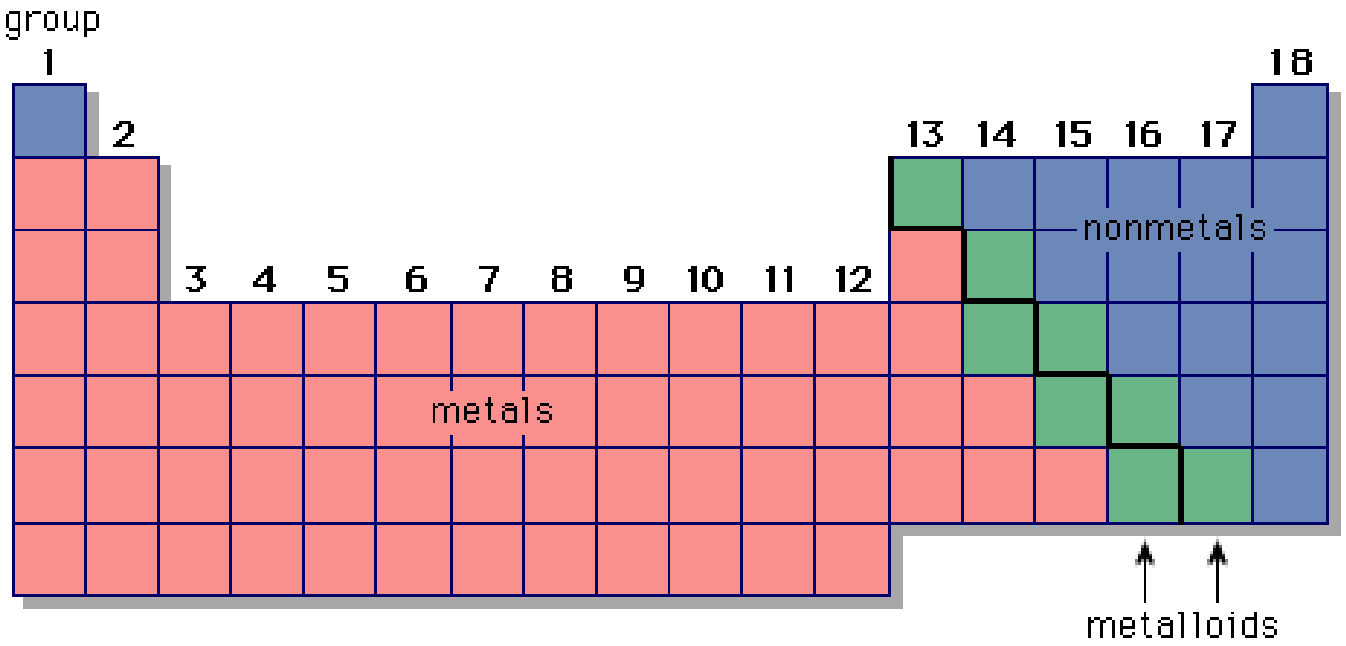


TABLE 1.7 Names of some Groups in the Periodic Table

Group	Name	Elements
1	Alkali metals	Li, Na, K, Rb, Cs, Fr
2	Alkaline earth metals	Be, Mg, Ca, Sr, Ba, Ra
16	Chalcogens	O, S, Se, Te, Po
17	Halogens	F, Cl, Br, I, At
18	Noble gases (or rare gases)	He, Ne, Ar, Kr, Xe, Rn



Characteristics of a metal:

- shiny
- good conductors of thermal energy and electric current
- malleable
- ductile

Characteristics of a Nonmetal:

- has dullness
- poor conductors of thermal energy and electric current
- brittle

Characteristics of a Metalloid:

- has properties of both metals and nonmetals

Ion

An ion is an atom or molecule in which the total number of electrons is not equal to the total number of protons.

Ion Example

Fe^{2+}

(Iron Atom that lost Electron)

Oxidation Number

An oxidation number is a positive or negative number that indicates how many electrons an atom has gained, lost, or shared to become stable.

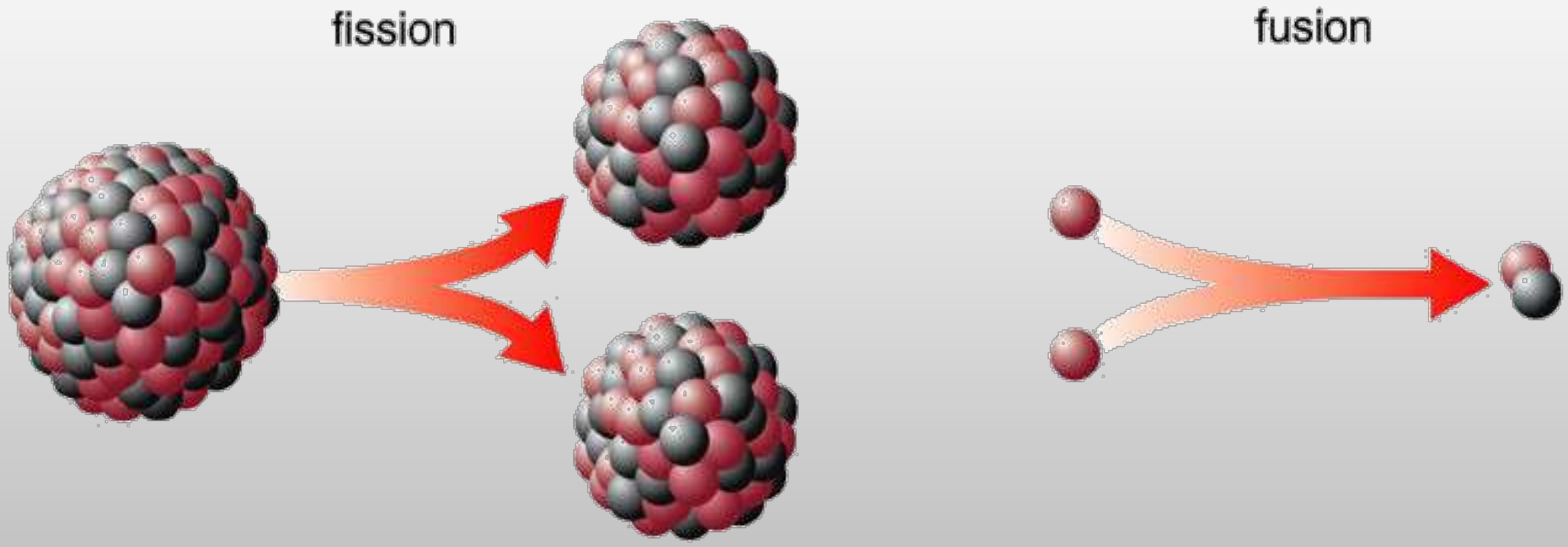
Isotope

Isotopes are variants of atoms of a particular chemical element, which have differing numbers of neutrons.

Isotope Example

Carbon-13

(Carbon Atom with the atomic mass of 13)



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Atom vs. Element

Elements are made of multiple identical atoms.

Compound vs. Molecule

Molecules are formed when two or more of the same atom combine while compounds are created with different types of elements.

Heterogeneous vs. Homogeneous Mixture

The difference between Heterogeneous and Homogeneous Mixtures is that in heterogeneous mixtures, the scientist can see that the mixture is not evenly distributed.

