Chapter One

Matter & Mass

Matter

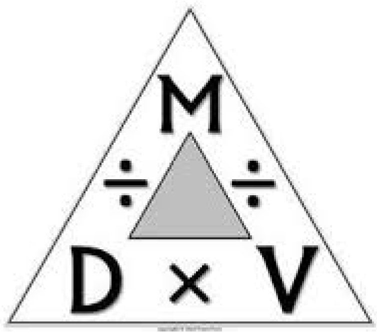
Matter is anything that takes up space and has mass

Examples include water, planets, and atoms

Density

Density (D) is the Mass (M) per unit of Volume (V); how packed molecules are

Density (kg/m^3) is equal to Mass (kg) divided by volume (m^3)



Law of Conservation of Mass

In an isolated system (enclosed space) mass can be neither formed, nor destroyed through chemical reactions and physical transformations, but will remain constant.

Classification of Matter

Properties of Types of Matter

Atoms: The smallest part of an element that retains its chemical properties.

Elements: A substance where all atoms of the substance share the same properties.

Compounds: A substance which is made up of two or more different elements.

Mixtures: A material that is made up of two or more different substances that are physically mixed together, and can be separated physically.

Pure and Impure Substances

A **pure** substance is a substance that is made up of only one type of molecule. For example: An Oxygen or Water.

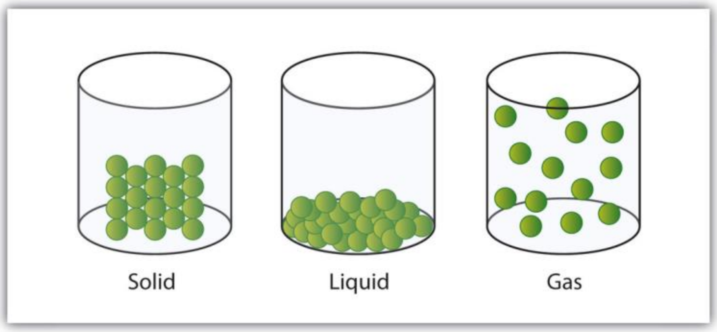
An **impure** substance is a substance that is made up of two or more different molecules. For example: Air or Salt Water.

States of Matter

Solid: High density and resistant to changes: For example: Rock

Liquid: Medium density fluid that maintains its volume. For example: Water

Gas: Low density fluid that can change its volume. For Example: Air



Particle Arrangement

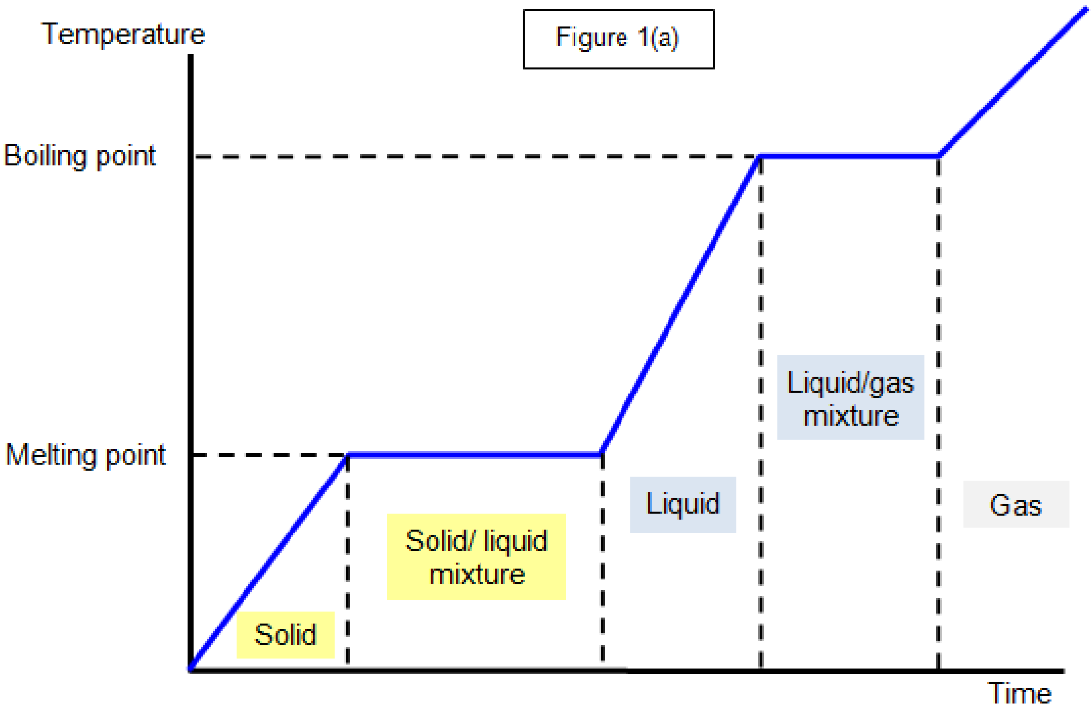
STP and Gas Volume

STP stands for Standard Temperature and Pressure, which is the state of an enclosed system when the temperature is *0*˚C, and the pressure is 1 atm (the pressure of the atmosphere at sea level).

At STP, one mole, a unit of mass specific to a substance, of a gas takes up 22.4 liters of volume.

Standard Ambient Temperature and Pressure (SATP) is the same as STP with following difference: the temperature is considered *25*°C, and the molar volume of gas at SATP is 24.8 liters.

Changes of State



When a substance is heated up, its molecules move faster with greater energy. The resulting increase in collisions causes the substance to move farther away from one another, becoming less dense.

Kinetic Theory

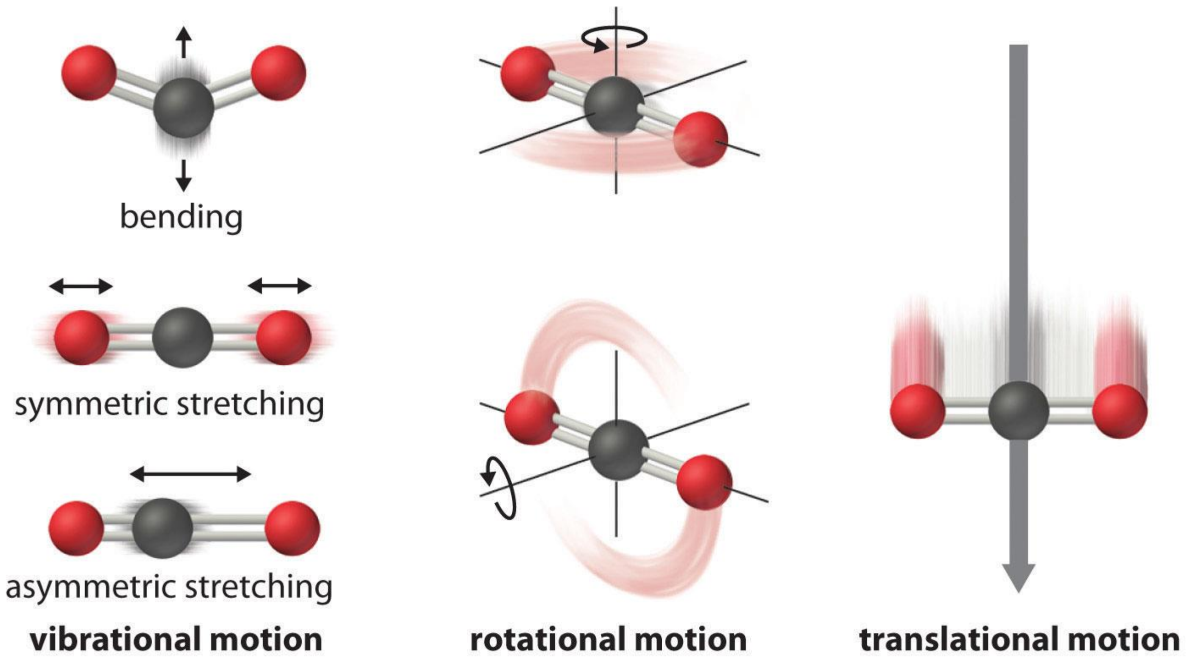
Definition: There are 2 parts to kinetic theory

1. the temperature of a substance increases with an increase in either the average kinetic energy of the particles or the average potential energy of separation (as in fusion) of the particles or in both when heat is added
2. the particles of a gas move in straight lines with high average velocity, continually encounter one another and thus change their individual velocities and directions, and cause pressure by their impact against the walls of a container

Relation to Temperature

According to part one, an increase in average kinetic energy or average potential energy as well as an increase in temperature will occur if heat is added. This means that an increase temperature and average energy both occur simultaneously, so they will be proportional to one another.

Particle Movement



Diffusion

Definition

The movement of a fluid from an area of higher concentration to an area of lower concentration.

Factors that Affect Diffusion

Temperature: An increase in temperature increases the rate of diffusion as it increases the energy of the particles, enabling them to move faster.

Concentration Difference: A higher concentration difference will result in a faster rate of diffusion, as a lot more diffusion needs to take place.

Diffusion Distance: The shorter distance the particles have to move, the faster they will be able to diffuse.

Mass of the Molecule: The more mass a molecule has, the rate of diffusion will decrease, as greater mass means that more energy is required to move it.

