Physical Science Semester Study Guide

The nature of Physical science

The scientific method: The scientific method is a tool that scientists use to solve the mysteries of science.

Basic steps:

- **State the problem**
- **Gather information**
- **Form Hypothesis** (Proposed solution to the problem educated guess)
- **Experiment** to test the hypothesis
  - **Variables**- The factor being tested (**independent variable**)
    - **Dependent variable**- The result from the independent variable
  - **Control**- does not contain the variable
- **Record and analyze data** (observations and measurements)
- **State conclusion**
- **Repeating the work** (done by scientists worldwide)

Theory: A logical explanation for events in nature. Theories are time testes and are experiments that have been repeated many times.

Law: A law is a theory that has been tested many times(is more certain than a theory)

The branches of science:

Physical science- Deals with the study of matter and energy

- **Chemistry**- What substances are made of and how they change.
- **Physics**- The forms of energy, such as heat.

Metric System

Basic units

- **Length-** Meter
- **Volume-** Liter: Volume is the amount of space an object takes up.
  - Milliliter- 1000ml = 1Liter
  - 1ml = 1 cm^3 or cc (cubic centimeter)
- **Mass-** Gram: Mass is the measure of the amount of matter in an object.
- **Temperature-** Celsius or Kelvin
  - **K° = C° + 273**
  - **Example:**
    - Water freezes at 0C° or 273K°
    - Water boils at 100C° or 373K°

Dimensional Analysis: Converting one unit to another.

Uses a **conversion factor** that is a fraction that is always equal to 1

1Km = 1000m

Conversion factor is $\frac{1Km}{1000m}$ or $\frac{1000m}{1km}$

Example: convert grams to kilograms $2500grams \times \frac{1\ kilogram}{1000grams} = 2500 \times \frac{1kilogram}{1000}$

$= \frac{2500kilograms}{1000} = 2.5kg$

Physical Properties of Matter

Matter: is what the visible universe is made of.

Properties or characteristics describe an object.

Specific properties distinguish one object from another, (Ex- color, odor, texture, shape.)

General properties describe how all mater is the same. All matter has the general properties of mass, weight, and density

Mass: the amount of matter in an object.

-Mass is constant unless matter is added or removed from an object.

Mass and inertia: The more mass an object has the greater the inertia

Inertia: is the resistance of an object to changes in motion. A force must be used to make a stopped object move and a force must be used to make a moving object stop.

Weight: A changeable property of matter.

Weight changes according to certain conditions and depends on an objects location.

Example: if an object is in the water the buoyant force will make its weight less.

Weight and Gravity:

Gravity is the attraction between all objects. The greater the mass the greater the gravity.

The pull or force of gravity determines the weight of an object.

The metric unit for force is the **Newton(N).** On earths surface the force of gravity on a 1kg mass is 9.8 N

Volume: how much space an object has or its displacement

Density: is the mass per unit of volume

$$\textbf{Density} = \frac{\textbf{Mass}}{\textbf{Volume}}$$

$$D = \frac{M}{V}$$

-water has the density of 1g/cm^3

- any object with a higher density will sink in water and any object with a lower density will float

Phases of matter

Physical Properties are characteristics (descriptions) of a substance that you can see without changing what a substance is made up of.

Examples: mass, weight, volume, density, color, shape, hardness, and texture

Matter can exist in 4 phases: solid, liquid, gas, and plasma.

Example: Ice, liquid water, and water vapor are all made of the same substance, but in different states or phases.

Solids: Have a definite shape and definite volume because the tiny particles they are made of are packed close together so they cannot move out of place.

Crystalline solids- are arranged in regular, repeating patterns called crystals.

Amorphous solids – will not hold their shape permanently and particles are not arranged in regular, repeating patterns. Their particles can flow slowly past each other.

Liquids: Have no definite shape but do have definite volume. They take the shape of their containers. Particles move a little more freely.

Viscosity – is the resistance of a liquid to flow. Example: honey flows more slowly than water.

Gases: Have no definite shape but are a lot less dense than liquids. Gases fill all available spaces, no matter the size of the container. Gas particles move freely and have more energy than particles in liquids or solids.

Plasma: Rare on Earth, but one of the most common phases in which matter is found in the universe. Found in sun and stars and is extremely high in energy therefore dangerous to all living things.