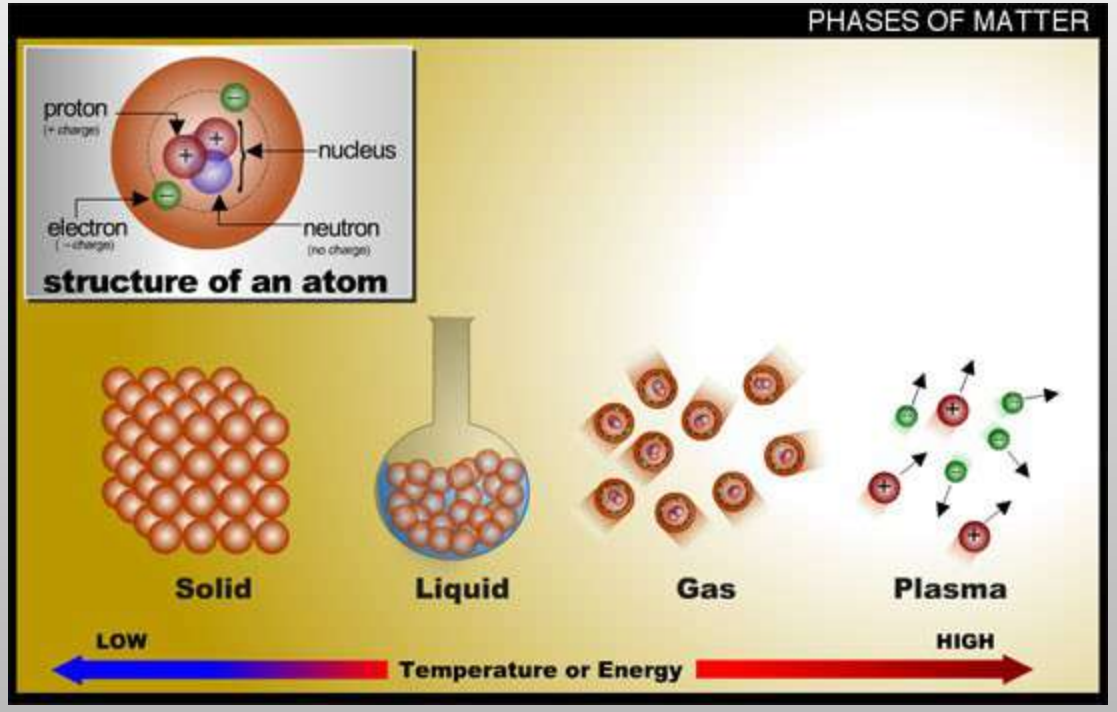
Inorganic vs. Organic Compounds

The difference between Inorganic and Organic Compounds are that Organic compounds have at least one carbon atom.

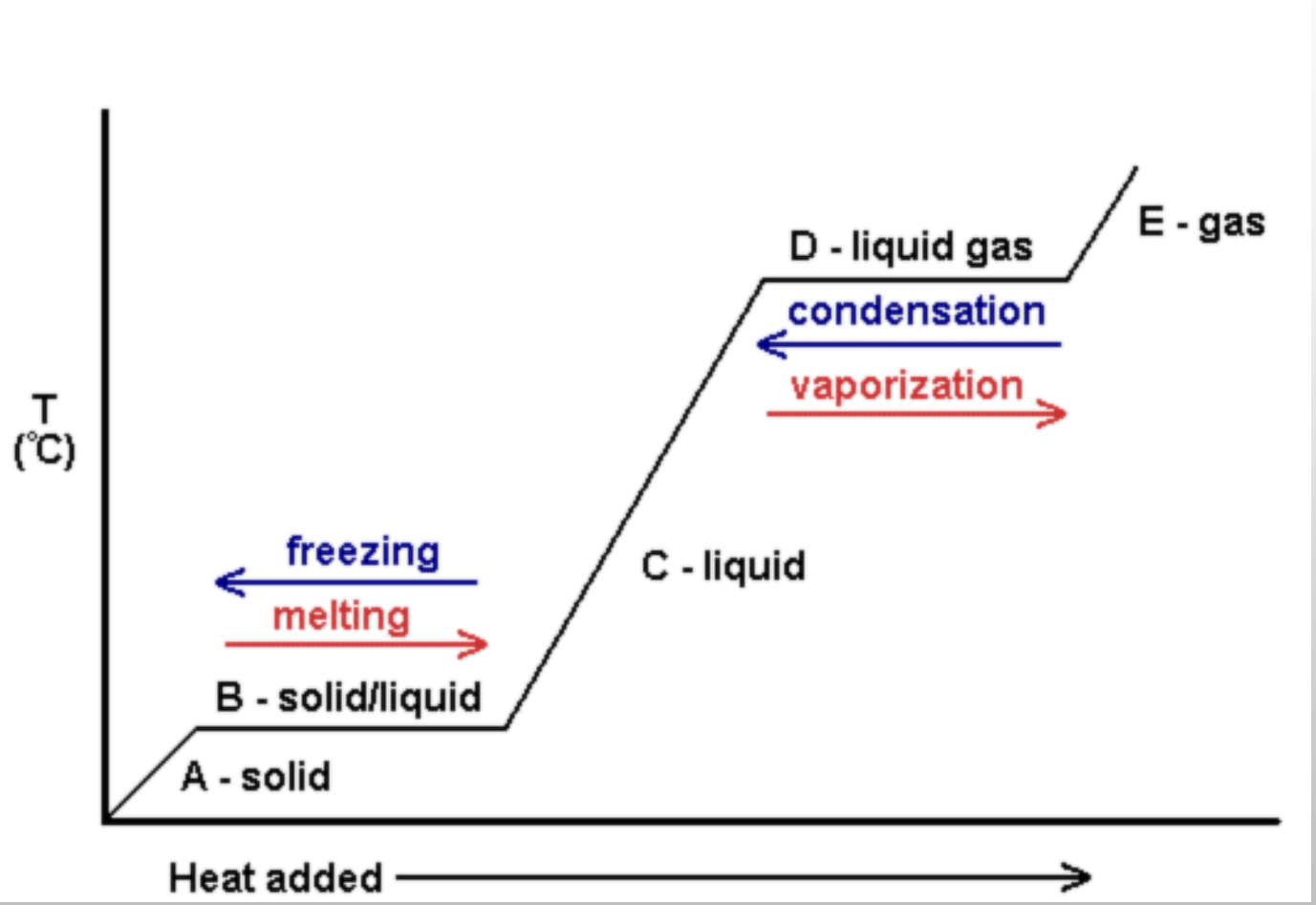
Kinetic Theory

Kinetic Theory states that as the temperature of an atom increases, the atom will have more kinetic energy.

Solid vs. Liquid vs. Gas vs. Plasma



State Change Graph



Chemical Properties

A chemical property is any of a material's properties that becomes evident during a chemical reaction.

For an example:

Oxidation, Combustibility and Corrosion are all signs of chemical properties.

Physical Properties

Physical properties can be observed or measured without changing the composition of matter.

Examples:

State, Viscosity, Conductivity, Density, Solubility.

Increasing Rate of Solubility

Ways to increase the rate of solubility of a mixture are by increasing the surface area, temperature and by stirring the mixture.