Terminology and Skills

SI Units: These are the units used for all calculations and investigations in chemistry:

Length - meter (m)
Time - second (s)
Amount of substance - mole (mole)
Electric current - ampere (A)
Temperature - kelvin (K)
Luminous intensity - candela (cd)
Mass - kilogram (kg)

Parallax Error

This happens when you measure with your eyes at a different perspective causing you to get the wrong reading.
Always ensure that the measuring cylinder is placed on a flat surface and crouch down to ensure that you are at eye level with the measurement.

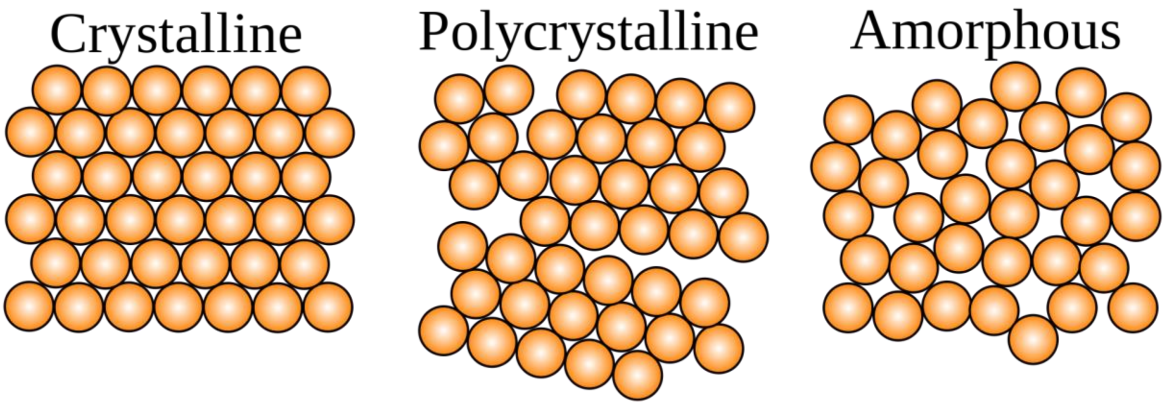
Meniscus

The effect when a liquid forms a small curve at the top in beaker where it’s meant to be measured. Measure from the middle of the curve to get the right reading.

Chapter Two

Matter

Arrangements of Matter



Impure Substances

A **homogeneous** substance is a substance from which all samples taken will have the same properties

A **heterogeneous** substance is a substance from which all samples taken will not have the same properties.

A **pure** substance has one melting point and one boiling point, whereas an impure substance will have different melting and boiling points for each of the different molecule within it.

Phases

Definitions

Solute: The minor component in a solution, dissolved in the solvent.

Solvent: The liquid in which a solute is dissolved to form a solution.

Phase: A physically distinctive form of matter with uniform properties

Suspension: A state in which larger particles are dispersed throughout a fluid, which eventually settle and form layers.

Colloid: A state in which smaller particles are dispersed throughout a fluid.

Gel: A dispersion of liquid molecules in a solid.

Emulsion: A mixture with two substances that originally don't mix but bind together with the aid of a chemical agent (emulsifier).

Miscible V/S Immiscible

Miscible substances are substances that are able to form a solution with one another, whereas immiscible substances cannot.

Emulsifiers

An emulsifier is a chemical agent that is used to make immiscible substances form a solution. This is done by binding the two substances to different ends of the emulsifier.

For example, water and oil are immiscible, but if one end of an emulsifier bonds to water (hydrophilic end) and the other bonds to oil (hydrophobic end) then a solution will be made.

Separating Substances

Definitions

Filtrate: The product of filtration

Residue: What is left after filtration takes place.

Distillate: The vapor collected in distillation which is then cooled to form a liquid.

Volatile: When a substance can easily undergo a change from liquid into a gas.

Methods of Separation

Decantation: Separating a solid + liquid mixture by pouring out the liquid and leaving only the solid.

Evaporation: Heating up a solution so that the solvent of the solution evaporates and leaves the solute in the container.

Vaporization: Heating up the solid/liquid to turn it into a gas.

Filtration: Using a funnel and filter paper over a beaker, place a solid + liquid mixture in the funnel, and only the liquid will pass through.

Separation Funnel: Place a suspension of 2 liquids in a separation funnel, the higher density liquid will sink to the bottom and will flow through the funnel.

Distillation: Attached to a Liebig condenser with cold flowing water, heat up (its boiling point) mixture and collect the condensed vapor on the other end of the Liebig condenser. For example, take a solution of alcohol and water, with a boiling point of 70 and 100 degrees respectively. In order to separate the two solutions, the mixture is heated to boiling point. Alcohol will soon reach the boiling point and will evaporate. Leaving behind water molecules. The evaporated solution is condensed and collected through a Liebig condenser. Hence both elements are separated.

Chromatography: Place a small spot of the ink 2cm from the bottom of a piece of paper, and suspend the paper so that the bottom 1cm is in the water in a beaker.

Retardation Factor

The retardation factor is the distance moved by the sample divided by the distance moved by the solvent (water).

Dialysis

Definitions

Diffusion: When a fluid moves from an area of high concentration to an area of low concentration.

Osmosis: When a solvent (water) moves from an area of high concentration to an area of low concentration through a semi - permeable membrane.

Semi - permeable: A barrier that only allows certain substances to go through it.

Dialysate: The part of a mixture that flows through the membrane in dialysis.

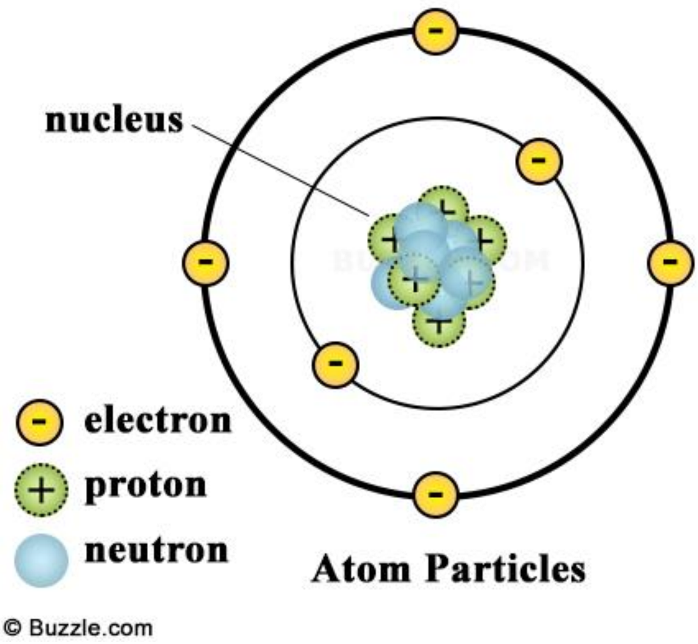
Process

1. Either the bloodstream gets connected to a dialysis machine or a dialysis fluid is pumped into the abdominal area.
2. The machine or the dialysis fluid diffuses out the toxins from the blood into it through osmosis.
3. Since the toxin is a solvent, and there is a lower concentration of the toxin in the dialysis fluid or the machine, then osmosis takes place.

Chapter Three

Atomic Structure

Atom



Definitions

Mass Number (A): The relative mass of an atom of an element

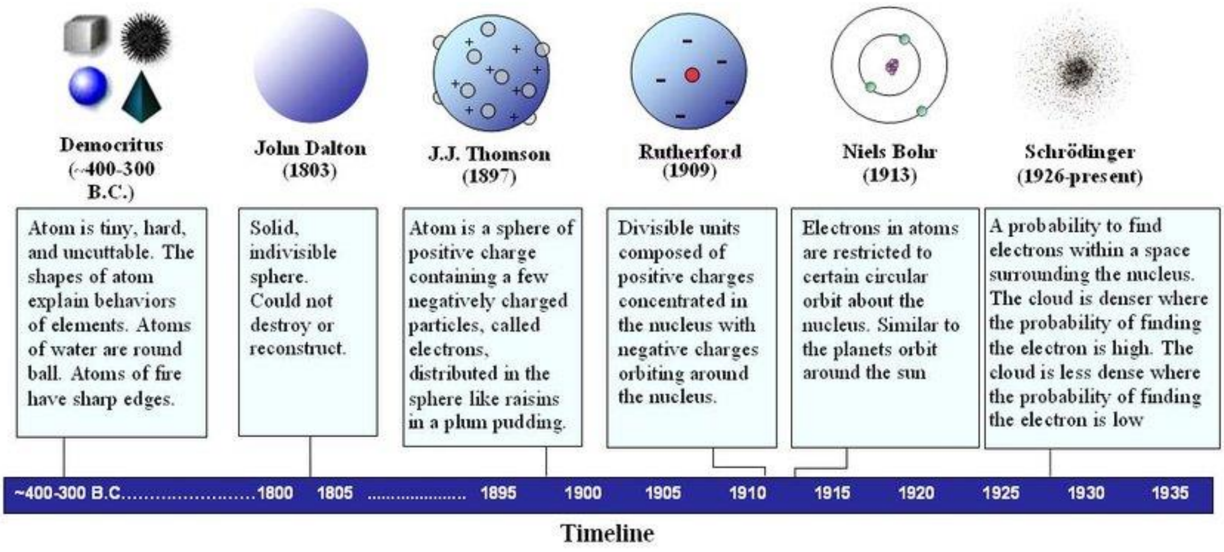
Atomic number (P): The amount of protons per atom of that element

Subatomic Particles

Subatomic Particle	Relative Mass	Relative Charge
Proton	1	1
Electron	0 (negligible amount)	-1
Neutron	1	0

Valence is the amount of electrons in the outer shell of the atom

Atomic Models



Isotopes

Definition

An atom that has more or less neutrons in its nucleus than normal, and therefore has a change in atomic mass but not atomic number.