Phase Changes

Kinetic Theory The amount of energy a substance contains determines the different phases of matter. Substances can be made to change phases by adding or taking away energy.

Phase changes of matter are: melting, freezing, vaporization, condensation, and sublimation. In physical changes a substance can change phases but what it is made of will not change.

Solid – Liquid Phase Change

Melting – change of a solid to a liquid when a substance absorbs heat energy.

Melting Point – is the temperature at which a solid changes to a liquid. Example: melting point of ice is 0°C and for table salt is 801°C.

Freezing – is the change of a liquid to a solid when energy is lost or removed.

Freezing Point – is the temperature at which a liquid changes to a solid.
Example: water freezes at 0°C. So ice melts at 0° C and water freezes at 0°C.

Liquid – Gas Phase Changes

Vaporization – is the change of a substance from a liquid to a gas.

Evaporation – is when vaporization takes place from the surface of a liquid.

Boiling – is when vaporization occurs throughout a liquid.\

Boiling Point – is the temperature at which a liquid boils. Example: the boiling point of water at sea level (normal) is 100°C while the boiling point of salt is 1413°C. Boiling point is related to the air pressure above the liquid.

Condensation – is the change of a gas to a liquid. Example: glass of ice tea sweats.

Solid – Gas Phase Changes

Sublimation – is the change of a solid directly to a gas without going through the liquid phase.
Example: dry ice

Chemical Properties and Changes

Chemical Properties – describe a substances ability to change into other new and different substances. Example: wood has the ability to burn.

Flammability – is the ability to burn

Chemical changes – When a substance undergoes a chemical change a new substance is produced.
Example. Wood burning.

Chemical reaction – is another name for a chemical change.

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Heat (Thermal Energy)

Heat is energy associated with the random motion of atoms. Heat is transferred by conduction, radiation, and convection.

Conduction- Heat is transferred through a substance, or from one substance to another by direct contact.
Example- cold hands to a warm face.

Conductors- are substances that conduct heat well

Example- metals such as copper, iron, aluminum and silver.

Insulators- are substances that **do not** conduct heat well

Example- glass, wood, plastic, and rubber

Convection- heat transfer takes place in liquids or gases

Example- Hang gliders and buzzards

Radiation- heat energy is transferred through empty space.

Example- heat from the sun to earth

Heat and temperature are related but not the same.

Heat is dependant on mass and cannot be measured directly.

Ex: 1kg of hot lead has more heat than 1g of hot lead.

Heat is measured in Joules(J).

Heat of Fusion- is the amount of heat needed to change 1 gram of a substance from a solid to a liquid.

Heat of Vaporization- is the amount of heat needed to change 1 gram of a substance from a liquid to a gas

Temperature remains constant in phase changes.

Thermal Expansion: The expansion or increase in size of an object caused by the addition of heat.

Example: Seams are put in bridges because that metal expands when it warms up.

Mixtures, Elements, and Compounds

Classes of matter: In order to cut down on confusion scientists use a classification system based on the make up of matter. Matter exists as **mixtures, solutions, elements, or compounds**.

Mixtures: A mixture consists of two or more substances mixed together but not chemically combined. Each substance maintains its properties in a mixture.

- No new substances are formed
- Substances can be separated by physical means

Types of mixtures they are defined by how well mixed they are.

Heterogeneous Mixture: The least mixed of the mixtures with particles that can be seen

Example: Concrete, salad, vinegar and oil

Homogeneous Mixture: This mixture is well mixed and even throughout.

Example: Stainless steel, ice tea, soda.

Colloids: These are homogeneous mixtures that have relatively large particles but they stay suspended. They will not separate when left standing and often appear cloudy, because the particles scatter the light.

Examples: Milk, whipped cream, suntan lotion

Solution – a homogeneous mixture of two or more substances in a single state. The best mixed mixture.

- There are two parts of all solutions
- **Solvent** - which does the dissolving.
- **Solute** - that which gets dissolved.

Aqueous Solution : A solution with water as a solvent.

Solubility : measures the ability to dissolve of a solute to dissolve in a solvent at a given temperature.

- Solubility generally increases when the temperature of the solvent increases.
- For gaseous solutes temperature increases decrease solubility.

Insoluble : a substance that cannot be dissolved in a solvent.

Alloys: A solution of two or more metals.

Temperature and Solubility : The solubility of most solids increases as the solvent temperature increases.
-The solubility of the gases decrease as the temperature goes up.