	$[H^+]$	pH	Common examples
Acids	1×10^{0}	0	Hydrochloric acid
	1×10^{-1}	1	Stomach acid
	1×10^{-2}	2	Lemon juice
	1×10^{-3}	3	Vinegar
	1×10^{-4}	4	Soda (carbonic acid)
	1×10^{-5}	5	Rainwater
	1×10^{-6}	6	Milk
Neutral	1×10^{-7}	7	Pure water
Bases	1×10^{-8}	8	Egg whites
	1×10^{-9}	9	Baking soda
	1×10^{-10}	10	Antacid
	1×10^{-11}	11	Ammonia
	1×10^{-12}	12	Quicklime (calcium hydroxide)
	1×10^{-13}	13	Drain cleaner
	1×10^{-14}	14	Lye (sodium hydroxide)

Acids and Bases

Acid: A solution that has an excess of H+ ions. It comes from the Latin word acidus that means "sharp" or "sour". Lemons. 6-0 on Ph scale. Sticky to touch.

Base: A solution that has an excess of OH- ions. Another word for base is alkali. Ammonia. 8-14 on Ph scale. Slippery to touch.

Neutralization Reaction

Covalent & Ionic Bond

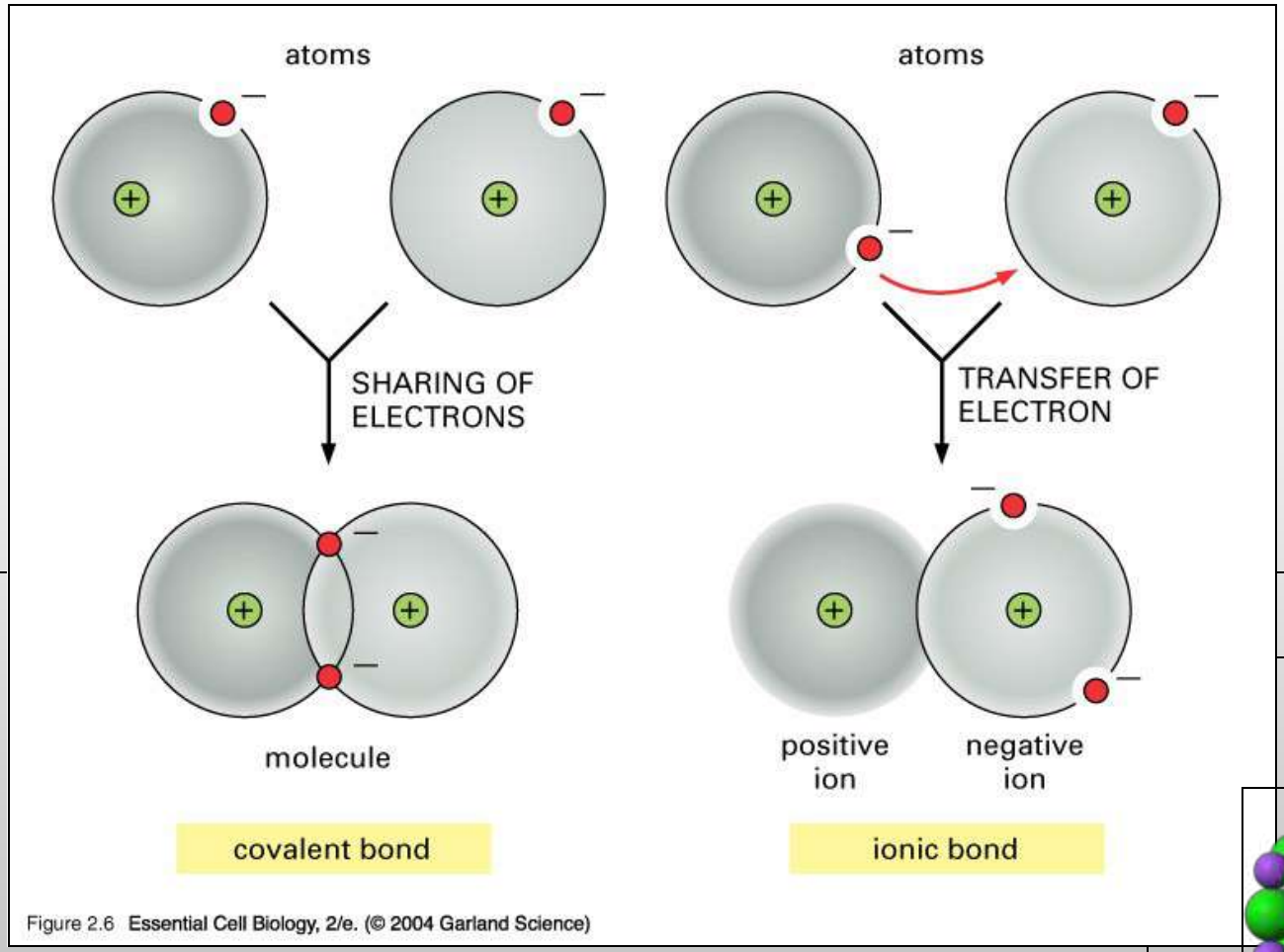
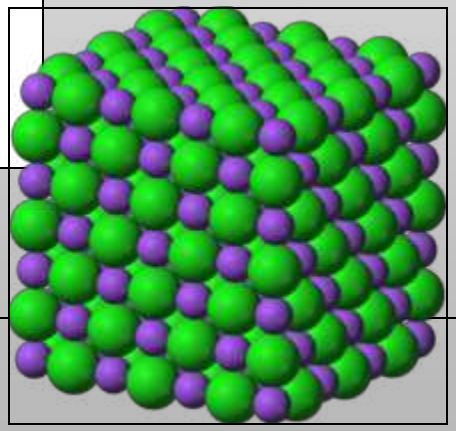


Figure 2.6 Essential Cell Biology, 2/e. (© 2004 Garland Science)

Crystal Lattice



Types of Chemical Reactions

- **Synthesis-** two or more simple substances combine to form a more complex substance.
- **Decomposition-** a more complex substance breaks down into its more simple parts.

Synthesis:	$A + B \rightarrow AB$ $E_1 + E_2 \rightarrow C$
Decomposition:	$AB \rightarrow A + B$ $C \rightarrow E_1 + E_2$
Single Replacement:	$AB + C \rightarrow AC + B$ $C_1 + E \rightarrow C_2 + E$
Double Replacement:	$AB + CD \rightarrow AC + BD$

- **Single Replacement-** when one element trades places with another element.
- **Double Replacement-** when two elements switch places with two others.

Writing Formulas for Compounds

Ionic Cmpd: contains a metal ion and a nonmetal ion

1. write the symbol for the metal ion
2. write the symbol or formula for the nonmetal or polyatomic ion
3. check the oxidation numbers of each ion; if they add up to zero, this is the formula.
4. use the proper subscripts after the symbol for each ion so that when multiplied times the ox. no., the algebraic sum of each is zero
5. a Roman numeral after the name of the metal ion denotes it oxidation number

Examples:

sodium chloride is NaCl
copper(II) carbonate is $CuCO_3$
aluminum oxide is Al_2O_3
strontium nitrate is $Sr(NO_3)_2$

Binary Covalent: contain two nonmetals or a metalloid & nonmetal

1. write the symbol of the first element named; if a prefix accompanies the name, place a subscript equal to the prefix after the symbol.
2. write the symbol of the second element; place a subscript after its symbol if the prefix means two or higher

Examples:

carbon monoxide is CO
sulfur dioxide is SO_2
phosphorus trichloride is PCl_3
dinitrogen tetraoxide is N_2O_4
carbon tetrachloride is CCl_4
diarsenic trisulfide is As_2S_3

Increasing Rate of Reaction

A scientist can increase the rate of a reaction by:

- Increasing the surface area
- Increasing the temperature
- Adding a catalyst

Physical Change

When a physical change occurs the compound is not altered.