Examples and Uses

Heavy Water: Water made up of oxygen and isotopes of hydrogen (H-1, H-2, and H-3) is used to slow down neutrons in order to increase the likelihood of a nuclear reaction.

Uranium 235: Used as an energy source in a nuclear power plant.

Relative Atomic Mass based on Abundance

Average Relative Atomic Mass = ((Mass of Isotope 1 * Percentage Abundance) + (Mass of Isotope 1 * Percentage Abundance)) / 100

The Periodic Table

Terminology

Group: All elements in a group share the same number of valence electrons

Period: All elements in a period share the same number of shells

History of the Periodic Table

Lavioser: Discovered the role oxygen plays in combustion, developed a method for naming compounds

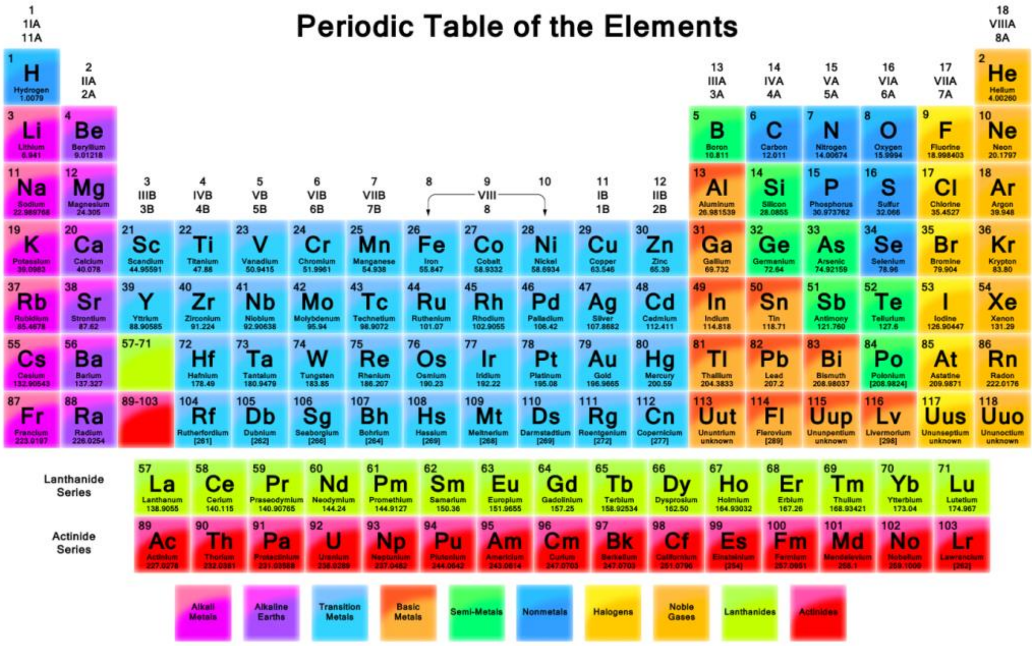
Dobereiner: Discovered that the relative atomic mass of the middle element in a group is close to the average relative atomic mass of the other two (there were only three elements placed per group at the time).

Newlands: Discovered that the element eight elements after another element is similar when arranging elements based on relative atomic mass.

Mendeleev: Arranged them similarly to Newlands but left spaces for undiscovered elements as they were not discovered yet but were theorized to have similar properties to others in the group.

Moseley: Ordered the periodic table based on atomic number, not atomic weight.

Modern Periodic Table:

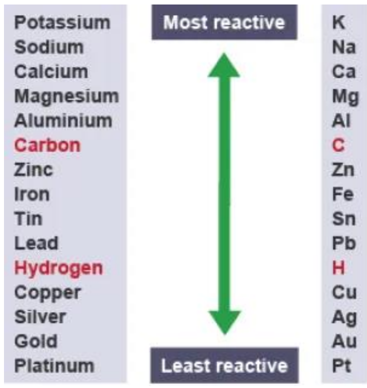


Metals & Non-Metals: Properties

Metals	Non-Metals
Lustrous	Dull
Malleable	Non-Malleable
Ductile	Non-Ductile
Good Conductor of Heat/ Electricity	Bad Conductor of Heat/ Electricity
Solid at Room Temp (except mercury and gallium)	Solid/ Liquid/ Gas at Room Temp
High Density	Low Density
Positive Ions (Cations)	Negative Ions (Anions)
Hard	Brittle
Sonorous	(metalloids have properties from both columns)

Metal Extraction

- Metals are listed on what's known as the reactivity series, a list that describes which metals are more reactive than others.
- Metals that are less reactive than carbon can be extracted by having carbon replace them in whatever compound they are currently in.
- Metals that are less reactive hydrogen are considered ‘native,’ and do not need to be extracted.
- Metals above carbon need to be extracted through electrolysis, through the use of special bacteria, which then release leachate solution, which contains the extracted metal. Electrolysis drives chemical reactions through the use of currents.



Groups in the Periodic Table: Properties

Group 1	Group 7	Group 8
Good conductor of electricity	Highly reactive with metals	Does not react at all
Malleable	Different states at room temperature	Gas at room temperature

Trends

Group 1	Group 7	Group 8
Atomic radius gets larger as you go down the group		
MP and BP go up as you go down the group		
More reactive as you go down the group	Less reactive as you go down the group	Non-reactive

Ions and Valence

Groups 1, 2, 3

Group 1: Forms +1 ions
Group 2: Forms +2 ions
Group 3: Forms +3 ions

Groups 5.6.7

Group 5: Forms -3 ions
Group 6: Forms -2 ions
Group 7: Forms -1 ions

Compounds

All compounds have a charge of 0

Transition Metals

Transition metals can sometimes have different charges
For example, iron can have a +2 or +3 charge, shown as iron (II) or iron (III)

Polyatomic Ions

Ions made of 2 or more atoms
Common Polyatomic Ions:

Formula	Polyatomic Name	Charge
SO_4	Sulphate	-2
CO_3	Carbonate	-2
CrO_4	Cromate	-2
NO_3	Nitrate	-1
OH	Hydroxide	-1
CN	Cyanide	-1
ClO_3	Chlorate	-1
HCO_3	Hydrogen carbonate	-1
PO_4	Phosphate	+3
NH_4	Ammonium	+1

Chapter Four

Balancing Equations

Law of Conservation of Mass

In any chemical reaction, mass cannot be created or destroyed.

Rules of Balancing Equations

There should be the same proportion of each element on each side of the equation.

Ionic Bonding

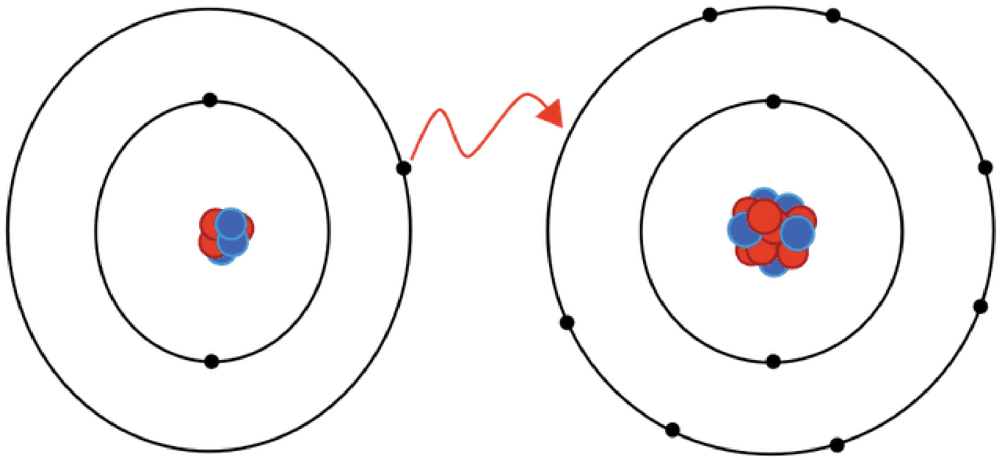
Ions

- Ions are atoms that are positively or negatively charged. When electron transfer happens, atoms have more or less electrons than protons, making them ions.
- AnIons: Negatively charged Ions
- CatIons: Positively charged Ions

The Process

All atoms want to have a full outer shell. Ionic bonding occurs when atoms exchange electrons with each other to fulfill this. Because one atom loses an electron, making it positively charged, and vice versa for the other atom, they are attracted to each other, and therefore they bond. This happens between metals and non-metals.

Diagram



Covalent Bonding

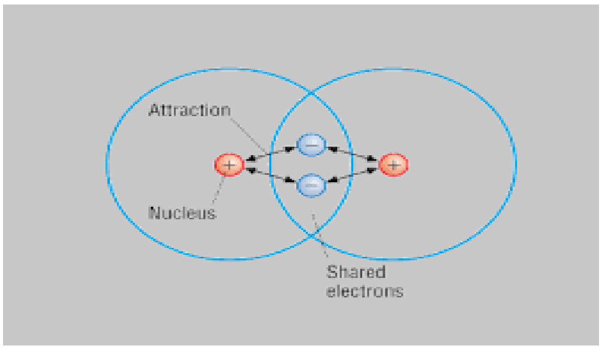
The Process

Covalent bonding is the sharing of electrons for atoms to fill each other's outer shells. The positive nucleuses are attracted to the shared electrons, thus they become a bond.