Pressure and Solubility: External pressure has little affect on the solubility of solids in liquids but greatly affects the solubility of gases.
-An increase in external pressure increased the solubility of gases in a liquid and vice versa.

Examples: The pressure in a coke can keeps the CO_2 gas dissolved in the drink. When the can is opened and the pressure relieved the gas.

Elements and Compounds

Pure substances are when all the particles in the substance are the same.

Elements: They are the simplest of the pure substances. An element cannot be changed be changed into a simpler substance by heating or a chemical change.

Atom: The smallest particle of an element that has the characteristics of that element
- An atom is the basic building block of matter
- Atoms of the same element are alike

Chemical Symbols: They are the shorthand way of representing the elements. Each symbol has one or two letters. The first letter is always capitalized but the second letter is never capitalized.

Compounds: Pure substances that are made up of two or more elements that are chemically combined.

Compounds and Molecules: Compounds are made up of molecules.
- Compounds can be broken down into simples substances.
- The properties of a compound are different from the properties of the elements that make up the compound. Example: Table salt(NaCl) Water(H_2O)

Chemical formulas: They are a shorthand way to write chemical substances
- When you write a chemical formula you use a symbol for each element in the compound
- **Subscripts** to the lower right of the symbol represent the number of atom of that element that are in the compound. If there is no subscript there is only one atom of that type.
- Chemical formulas save space they tell the elements in the compound and tell how many atoms of each element there are.

Chemical equations- In a chemical equation the chemical symbols and formulas are like words, but chemical equations are like sentences.
- The chemical equation is a description of a chemical reaction using symbols and formulas
- The chemical equation must be balanced. There must be the same number of atoms of each element on both sides of the equation
- When you balance a chemical equation you change the **coefficients** until the atoms are equal
- The coefficient is the number in front of the chemical formula that tells how many of that formula are needed to balance the atoms on each of the equation.

$$\mathbf{4P + 5O_2 \rightarrow P_4O_{10}}$$

Reactants **Products**

The Structure and Properties of Matter

1. the atom has a large positive nucleus
2. Atoms are mostly empty space.
3. Electrons are found in the electron cloud surrounding the nucleus.

   - Energy level 1 has 2 electrons
   - Energy level 2 has 8 electrons
   - Energy level 3 has 18 electrons
   - Energy level4 has 32 electrons

Wave Theory: The modern model is significantly different due to the wave nature of electrons. The speed and location of an electron cannot be known. Only the most probable location or cloud as it is described.

Protons: The positive particles found in the nucleus of an atom. A protons mass is 1 atomic mass unit or amu.

Neutrons: have no electrical charge (neutral). They are found in the nucleus. Their mass is just slightly larger than 1 amu.

Electrons: are negatively charged particles found in energy levels around the nucleus. Their mass 1/1837th amu is much smaller than a proton.

Atomic Number: The number of protons in the nucleus of an atom.
-All elements have a unique atomic number and these numbers are used to sort the elements on the periodic table. The number of Protons and Neutrons are equal.

Mass Number: The sum of protons and neutrons in a single atom.

Isotopes: Atoms of an element that have a different number of neutrons, resulting in a different mass.
Ex. Carbon 12 – 6 neutrons
Carbon 14 – 8 neutrons

Atomic mass: The mass of an atom in atomic mass units. It is an average of all atoms and isotopes of an element in existence in the universe.

- Gamma decay: Strong electromagnetic waves (gamma rays) are produced. These rays are very dangerous and require several centimeters of lead to protect you.

Nuclear Fission: This is the splitting of a nucleus into fragments of about the same mass. The small loss of mass is converted into large amounts of energy according to Einstein's famous $E=mc^2$ equation.
Ex. Nuclear power
- the atomic bomb is an uncontrolled fission reaction

Fusion: This is the joining of lighter nuclei to form a single nucleus of slightly less total mass. Again the missing mass is converted into large amounts of energy.
Ex. Fusion inside the sun
Fusion takes extremely high temperatures 15 million C°

The Periodic Table

The **symbols** of the periodic table came from the Latin names, names of places and scientists.
- in a symbol with 2 letters the first is always capitalized and not the 2nd

Ex. Co – Cobalt
Two capitals, like CO, is carbon monoxide.