Endothermic Reaction

A reaction that absorbs heat.

Exothermic Reaction

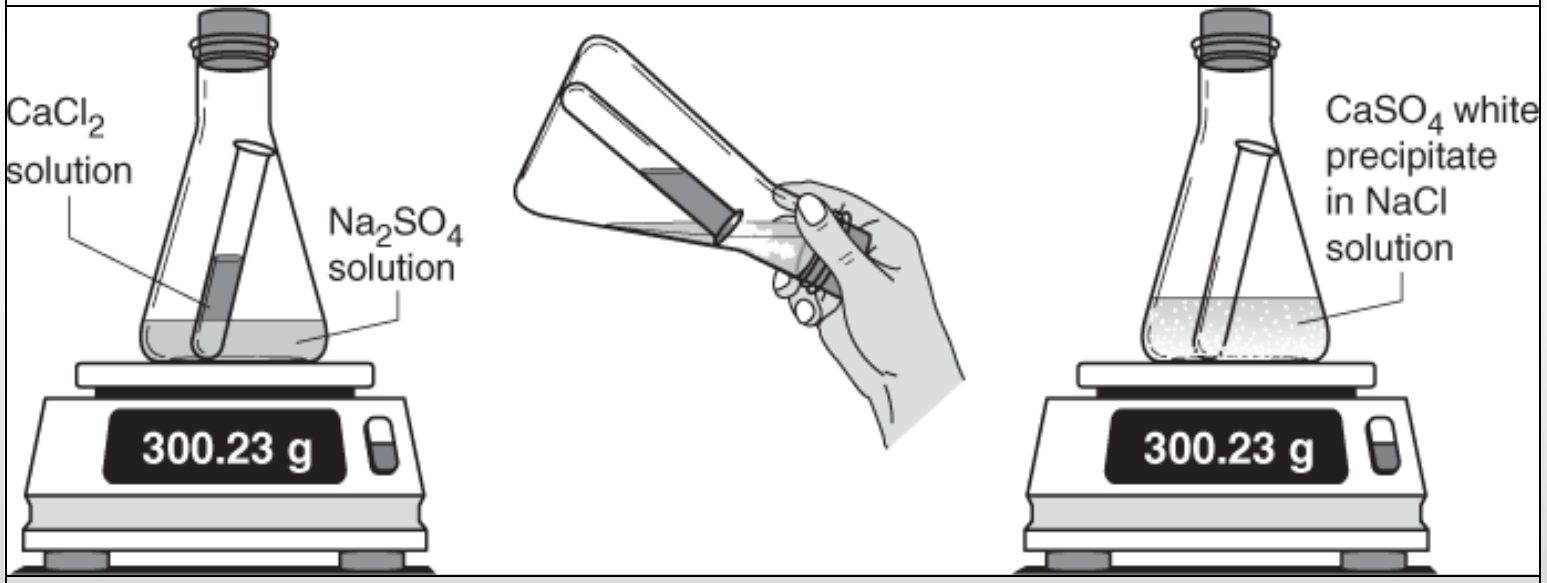
A chemical reaction that releases energy in the form of light or heat.

Chemical Change

When a chemical change occurs a new substance is created.

Odor, gas, color change, temperature change and precipitation are indicators.

Law of Conservation of Mass



The Law of Conservation of Mass states that mass must remain constant throughout a reaction.

Balancing Chemical Equations

The product of a reaction must have the same amount of atoms as before the reaction took place. Therefore, scientist use coefficients to balance equations.

Speed

The formula for speed is S=Distance/Time. Speed is usually measured in meters per second.

Velocity

Velocity is speed with a direction.

Acceleration

Acceleration is the rate of increase in velocity.

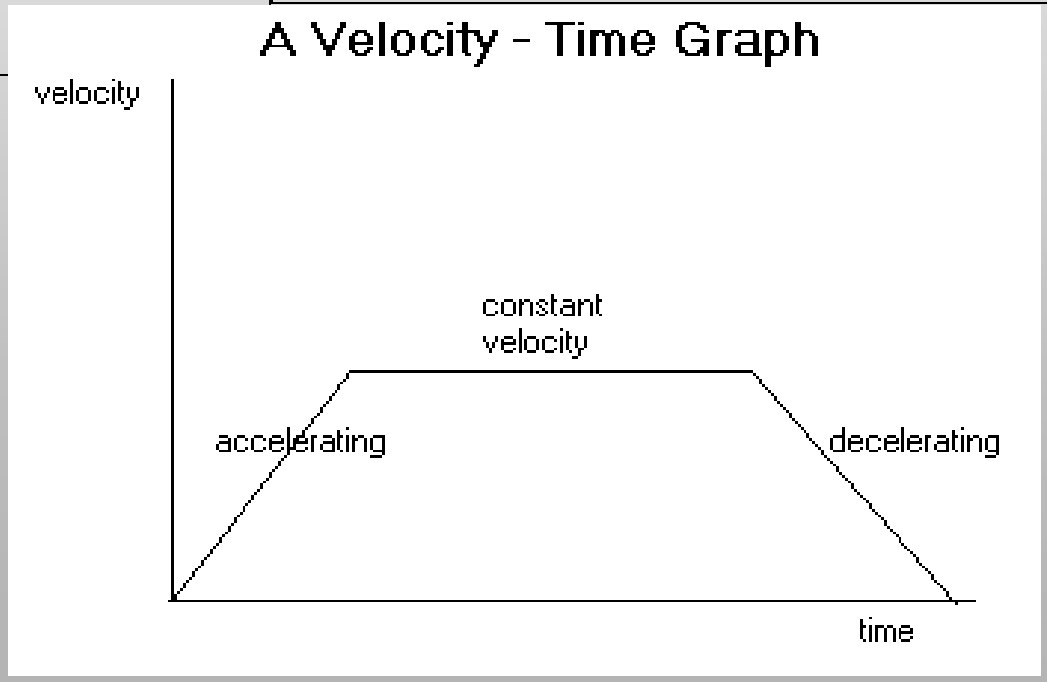
$$a = \Delta v / \Delta t$$

Instantaneous Velocity

Instantaneous speed is comparable to what a speedometer in a car

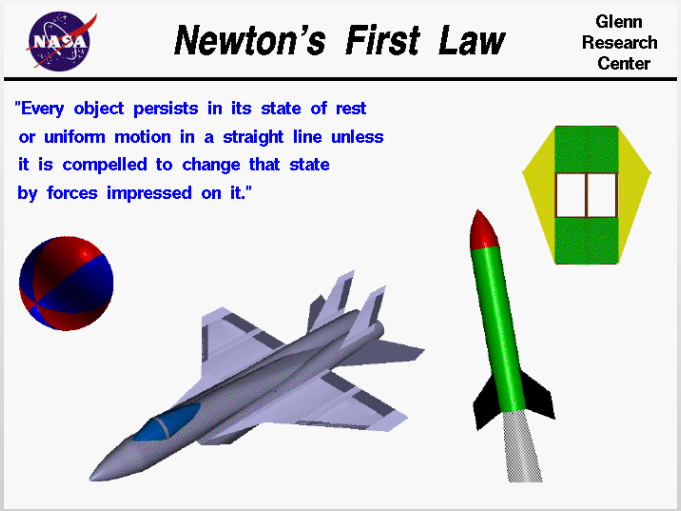
Average Velocity

Average velocity is just net distance traveled divided by time.