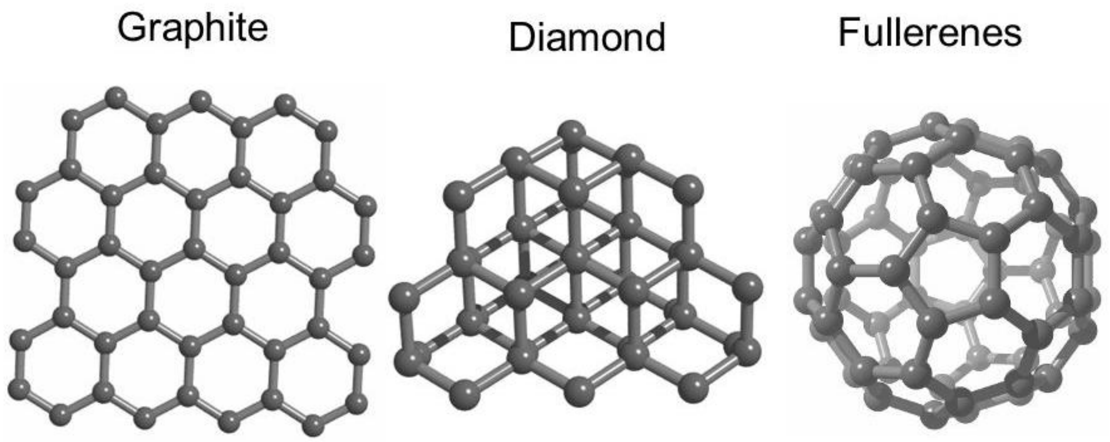
Single, Double and Triple Bonds

Single bonds occur when there is a single pair of electrons shared (2 electrons)
Double bonds occur when there is a double pair of electrons shared (4 electrons)
Triple bonds occur when there is a triple pair of electrons shared (6 electrons)

Diagram



Carbon Allotropes



Allotrope	Appearance	Conductivity	Hardness	Density	Uses
Graphite	Black and Opaque	Good Conductor	Soft, slippery	Low	Batteries, Pencils, Lube
Diamond	Transparent	Poor Conductor	Very Hard	High	Jewelry, Machinery

Simple and Giant Covalent Structures

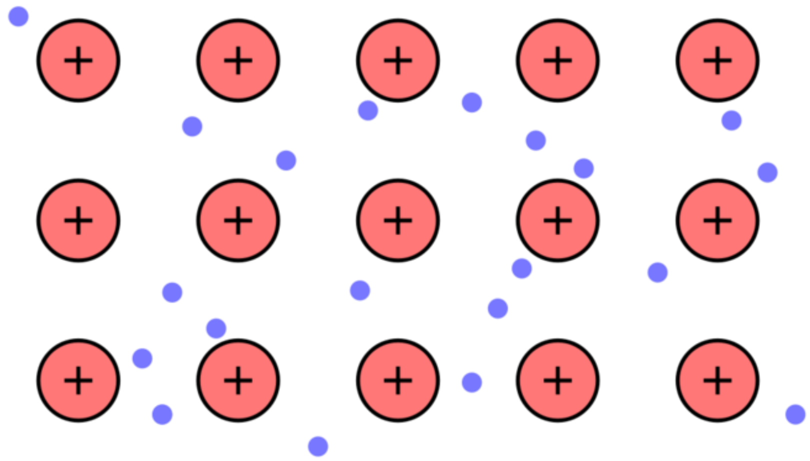
Simple covalent structures are made up of individual molecules. Giant covalent structures consist of rigid 3D lattices where atoms are held in place

Metallic Bonding

The Process

Atoms share delocalized electrons which float around in a ‘sea of electrons.’ Since the atoms have lost electrons, they become **Cations.** The positively charged atoms are attracted to the negatively charged delocalized electrons. The atoms form a grid.

Diagram



Properties of Metals

Conductive, as the delocalized electrons are free to move and have a charge
Malleable, as the metals form layers, which are easy to bend
Ductile, as the metal forms layers, which can be stripped off

Skills

Properties of Substances

The properties of a substance can be linked to what kind of compound it is, for example, since oxygen is a covalent bond, it cannot conduct electricity, as it has no free-to-move charged particles.

Types of Molecular Forces

Intermolecular Forces: Forces that take place between multiple molecules

Hydrogen Bonding - Is an electrostatic attraction created between covalently bonded hydrogen atom to an electronegative atom (Oxygen, Fluorine, and Nitrogen). This creates strong dipoles that can then interact.

Dipole-Dipolele Action - Different atoms have different electronegativity values hence dipoles are created as the shared electron are more attracted to one side.

London Dispersion Forces- These are temporary dipoles created in a molecule through the movement of electrons. Often large molecules have very strong diples created by LDF's; this is cause they have many electrons.

Intramolecular Forces: Forces that take place within a molecule

Lewis Structure -

https://www.dummies.com/education/science/chemistry/drawing-lewis-dot-structures-for-chemistry/

Chapter 5

Acid and Alkalis

- There have been multiple different definitions over the time. Although, keep in mind that they are all correct with the scope increasing:

    - The most basic is the Bronsted Lowry definition that describes an acid as an H+ donor or give an H+, while a base is something which accepts that H+.
    - While on the other hand Leview describes base is something that can donate a lone pair of electrons, while an acid is something which can accept the lone pair.
    - Finally you have something which is known as an Arrhenius acid/base. This is something which when dissolved in water form H+ while a base when dissociates does increase the OH concentration of the solution.

	Acid	Name	pK_a	Conjugate base	Name	
Weaker acid	CH_3CH_2OH	Ethanol	16.00	$CH_3CH_2O^-$	Ethoxide ion	Stronger base
	H_2O	Water	15.74	HO^-	Hydroxide ion	
	HCN	Hydrocyanic acid	9.31	CN^-	Cyanide ion	
	$H_2PO_4^-$	Dihydrogen phosphate ion	7.21	HPO_4^{2-}	Hydrogen phosphate ion	
	CH_3CO_2H	Acetic acid	4.76	$CH_3CO_2^-$	Acetate ion	
	H_3PO_4	Phosphoric acid	2.16	$H_2PO_4^-$	Dihydrogen phosphate ion	
	HNO_3	Nitric acid	−1.3	NO_3^-	Nitrate ion	
Stronger acid	HCl	Hydrochloric acid	−7.0	Cl^-	Chloride ion	Weaker base

- Acid V/S Bases V/S Neural
    - Together with multiple definition of Acid mentioned above, it is classified on basis of the pH scale. The pH scale basically shows the concentration of H+ ions. So the lower the pH number, the higher the concentration. Hence an inverse relationship exists between pH and acidity
    - A base is something which has a low amount of H+ ions or is not very acidic. It is when the pH scale is above 7.
    - Finally neutral is 7 where you have the same amount of acid and bases.

- Strong V/S Weak Acid and Bases
    -

Strong	Weak
They normally tend to have a much larger K value. This is because of the equilibrium favoring the right side.	They tend to have a much lower value as they do not dissociate much due to the fact they are not very polar.
More conductive	Less Conductive due to the fact that less ions dissociate

Takes a larger volume of the opposite, base -acid or vice versa to neutralize using titrations.	Takes a small volume the opposite, base - acid or vice versa to neutralize using titrations.
Often react much faster	Reacts much slower

- Concentrated V/S Strong Acid
  - A concentrated acid means that there are more molecules per volume; however, it does not share the same properties of a Strong acid as mentioned above. A concentrated weak acid can have the same pH as a strong acid. This is because pH measures the concentration of H+ ions.

Neutralization

- Neutralization is a chemical reaction in which an acid and a base react quantitatively with each other. This often leads to the production of a salt
- There are multiple different types of acid-base reactions. However, the basic reactions are:
  - Acid + Base ---> Salt + Water
    - $HCl + NaOH \text{ ---> } H_2O + NaCl$
    - $H_2SO_4 + KOH \text{ ---> } H_2O + K_2SO_4$
  - Acid + Metal ---> Hydrogen Gas + Salt
    - $HBr + Mg \text{ ---> } H_2 + MgBr_2$
    - $HNO_3 + Zn \text{ ---> } H_2 + ZnNO_3$
  - Acid + Metal Hydroxide ---> Salt + Water
    - $Mg(OH)_2 + HCl \text{ --->} MgCl_2 + H_2O$
    - $Zn(OH)_2 + HCl \text{ ----> } ZCl + H_2O$
  - Acid + Metal Oxide ----> Salt + Water
    - $MgO + HNO_3 \text{ -----> } Mg(NO_3)_2 + H_2O$
    - $ZnO + H_2SO_4 \text{ -----> } ZnS_2 + H_2O$
  - Acid + Metal Carbonate ----> Carbon Dioxide + Salt + Water
    - $CuCO_3 + 2HNO_3 \text{ ---> } Cu(NO_3)_2 + H_2O + CO_2$
    - $ZnCo_3 + H_2SO_4 \text{ ---> } ZnSO_4 + H_2O + CO_2$
- There are multiple uses of Neutralization in industries such as:
  - Treatment of wasp stings
    - These stings are traditionally very basic. Although, applying something acid-like vinegar neutralizes them.
  - Toothpaste
    - When you eat throughout the day acidic and basic food goes in and out of your mouth. Hence, when you brush your teeth one of the main jobs of tooth paste is to neutralize what is present and create a buffer. A buffer basically is something that resist pH changes meaning that adding acid will not change the pH significantly.
  - To combat acidification
    - In farming there is something known as acid soil; this often leads to less plant growth and yield. In order to combat this issue farmer often use a basic substance, to neutralize the soil after acid rain.