Families and Groups: The periodic table is divided into 18 **families** or **groups** in the columns of the elements. These groups have similar but not identical chemical properties (excluding Hydrogen)

- As you go down a in a group the atom size of the elements increases.
- This increase in size causes the elements at the bottom of a family to be more reactive than the elements at the top of the family.

Periodic Properties of the Periodic Table

- **Periodic Law** states that the properties of elements are periodic functions of their atomic # 's.

The table is divided into periods which run Horizontally across the table. The following are the trends and patterns that exist in the periods.

- Electron arrangement --- Every period you go down on the periodic table you add a shell of electrons.
- Reactivity across the period from left to right. High reactivity to low reactivity to high reactivity to no reactivity in the noble gases.
- Atomic size The atoms in a period get slightly smaller from left to right.
- Metallic properties --- From metals on the right to metalloids to nonmetals from left to right in a period.

Other Groups on the Periodic Table

Metals: The large majority of the 109 elements on the periodic table are Metals. They are found on the center and left of the periodic table.

Properties of metals:

Physical properties

- Luster- Shininess
- Good conductors of heat and electricity
- High density
- High melting points
- **Ductile**: Can be drawn into wires
- **Malleable:** Can be rolled into sheets

Chemical properties:

- Will **Oxidize:** React with water and oxygen to from rust
- Corrosion
- Loose outer electrons in reactions

Nonmetals: They are found in the upper right of the periodic table.

Properties of nonmetals

Physical properties:

- No luster, Dull in appearance
- Poor conductors
- Brittle
- Not ductile or malleable
- Lower melting points and densities than metals
- Many nonmetals are gases

Chemical properties

- Elements tend to gain electrons in chemical reactions
- The noble Gases are not reactive

Metalloids: Elements that have properties of both metals and nonmetals. For example they are more ductile and malleable and conduct heat and electricity better than nonmetals but not as well as metals.

Diagram

Chemical Reactions

Law of Conservation of matter: Matter cannot be created or destroyed I a chemical reaction.

A **chemical reaction** is when a new substance is formed from the bonding of two or more atoms.

The Octet Rule: States that bonding is caused by the tendency of atoms to reach a state of stability which is a full outer shell of 8 electrons (or 2 for those with an atomic # less than 5)

- In the process of bonding (obtaining 8 electrons) an atom can lose, gain or share Electrons
- **metals** usually lose electrons with oxidation #'s 1,2,or 3
- **non-metals** usually gain electrons with oxidation #'s 5,6, or 7

Ionic Bonds: form when an atom (usually metal) loses electrons and becomes positively charged and another atom (usually a non-metal) gains these electrons and becomes negatively charged

- electrons are transferred resulting in the creation of charged ions
- These ions usually form **crystalline solids** (such as diamonds)

Examples: NaCl (sodium chloride/ table salt)
NaOH (sodium Hydroxide
Oxides: rust/ iron oxide Fe2O3 and magnesium oxide MgO

Covalent Bonds: form when a pair of electrons are shared between the atoms.

Examples: H_2O, CO_2, CO (carbon monoxide), NH_3 (ammonia) HCL, and
diatomic elements: O_2, N_2, F_2, H_2, Cl_2, Br_2, I_2, and At_2

Metallic Bonds: In a metallic bond the outer electrons of the atoms form a common electron cloud or sea of electrons. The nuclei are surrounded by free moving electrons that are attracted to all nuclei at the same time.

Ionization Energy: The amount of energy required to remove an electron from an atom or element

Electron affinity: Refers to the how well atoms hold onto their electrons.

Polyatomic Ions: A compound that has a charge and has some similar properties to single atom ions.

Chemical Reaction Types

Oxidation: a Reaction in which the atoms or ions of an element lose one or more electrons and hence attain a more positive (or less negative) oxidation state.

Oxidation Number: The number that describes an element's ability to react.

Ex. Oxygen has an oxidation number of –2; when it bonds it can accept 2 electrons
- Calcium has an oxidation number of +2; when it bonds it will give up 2 electrons
- Ca^{+2} + O^{-2} = CaO

Polymerization: polymers are large chains of molecules called monomers.

Ex. – polyethylene, polyesters, PVC pipe
- Gak, proteins in your body, DNA

Chemical Formula: The short hand way to write a compound using chemical symbols.