Inertia

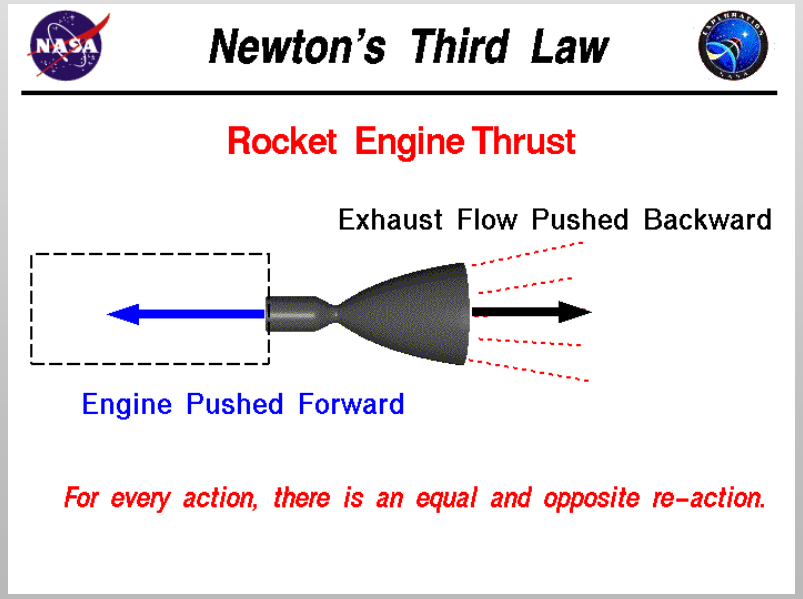
Inertia is the resistance of any physical object to a change in its state of motion or rest, or the tendency of an object to resist any change in its motion

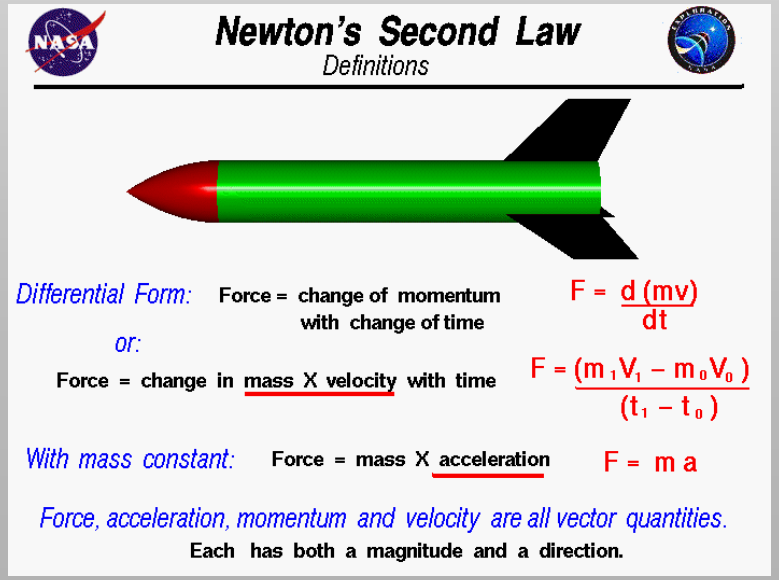


Force

Force=Mass×Acceleration

The ability to move.





Roller Coasters and Pendulums

Both roller coasters and pendulums experience energy transformations. It switches back and forth between kinetic energy and potential energy.

Energy Transformations

Energy transformation is the process of energy changing from one form to another.

Work

Work=Force×Distance

Energy

The ability to do work. Measured in Joules.

Kinetic Energy

Possessed energy while an object is in motion.

Law of Conservation of Energy

States that energy cannot be either created nor destroyed.

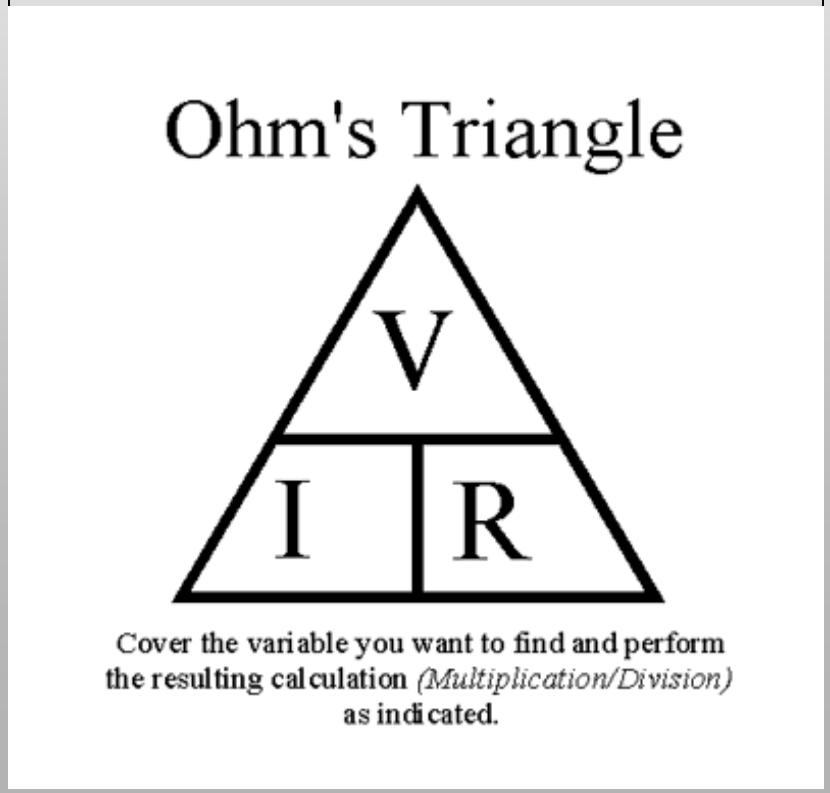
Potential Energy

Stored energy.