Chapter 6

Mole

- Much like the word *dozen,* a mole represent a certain amount of a substance. Mole is basically 6 * 10^26 of anything. This is often used to convert between amu (atomic mass units) and grams. Additionally, it is a convention and used in experiments.
    - A formal definition is that mass of substance containing the same number of fundamental units as there units as there are atoms in exactly 12.00g of carbon - 12
- A mole ratio is the ratio between the amounts in moles of any two compounds involved in a chemical reaction. Mole ratios are used as conversion factors between products and reactants in many problems.
- A few definitions
    - <u>Mass Number</u>: The total number of protons and neutrons in a nucleus
    - <u>Relative Atomic Mass</u>: The ratio of the average mass of one atom of an element to one twelfth of the mass of an atom of carbon - 12
    - <u>Relative molecular mass</u>: the ratio of the average mass of one molecule of an element or compound to one twelfth of the mass of an atom of carbon-12.
    - <u>Solute:</u> The minor component in a solution, dissolved in the solvent. Or in other words; it is the smaller part of the solution.
    - <u>Solvent:</u> Is the part of the solution in which the solute is dissolved. Or is the part of the solution present in greater amounts
    - <u>Solution:</u> A mixture of solvent and solute.

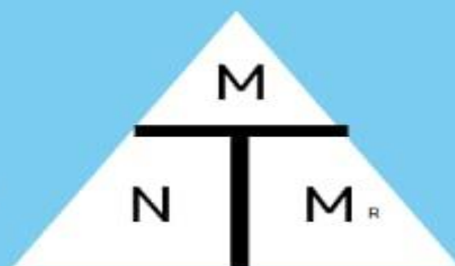
Common Equations

MOLE EQUATION

By Rishi

MOLES - SOLID

This equation is most often used in order to convert between moles and grams. The conversion between moles and grams is important. As in a lab you might be given grams although moles is used for calculations.



MOLES-LIQUID

This equation is used when calculating the amount of moles of some substance is need to make a liquid with a certain concentration. This can be combined with the mass formula to find grams

MOLES-GAS

This is often used to calculate the amount of moles of gas present in STP. This can be used in gas equation or mixed with the first formula to find mass then be used to get density.

Percentage Composition/ Limiting Reactant

- Percentage Composition
  - Percentage Composition is a technique in chemistry in which a certain elements mass is calculated from the complete element.
    - The formula for percentage composition is Mass/ Total mass * 100
- Limiting Reactant
  - Limiting reactants are important to calculate as they are used when forming mole ratios.
  - There are a few steps when calculating limiting reactants
    - Balance the equation for the chemical reaction.
    - Convert the given information into moles.
    - Use stoichiometry for each individual reactant to find the mass of product produced.
    - The reactant that produces a lesser amount of product is the limiting reagent.
    - The reactant that produces a larger amount of product is the excess reagent.
    - To find the amount of remaining excess reactant, subtract the mass of excess reagent consumed from the total mass of excess reagent given.
- Empirical Formula is the smallest Ratio while molecular formula is when the equation is not simplified.

Examples

Mass : https://www.youtube.com/watch?v=7Cfq0ilw7ps

Molarity : https://www.youtube.com/watch?v=-4E6rOkiw2I

Chapter Seven

Isotopes

Definition

An atom of an element which has more or less neutrons

Examples and Uses

Carbon-14, used for carbon dating organisms for archeology.

Stable isotopes used are markers to find migratory patterns

Average Relative Atomic Mass

Average Relative Atomic Mass = $\frac{(Mass\ 1 \times \%\ Ab1) + (Mass\ 2 \times \%\ Ab2) + (Mass\ 3 \times \%\ Ab3)\ldots}{100}$

% Ab = Percentage Abundance

Notation

(Element)- (Atomic Mass)

For example: Oxygen-17

Radioactivity

Stable V/S Unstable

Stable nuclei are those which do not undergo radioactive decay

Unstable nuclei are those which do undergo radioactive decay, as they have an excess of internal energy. If they actively release radiation, they are radioactive, hence unstable.

Definitions

Decay Series: The series of decay in which radioactive element is decomposed in different elements until it produces one stable atom.

Parent Isotope: The isotope that decays

Daughter Isotope: The isotope that is formed after the decay

Half-Life: The time it takes for the radioactivity of an unstable isotope to become half.

Trans-uranium Element: Any element that lies beyond Uranium on the periodic table.

Types of Decay

Alpha: When the isotope releases 2 neutrons, 2 protons and 2 electrons, forming a helium-4 atom.

Beta: When the isotope releases a high speed, high energy electron from its nucleus, and a neutron turns into a proton.

Gamma: When the isotope releases a high amount of energy in the form of gamma radiation.

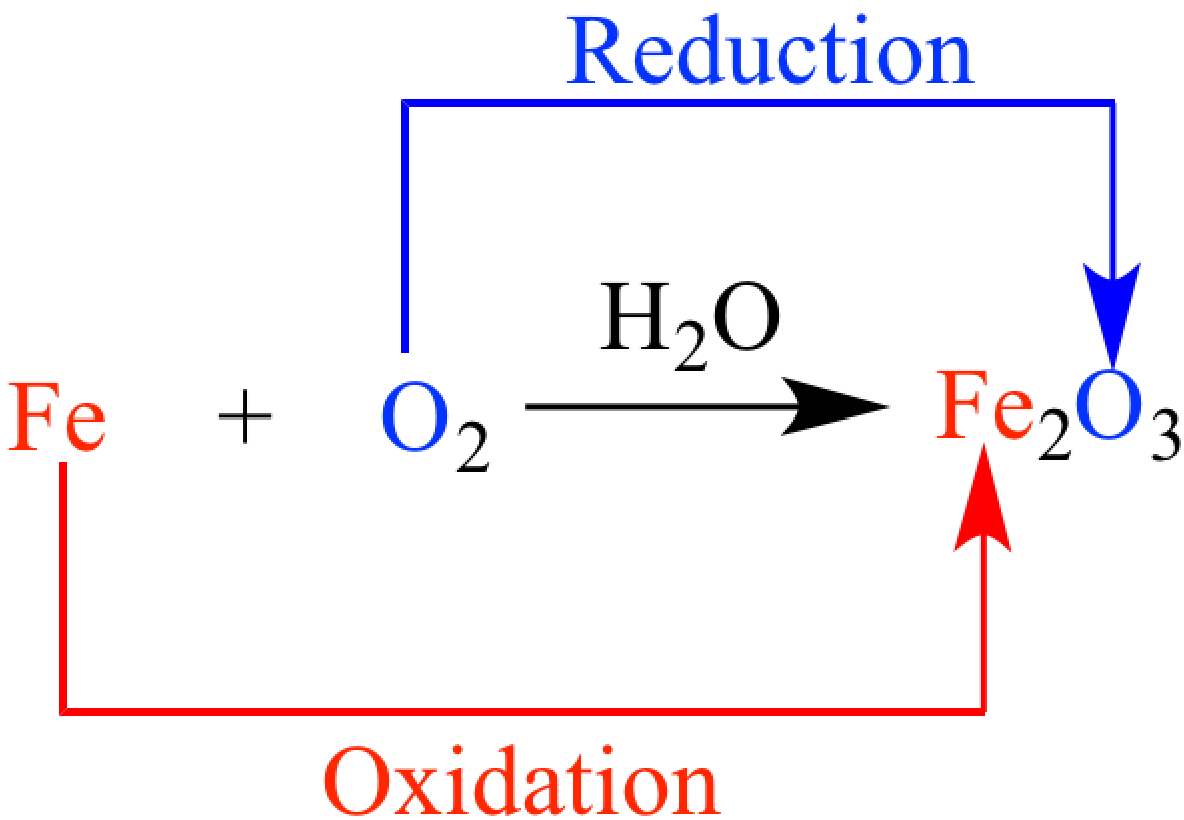
Geiger counter

A Geiger counter is an instrument that measures the radiation of an area. It is used to make sure that an area is habitable and safe to enter.