Ex. Water = H_2O, Glucose = $C_6H_{12}O_6$

Chemical equations-

$$4P + 5O_2 \rightarrow P_4O_{10}$$

Reactants **Products**

All matter is conserved therefore all equations must be balanced: the same number of each atom on each side of the equation.

To **Balance** an equation, coefficients are added in front of the correct formulas

***subscripts are not balanced**!!

Examples:

1. $HgO \rightarrow Hg + O_2$

Step1: balance the Oxygen

$2HgO \rightarrow Hg + O_2$

Step 2: Balance the Hg

$2HgO \rightarrow 2Hg + O_2$

2. $Fe + O_2 \rightarrow Fe_2O_3$

Step 1: Balance the Fe

$2Fe + O_2 \rightarrow Fe_2O_3$

Step 2: Balance the Oxygen

$2Fe + 3O_2 \rightarrow 2Fe_2O_3$

Step 3: Rebalance the Fe

$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

Types of Reactions

Single replacement: A + BX → AX + B

Example: $2Al + 3ZnCl_2 \rightarrow 2AlCl_3 + 3Zn$

-One element switches its bond from one element to another. An easy characteristic to look for is the single element left on both sides.

Double Replacement: AX + BY → AY + BX

Example: $BaCl_2$ + H_2SO_4 → $BaSO_4$ + 2HCl

-Both atoms switch the elements they are bonded with. It is best identified by pairs of elements in both compounds on each side of the reaction. It's the long one.

Decomposition: C → A + B

Example: 2HgO → Hg + O_2

- One reactant breaks into two or more products.

Synthesis: A + B → C

Example: 2CO + O_2 → $2CO_2$

- All the reactants combine to form a single product.

Combustion: Hydrocarbon + Oxygen → Carbon dioxide + Water

Example: CH_4 + $2O_2$ → CO_2 + $2H_2O$

-Combustion, which is incomplete, produces Carbon Monoxide (CO), a poisonous gas
-cars are regulated to keep them from producing too much CO

Acids and Bases

The pH scale

The pH scale goes from 1-14; 1-6 acidic; 7 neutral; 8-14 basic

Indicators tell whether the solution is an acid or a base.

Common Indicators: Litmas Paper (red or blue)
PH meter
Phenolphthalein

Acids: H^+ Ion Present

- have a sour taste
- contain Hydrogen example H_2SO_4
- react with metals to produce Hydrogen gas
- react with bases to form salt and water
- corrode metals
- for electrolyte solutions
- Common Acids:
  - HCl - stomach acid
  - H_2SO_4 - battery acid

Bases: OH^- Ion present

- have a bitter taste
- feel slippery to the skin
- react with acids to produce salt and water
- form electrolyte solutions
- Common Bases:
  - Drain cleaner
  - Antacid tablets

Concentration of a solution is a measure of the amount of solute in a standard amount of solvent.

Concentrated is a large amount of solute
Dilute is a small amount of solute
Example: weak tea vs. strong tea

<u>Strong Acids</u>

- HCl or Hydrochloric acid
- H_2SO_4 - Sulfur acid
- Nitric acid

<u>Weak Acids</u> acetic acid - vinegar
carbonic acid – in soda

<u>Strong Bases</u> NaOH – sodium hydroxide
KOH - potassium hydroxide

<u>Weak Bases</u> ammonia, aluminum hydroxide, iron hydroxide

Mechanics:

Motion: A change in position in a certain time
-must have a **frame of reference**: A background that motion is measured against. (most common earth)

S = **speed**: the rate of motion
V = **velocity**: speed in a direction
V = means average speed of velocity
V = change in speed or velocity

Constant speed: speed is the same throughout the time
Average speed or velocity: found by dividing the total distance covered by the time of the trip.

$$V = \frac{d}{t}$$

Instantaneous speed: the speed at the one point in time during a trip
Ex: a speedometer reading

Acceleration: the rate of change in velocity

- adding or subtracting velocity

$$a = \frac{\text{Velocity final} - \text{Velocity initial}}{\text{time}} \quad \text{or} \quad a = \frac{V_f - V_i}{t}$$

acceleration = velocity/ time
acceleration due to gravity 9.8 m/s

Momentum: The mass of an object times the velocity of the object. It determines how difficult it is to stop an object from moving

Momentum = Mass X Velocity

The law of conservation of momentum states that the momentum of any group of objects will remain the same unless acted upon by outside forces.

Newton's Laws

Force: a push or pull.
Ex. Gravity, kicking a ball

Friction: a force that acts against motion.