Static Electricity

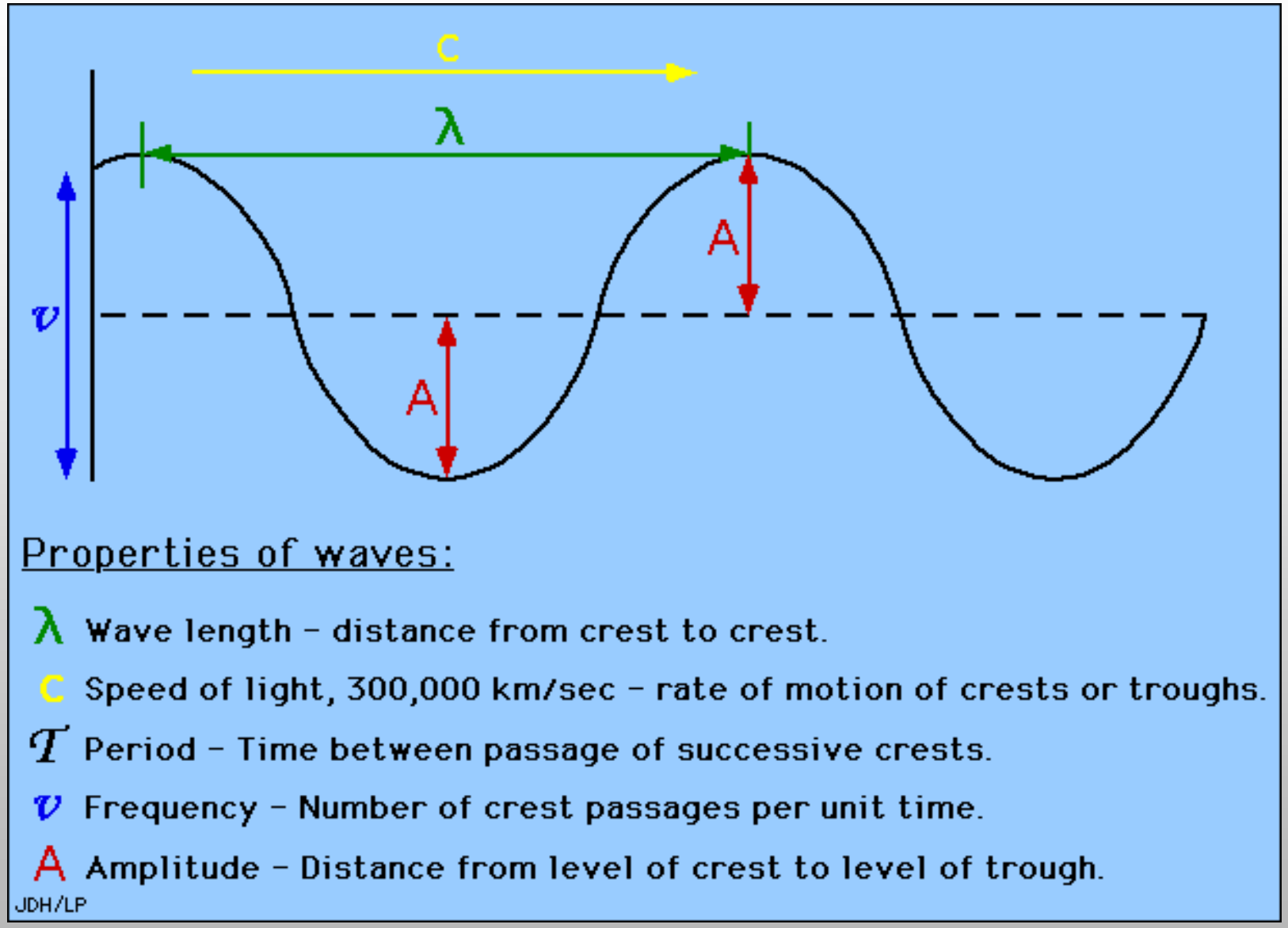
Static Electricity is the build up of excess electrons.

Ohm's Law



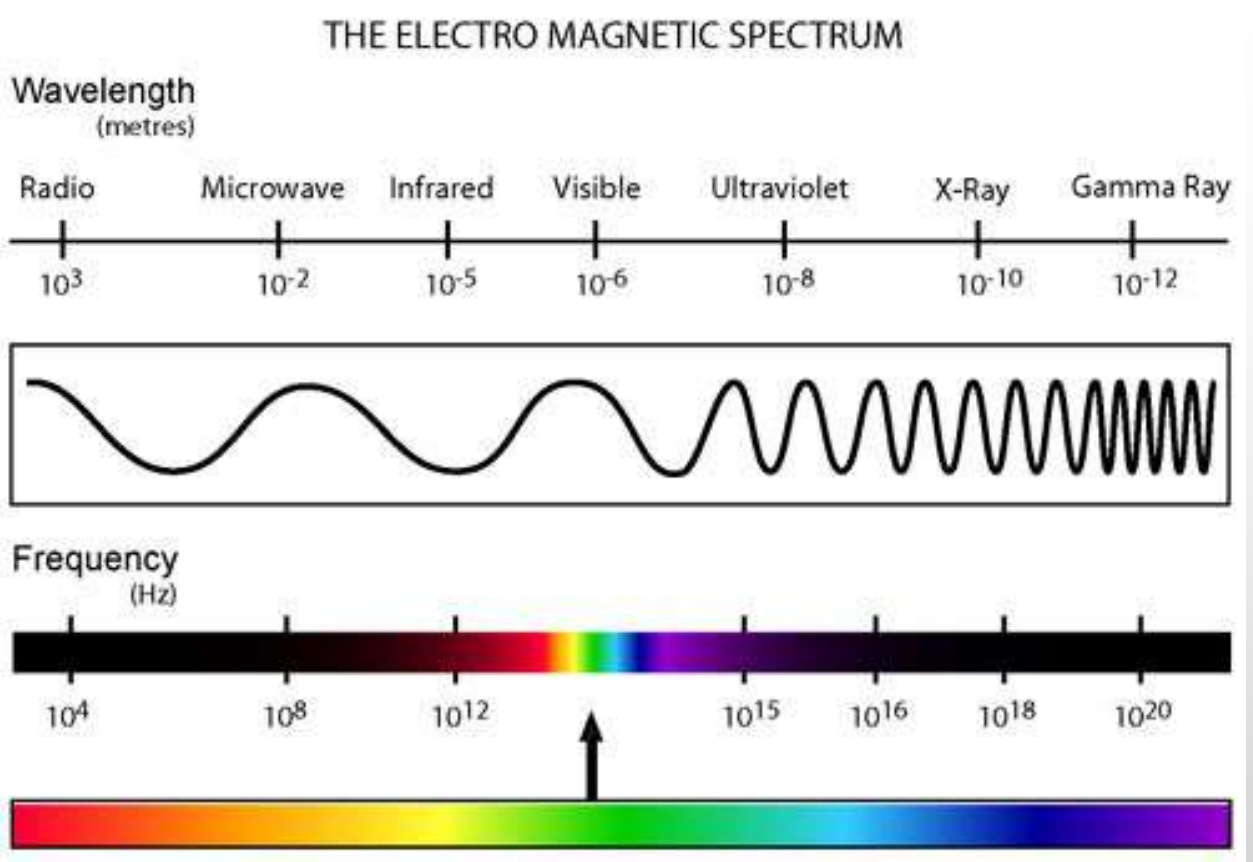
Lightning

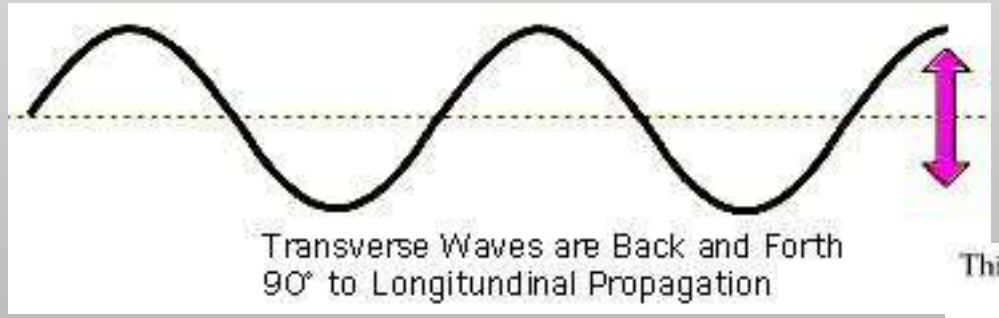
The discharge of electrons


c
λ
A
ν
A
Properties of waves:
λ Wave length – distance from crest to crest.
c Speed of light, 300,000 km/sec – rate of motion of crests or troughs.
T Period – Time between passage of successive crests.
ν Frequency – Number of crest passages per unit time.
A Amplitude – Distance from level of crest to level of trough.
JDH/LP