Chapter 8

Redox

- Definitions
  - **Reduction**: A reaction that involves the gaining of electrons by one of the atoms involved in a reaction, or two or more chemical species. Oxidation of that element is lowered.
  - **Oxidation**: Is the loss of electrons during a reaction by a molecule, atom or ion. When oxidation happens the oxidation state of the molecule increases.
  - **Reducing Agent:** This is an element or compound that loses/donates an electron to another chemical species in a redox chemical reaction.
  - **Oxidizing Agent**: Is a substance that has the ability to oxidize other substances. In other words, it is the one that gains electrons.
  - **The oxidation number** is the charge on an element or molecule.
- Oxidation and Reduction can be remembered by the acronym OILRIG. Oxidation is loss of electron, while reduction is the gain of electrons.
- When trying to figure out which elements are oxidized and which are reduced by taking the following example:



- Let's break up the example above:
  - Firstly let's take the Iron (Fe). Before reaction it has an Oxidation number of 0

        - Then let's look at the O_2. It is diatomic. It even has an Oxidation number of 0
        - Finally let's take a look at the other side, where we have the element Fe_2O_3
            - We know this element has a total charge of "0".
            - Oxygen normally have a charge of -2, meaning that 3 oxygen have a total charge of -6
            - Iron has to be positive to cancel it out. So the iron in total has to have a charge of +6, hence one Fe equals to +3.
            - From this is can be concluded that oxygen is an oxidation agent, while iron is the reducing agent.

- Half equations an example would be:

$$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$$

$$2Ag^+(aq) + 2e^- \longrightarrow 2Ag(s)$$

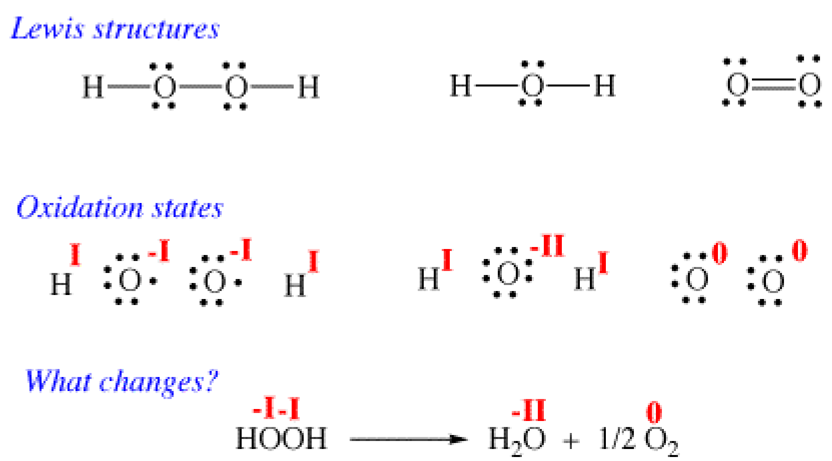
$$Cu(s) + 2Ag^+(aq) + 2e^- \longrightarrow Cu^{2+}(aq) + 2Ag(s) + 2e^-$$

or

  - $$Cu(s) + 2Ag^+(aq) \longrightarrow Cu^{2+}(aq) + 2Ag(s)$$

- For a more detailed look at this can be seen on the Lewis structure level

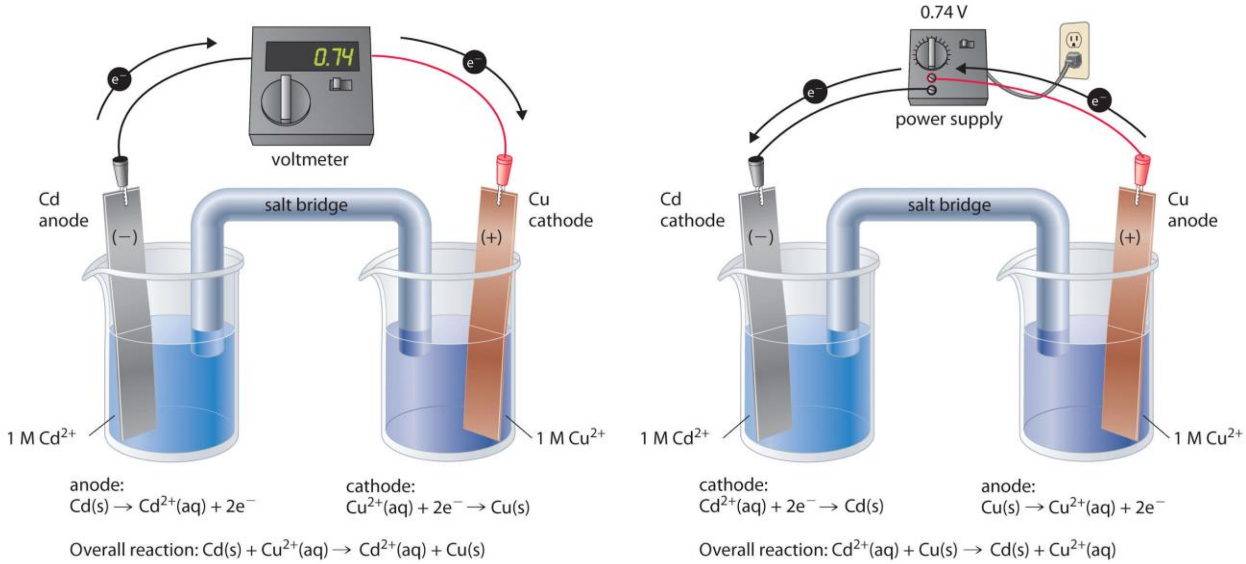
$$\mathbf{HOOH \longrightarrow H_2O + 1/2\ O_2}$$



Electrolysis

- Definitions
    - **Electrolysis:** Is the passing of direct electric current through an ionic substance that is either molten or dissolved in a suitable solvent, producing a chemical reaction at the electrode.
    - **Electrolyte**: Is a chemical compound that conducts electricity by changing into ions when melted or dissolved into a solution.
    - **Anode:** Anode is where oxidation takes place
    - **Cathode**: Where reduction takes place.

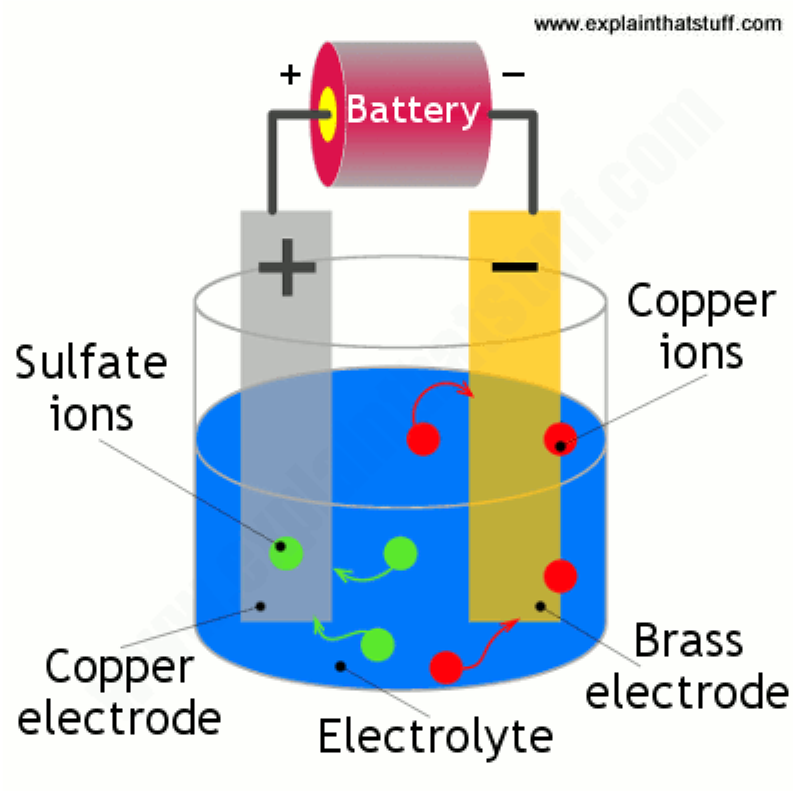
- **Corrosion**: is the irreversible damage or destruction of material due to a chemical or electrochemical reaction
    - **Reactivity series**: A series of metals from the most reactive to least.
    - **Ore:** A natural occurrence of a rock or sediment that contains sufficient minerals with economically important elements. Normally is combined with other elements.

- 

(a) Galvanic cell (b) Electrolytic cell
    - In the diagram above you have two examples: Galvanic cells & Electrolytic cells. Galvanic cells are spontaneous and no power is needed. While electrolytic cells require power as the reaction is not spontaneous.
    - Salt bridge is used to allow the current to flow
- Electrolysis cells function due to the difference in charge. Normally one of the metals is more electronegative than the other. Hence, the electrons get attracted to the more electronegative end (the Cathode.) The cathode will normally loose mass as it becomes more soluble. While on the other hand, Cu will increase in mass as it loses electrons.
- Metals are often found in ores hence extracting them has to take place. Electrolysis can be used to extract a more reactive metal from the ore. This can be done through a similar process as above where the metal gets plated.