Newton's 1st Law (inertia): An object at rest will stay at rest until acted on by a force and an object in motion will stay in motion until acted on by a force.
-the tendency of an object to resist a change in motion
Ex. Being pushed back against the seat when a car accelerates and being thrown against the seatbelt when it stops

Newton's 2nd Law: The acceleration of an object depends on the size of the force applied and the mass of the object.

F = ma

Units for force is Newtons (N) = 1 (kg)(m/s2)
Mass: is the amount of matter in an object
Weight: is the force of gravity an object
Weight is measured in Newtons
Weight = mass x acceleration due to gravity
W = m x g

Newton's 3rd Law: Forces occur in pairs; for every action there is an equal and opposite reaction.
Ex. You push on a wall and the wall pushes back. If it didn't the wall would fall over.

Work

Work is a force acting through a distance.
A person lifting a box does work
Skater with tray. No work is done on the tray, when tray picked up work is done.

W = Fd joules are the units for work

Machines make work easier

(f) small force using machine. x (D) large distance using machine = (F) large force output by machine x (d) small distance moved

A small force is put in the machine over a large distance and a large force comes out over a small distance

Ex: A crowbar moving a rock

Power = rate of doing work

P = w/t Watts are the units for power (1watt = 1 J/s)

Watts in appliances
1000 watt light bulb same for 2 hrs.
1000 watt hrs. or 2 kw. This is what is on your electric bill

horsepower
1hp = 746 watts

Kinetic energy: energy of motion, depends on mass and speed

K.E. = (1/2) mv^2 Joules are the units for Kinetic energy

V^2 in formula means velocity squared this means that kinetic energy changes more due to velocity than mass.
Doubling the speed of a car actually quadruples its moving energy. The resulting energy makes it four times as hard to stop

Potential Energy: energy of position or state
Ex. Objection ledge, compressed spring
Stretched rubber band, Drawn bow and arrow
Piece of wood, gun powder in shotgun shell

P.E. = mass x gravity (gravity is acceleration x height)

P.E. = mgh

Joules are the units for potential energy
Gravity = 9.8 m/s^2

Conversions of energy

Heat or thermal energy: All mater is made of atoms. The internal motion of atoms is heat energy.

Chemical energy/ Chemical potential energy: Energy is required to bond atoms together. This energy is called chemical energy. When bonds are broken and remade energy can be released.

Electromagnetic: The ability of a moving electric charge to do work. Light is another form of electromagnetic energy as are x-rays, radio waves, and lasers.

Mechanical or Kinetic energy: Matter that is in motion has energy
Example: You running across the room or the molecules in water moving and hitting each other

Nuclear energy: Nuclear energy comes from the splitting or fusion of the nuclei of atoms.

Conversions can happen back and forth between any of these forms of energy.

Law of Conservation of energy: Energy may change forms but is never lost or created during any conversion.
Ex. In ball drop the conversion from P.E. to K.E. is equal.
Ex. Roller coaster
Spring/ rubber band
pendulum

Electricity: The flow of electrons

The electrical force is a universal force that exists between a positive charged objects and negatively charged objects.

POS repels POS
POS attracts NEG
NEG repels NEG

Ways electrons move-

Friction- transfer electrons between 2 objects
Ex: rubbing a balloon

Conduction

-Direct contact between 2 objects
-Electrons move from one object to the good conductors, electrons move easily.
-Bad conductors(insulators), electrons move poorly.

The amount of conduction depends on the conductor.

Induction: The rearranging of electrical charges inside an object.

Current-the flow of electron through a wire or any conductive material.

Direct Current (DC) current flows only in one direction.

Alternating Current (AC) Current flows back and forth changing directions regularly

Electric Current- the rate at which electrons pass a given point at a given time. Measured in Amperes.
Tool: Ammeter

Electrical Potential Difference: The amount of work that is required to move a charge between two points.
-Work per unit
-Potential difference unit volts
-Can be positive or negative depending on the direction of the charge
Tool to measure: Voltmeter

Resistance: is the opposition of the flow of electric currents
-Measured in ohms

Resistance depends on:
-Types of material in the wire.
-Thickness of the wire
-The length of the wire
Tool: Ohmmeter

Ohms Law- States that the current in a wire (I) is equal to the voltage (V) divided by the resistance.