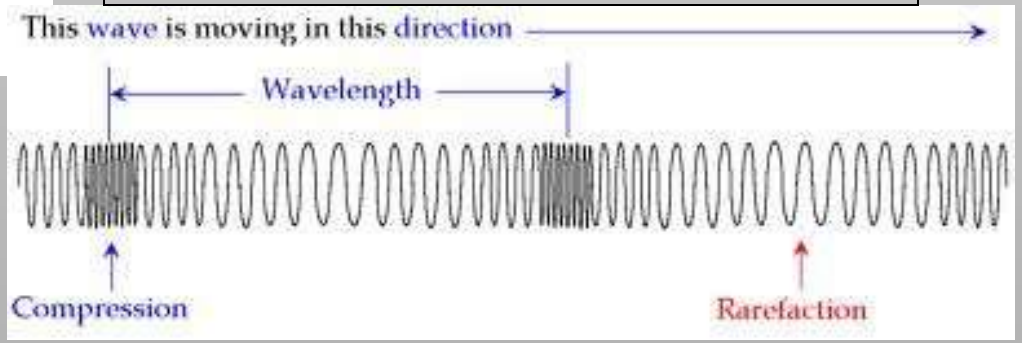
Mechanical Wave

A disturbance that moves through a medium.





Longitudinal Wave

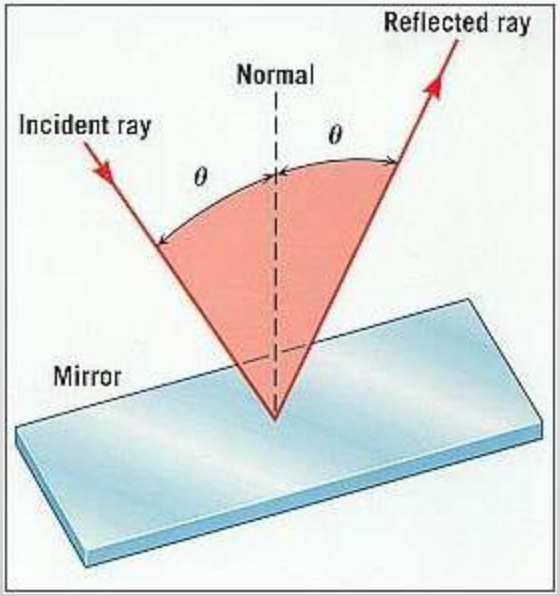


Wave Speed

Wave Speed=Distance/Time

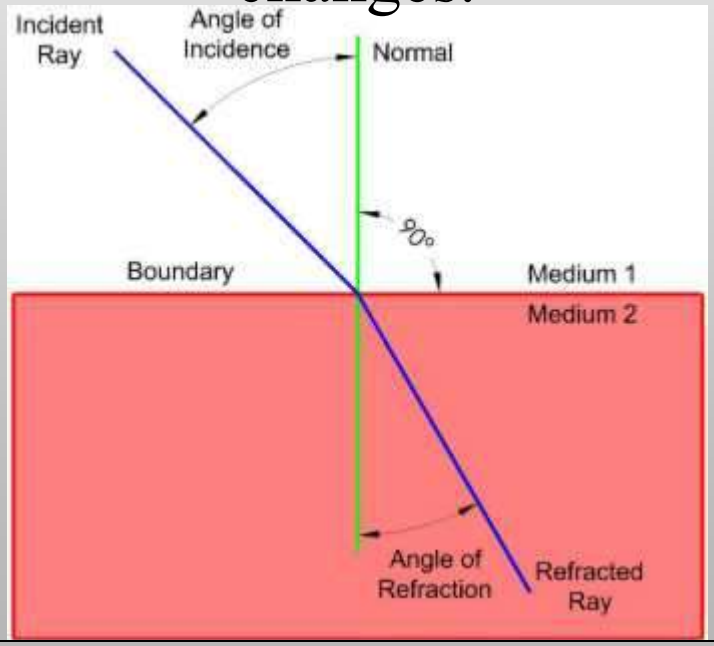
Reflection

When Light is reflected, the angle it hits the object is the same on both sides of the normal