Electroplating

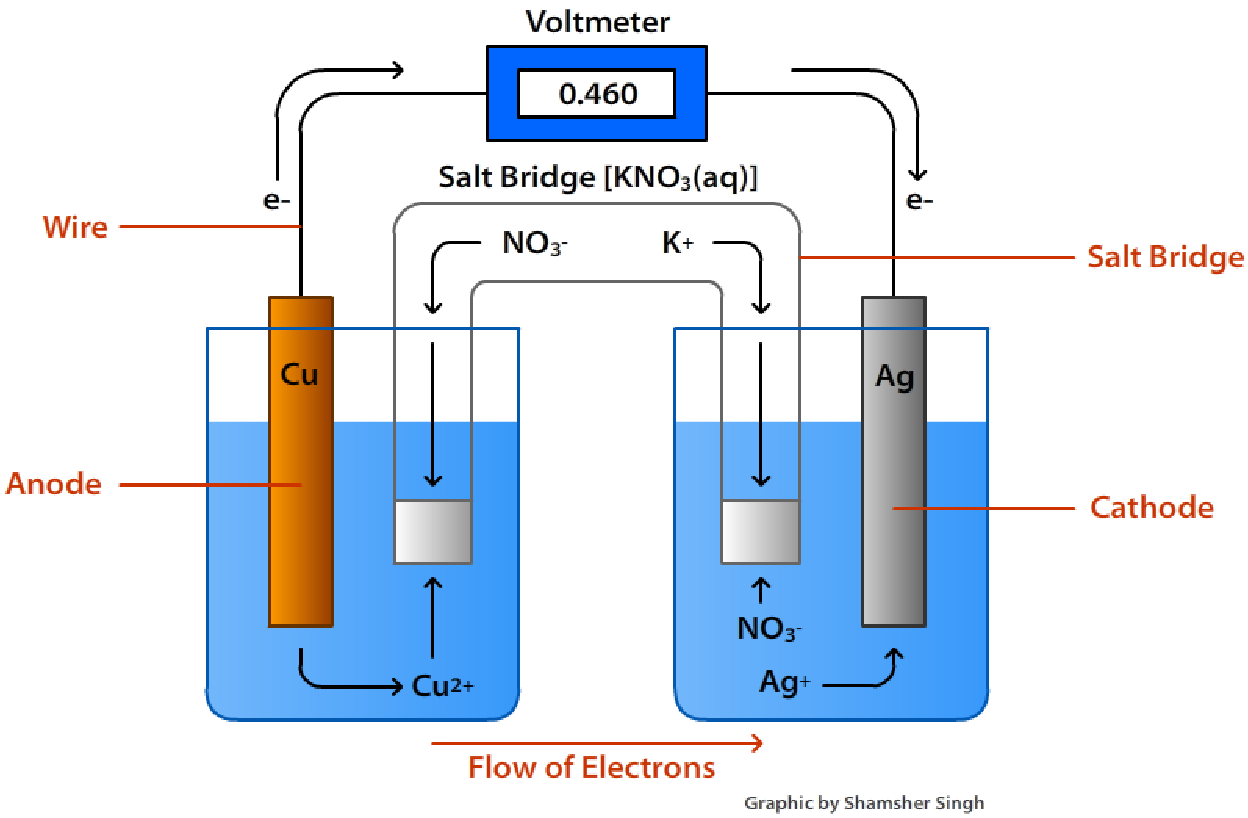
- Electroplating uses many of the same principles as mentioned above of electrolysis.
    - Firstly you have a solution known as electrolyte. Then in the solution two terminals are placed. They are known as electrodes (they can be anode and cathode). Then when electricity flows through the circuit the electrolysis solution start to split and plate on the cathode creating a thin layer.



- An industrial example of this is copper
  - There is a solution of copper containing compounds such as copper (II) sulfate. In the solution there is an anode made from impure copper and a cathode made from pure copper.
  - As the reaction takes place copper gets dissolved from the anode as it loses electrons, while the cathode gains mass of the deposited copper.
  - This can be seen through half-life reactions
    - Anode: Cu ---> Cu^{2+}+ $2e^-$
    - Cathode: Cu^{2+} + $2e^-$----> Cu
  - Half-life reactions are equations which show the oxidation and reduction taking place in a reaction.

Voltaic Cell

- Definitions
  - Salt Bridge: The purpose is to stop a reaction from reaching equilibrium too quickly. If salt bridge is not installed, then a high positive and high negative will accumulate on either side causing huge potential difference. Additionally, it helps to complete the circuit.
  - Half Cell: This is half of the normal cell normally consisting of one electrode.

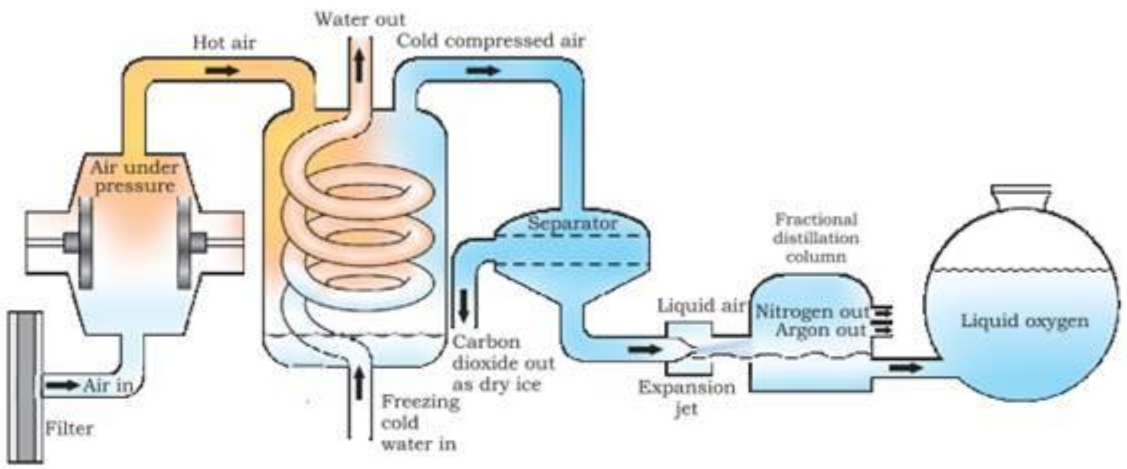


- As this is a spontaneous reaction, this means that for the flow of electrons no energy is needed. Moreover, the flow of electrons is electricity hence it produces electricity. An example of this would be the Baghdad battery.