Formulas **Current =** $\frac{\textbf{voltage}}{\textbf{resistance}}$ **or** $I = \frac{V}{R}$ **or** **Amperes =** $\frac{\textbf{volts}}{\textbf{ohms}}$

Circuits

A circuit is a closed path through which electricity flows.

- Circuits can be wire or any conductive material.
- The flow of electrons through the circuit is called current.

Circuits are composed of the following:

- A source of energy
- A load of resistor (lights or other electrical device)
- wire
- Switch

Closed Circuit- switch is closed electron is complete and current can flow.

Open Circuit- Switched open the electron path is not completed and the current can not flow.

Series circuit- Only one path for the current to flow.
Ex. Old x-mass lights, if one light goes out they all go out.

Parallel Circuit- Has separates paths that allow the current to flow to each electric device independently.

Waves

A **wave** is any periodic disturbance in a material which travels from one region to another.

Two major types:
-**mechanical**: these waves must travel through a material or medium
examples: rope
spring
water

-**electromagnetic**: these waves can travel through a vacuum at the speed of light
examples: radio, TV, radar
infrared, visible light, ultraviolet

Speed of light: 30,000,000 meters/second or 186,000 miles/second.

Wavelength ( ): Distance from crest to crest or trough to trough
Crest: Highest point of the wave
Trough: Lowest point of the wave
Amplitude: the distance above or below the x-axis

Types of Waves

Transverse waves: A wave where the motion of the medium is at a right angle to the direction of the wave.

Longitudinal waves: A wave that consists of a series of compression and rarefaction waves move back and forth.

Compressions: A crowding together or packing of molecules or particles at the crest of a wave.

Rarefaction: An area in the wave trough where molecules are spaced out and less dense.

Frequency: The number of complete wavelengths that pass a point in a given time.
Measured in hertz (Hz)
1 Hz = 1 wave/sec.

Period: the number of seconds that it takes for one wavelength to pass a certain point.
-mathematical opposite to wavelength

$$\textbf{period} = \frac{\textbf{1}}{\textbf{Frequency}}$$

$$\textbf{T} = \frac{\textbf{1}}{\textbf{F}}$$

The wave equation

$$\mathbf{V = f \times \lambda}$$

V = velocity
f = frequency
λ = wavelength

ex. 3 waves with a wavelength of 2 meters pass a point in a second of time

V = (3 Hz) (2m) = 6 m/s

Amplitude: measures the maximum displacement of a wave from the rest position or x-axis. Amplitude measures the amount of energy in a wave.

Ex. A wave with a large amplitude will carry a surfer farther.

- In sound waves amplitude is measured by the movement of the object making the wave. (how far the speaker come moves in and out)
- In a light wave, amplitude is measured as the maximum strength of the electric or magnetic field producing the waves

Reflection: A partial return of a wave pattern off an object in its path.
Ex.: -wave in a string bounces back when tied to a door knob
- sound will echo
- waves will angle if surface is not parallel to the incoming wave

Refraction: the bending of a wave pattern as it enters a new substance
Ex.: light as it goes from air to water
-Pencil
-Swimmers leg
The bending of light waves is color dependant
Ex. Rainbow

Interference: An interaction between waves in the same space at the same time that increases or decreases the amplitude.
Constructive interference: increase in amplitude
Destructive interference: decrease in amplitude

Diffraction: A bending of a wave around an obstacle

Doppler effect: The difference in frequency from a sound source when the listener or the source is moving

MAGNETISM

Electricity & Magnetism- are two aspects of a single electromagnetic force. This relationship is called electromagnetism.

Electromagnet- are coils of copper wire around a soft Iron Core. Increasing the current through the wire can increase the electromagnet.

Magnetism- is a property of matter. POLES

Pos repels Pos
Neg repels Neg
Neg attracts Pos

Magnetism is the strongest at the Poles!

Magnetic Field- The area around the magnet where the magnetic force acts.

- A magnet is composed of magnetic domains: which are groups of magnetically aligned atoms.
- In regular metals the alignment is random, but if you rub the metal onto two permanent magnets they will line up when placed in a strong magnetic field.
- A magnet can become ruined if heated or dropped.
- Magnets are made up of metals such as, iron, nickel and cobalt, or combination of all three, called alnico.

Magnets in your home:

- Microwave, Clocks, Motors, Stereo, Speakers (like big ones), Televisions