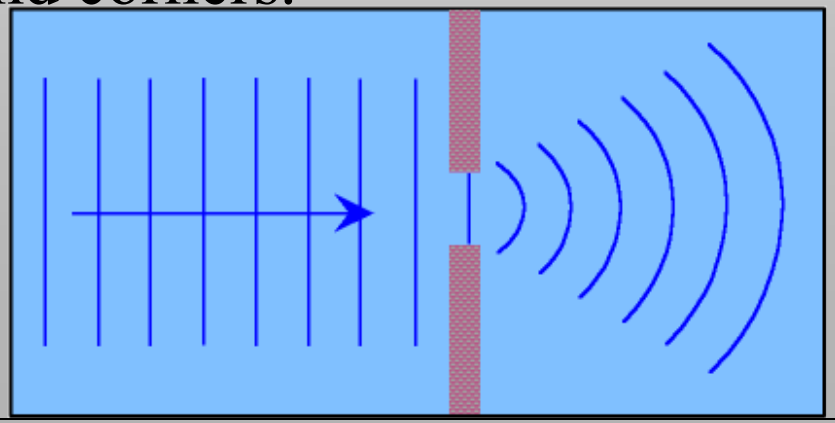


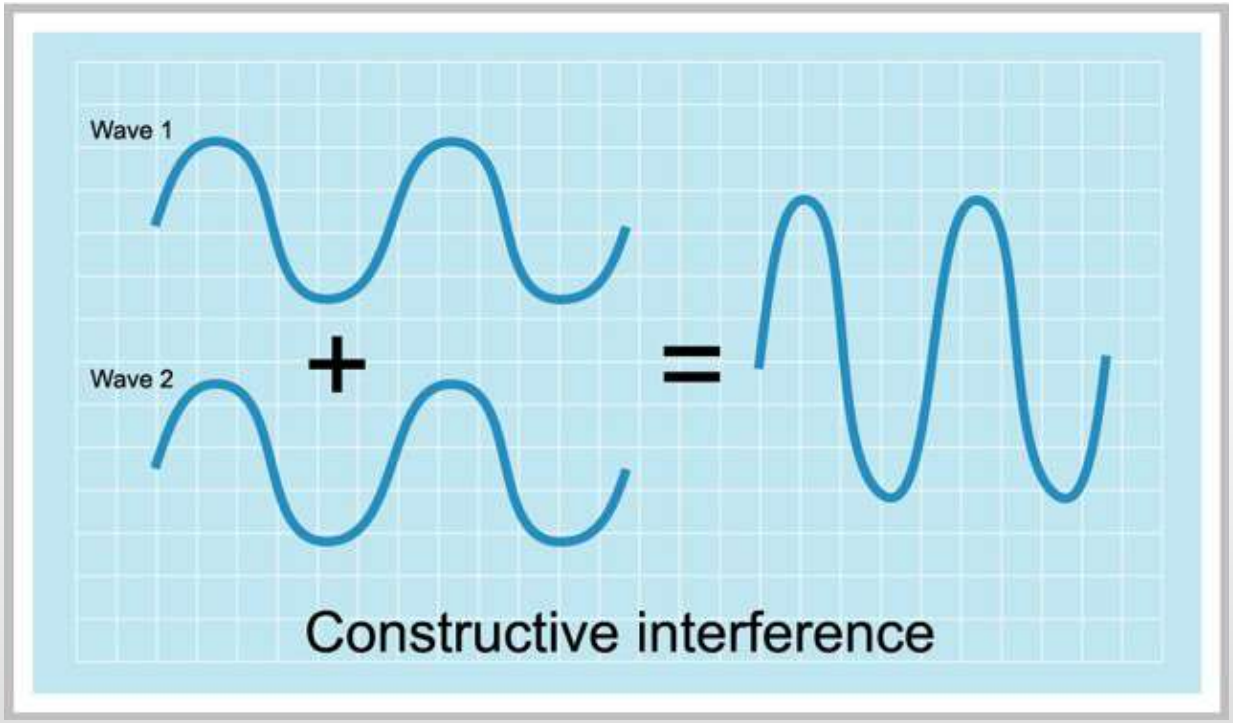
Refraction

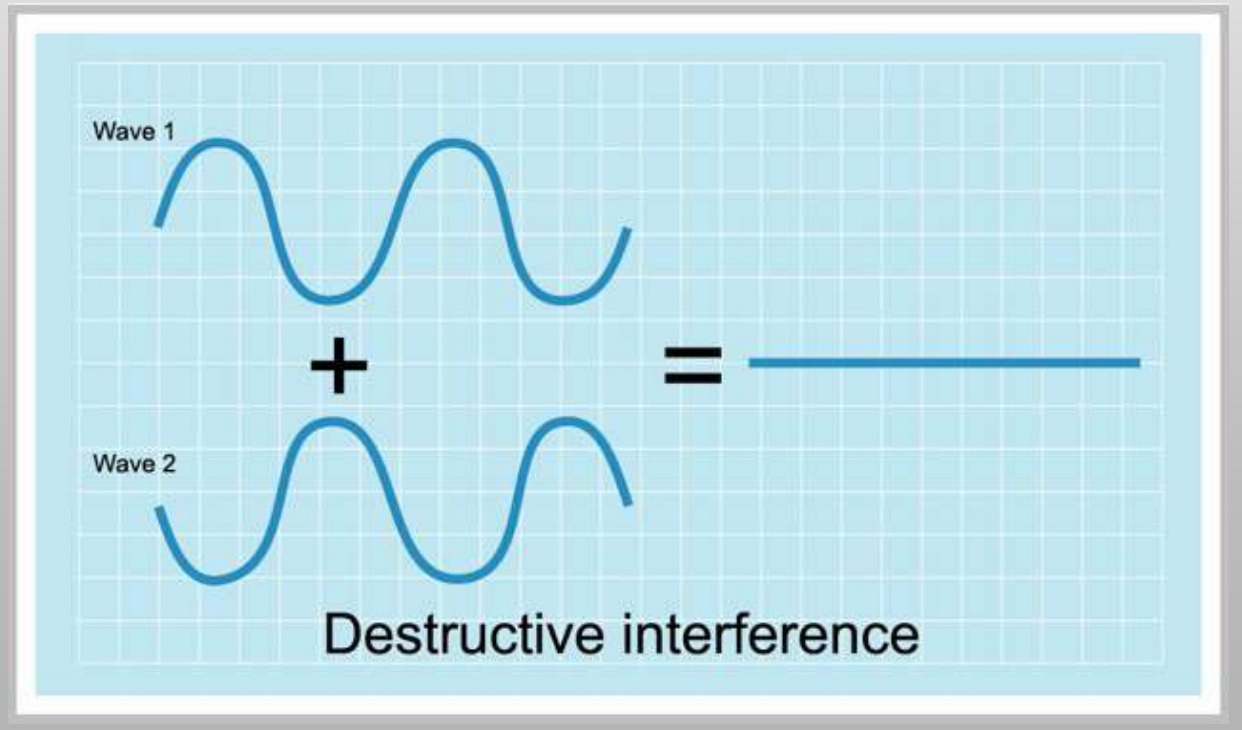
When light enters a new medium, the ray angle changes.



Diffraction– waves are able to bend around corners.




Wave 1
Wave 2
Constructive interference


Wave 1
Wave 2
Destructive interference

Sound Waves

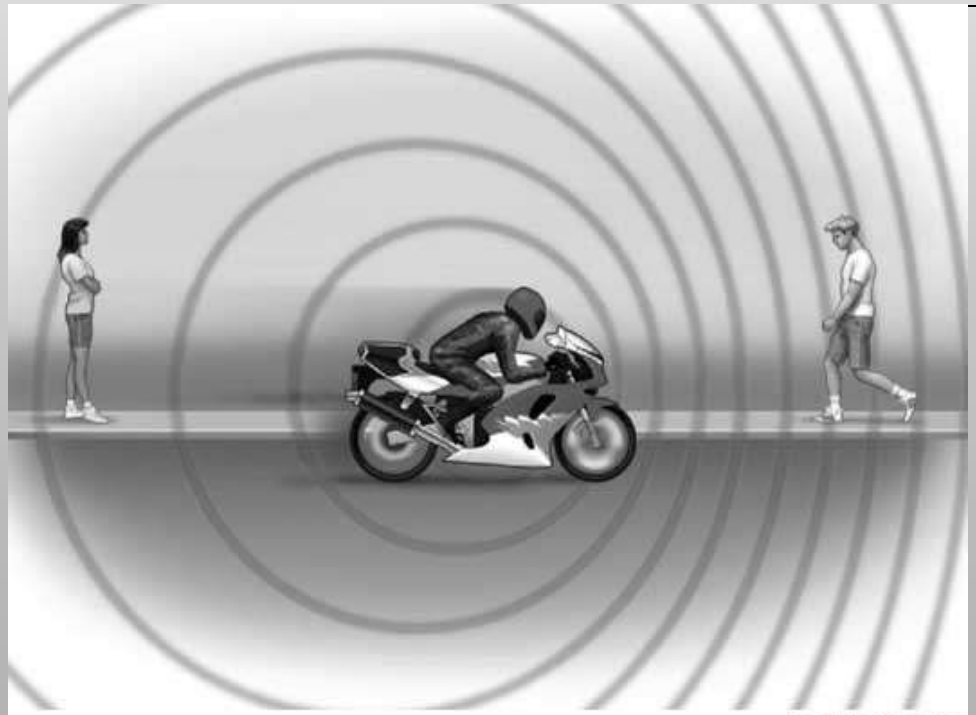
Mechanical waves that require medium to travel.

Pitch

Highness or lowness of sound characterized by the frequency

Echo

The bouncing of sound waves against objects that create a



Doppler Effect

Occurs when moving car passes you.