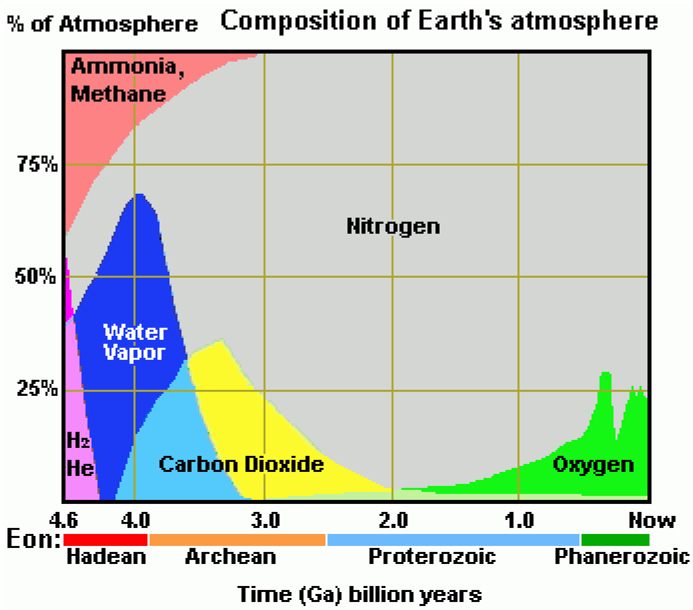
Chapter 9

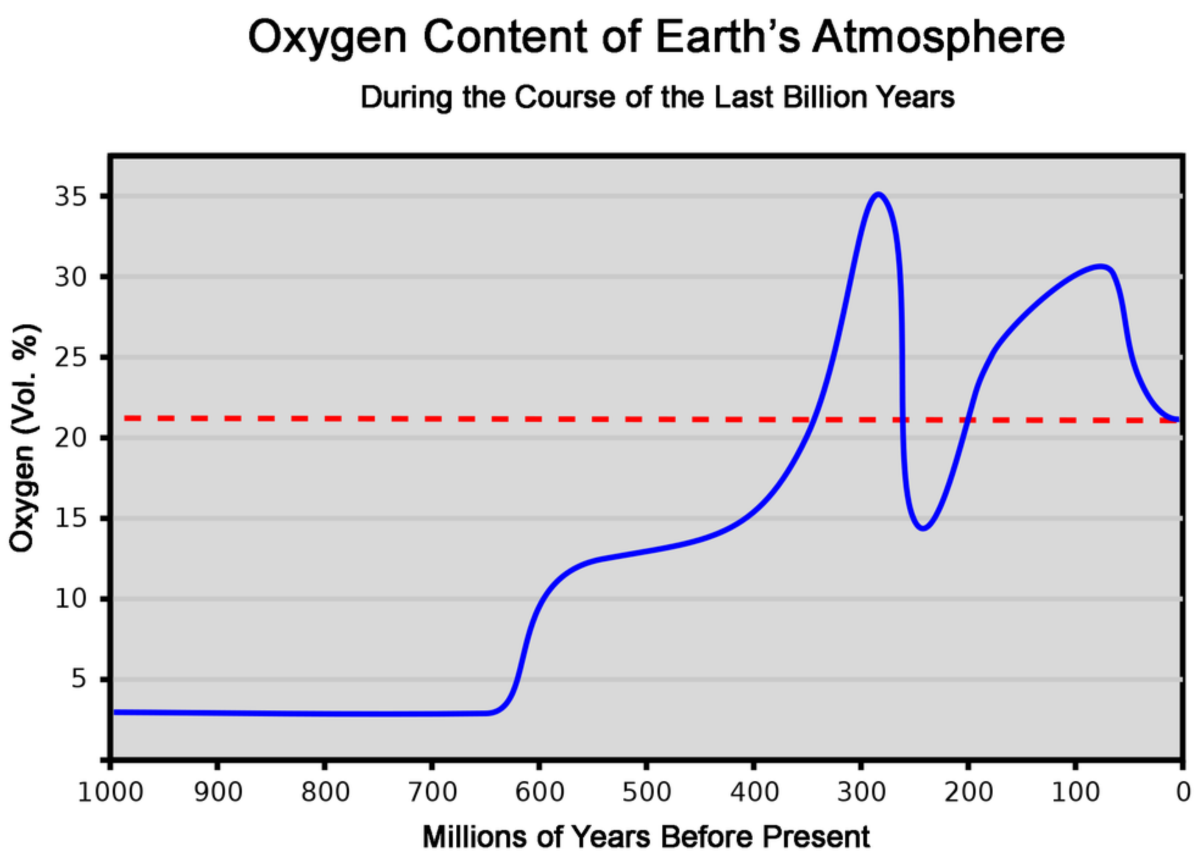
Atmospheric Composition

- The current composition of air by volume: 78.09% Nitrogen, 20.95% Oxygen, 0.93% Argon, carbon dioxide and small amounts of other gases. Air also contains a variable amount of water vapor, on average around 1% at Sea and 0.4% over the entire atmosphere
- Fractional Distillation is most commonly used to separate different gases from the general air. This is done due to a property of liquids that they all have different boiling & melting point. Basically it works through a system in which the gas is first cooled and turned into liquid. Sublimation of few gases convert into solid directly, hence they are easy to separate. Subsequently it is heated. Oxygen flows out while liquid nitrogen becomes a gas due to the different boiling points.



- Over time the composition of earth's atmosphere has changed. Multiple different factors can account for this
  - Industrial Revolution
  - Ice Age
  - Extinction
  - Plant Growth

- 



- Characteristics of the different atmospheric gases
    - Oxygen
        - Reactive and form oxides with nearly all elements
        - Colorless
        - Odorless
        - Tasteless

- Carbon Dioxide
  - Colorless
  - Odorless at small amount otherwise smells acidic.
- Nitrogen
  - Colorless
  - Tasteless
  - Diatomic
  - Does not react much
- Test for different gases
  - Hydrogen
    - The Lit splint test. You collect the hydrogen gas in a test tube and take a Lit splint. Place the lint splint in the test tube a pop sound should come.
  - Oxygen
    - Take a glowing splint and place it in the test tube where oxygen is meant to be. The glowing splint should ignite.
  - Carbon Dioxide
    - Take the Carbon Dioxide and pass it through lime water. The lime water should turn milky.

Greenhouse Effect

- The greenhouse effect is a process by which radiation from the planet's atmosphere warms the planet's surface to a point above what it would be without this atmosphere or additional particles.
  - When looking from physics preservative: As light enter the atmosphere it heats up earth and then bounces back. Although particles such as Water vapor and Carbon Dioxide absorb some of it, and later disperse it, some of the energy redistributes back to earth.
- The production and creation of the ozone can be described as a two-step process. The first step involves the ionization of oxygen. In the same step the ultraviolet light/radiation breaks apart O2 into 2O. In the second step the reactive 2O combine and soon form O3
- Main Greenhouse Gases

Greenhouse Gases	Sources
Water	Evaporation of Water from oceans, rivers, lakes, irrigation
Carbon Dioxide	Forest fires, volcanic eruptions, evaporation of water from oceans. Or Burning of fossil fuels in power plants and cars
Methane	Wetlands, oceans, lakes, and river, termites. Flooded rice field, farm animals and processing of

	coal and natural gases
Nitrogen Oxide	Burning of fossil fuels, forests, oceans, soil and grasslands. Manufacture of cement.

- When ultraviolet light hit CFC, the molecules in the upper atmosphere break the carbon chlorine bonds. This leads to the production of chlorine (CL) and the CL then reacts with an ozone molecule and breaks apart the ozone layer.

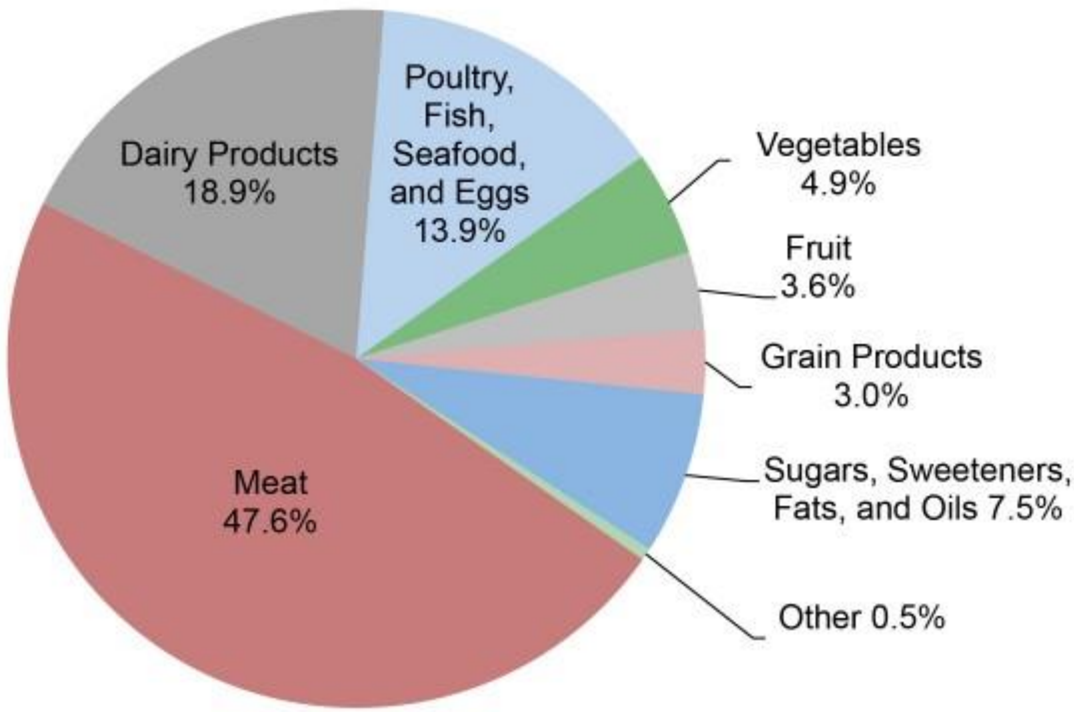
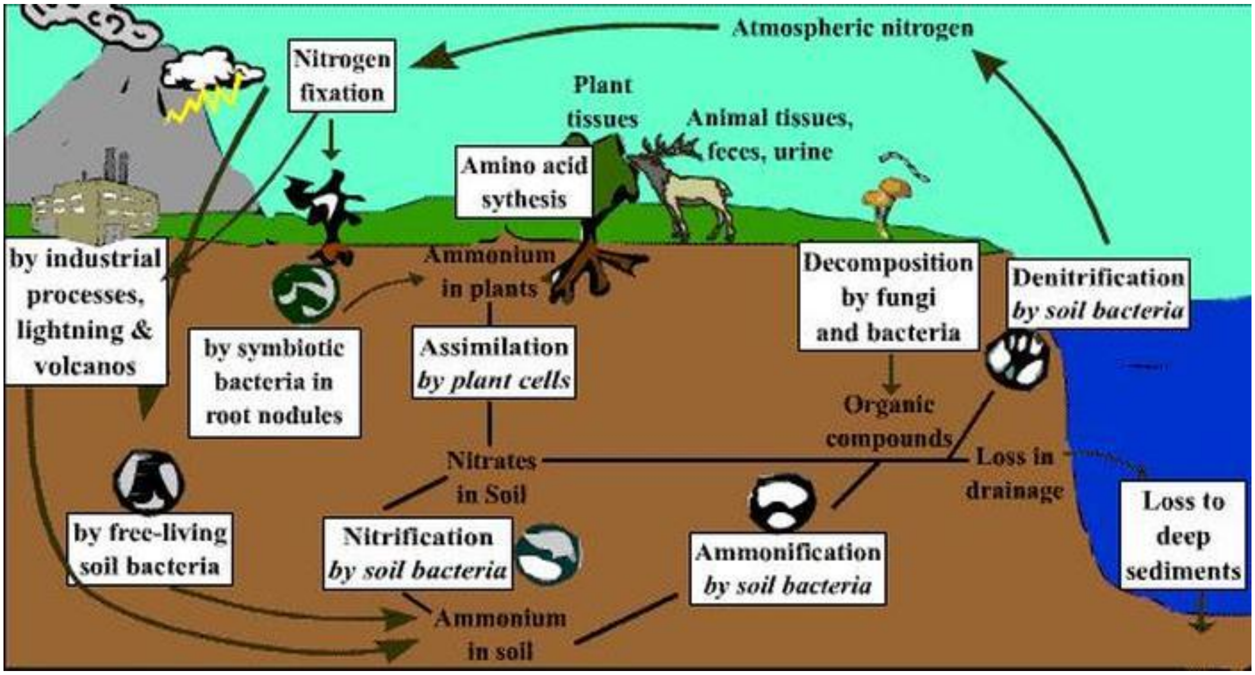


Figure: Source of Fossil Fuels

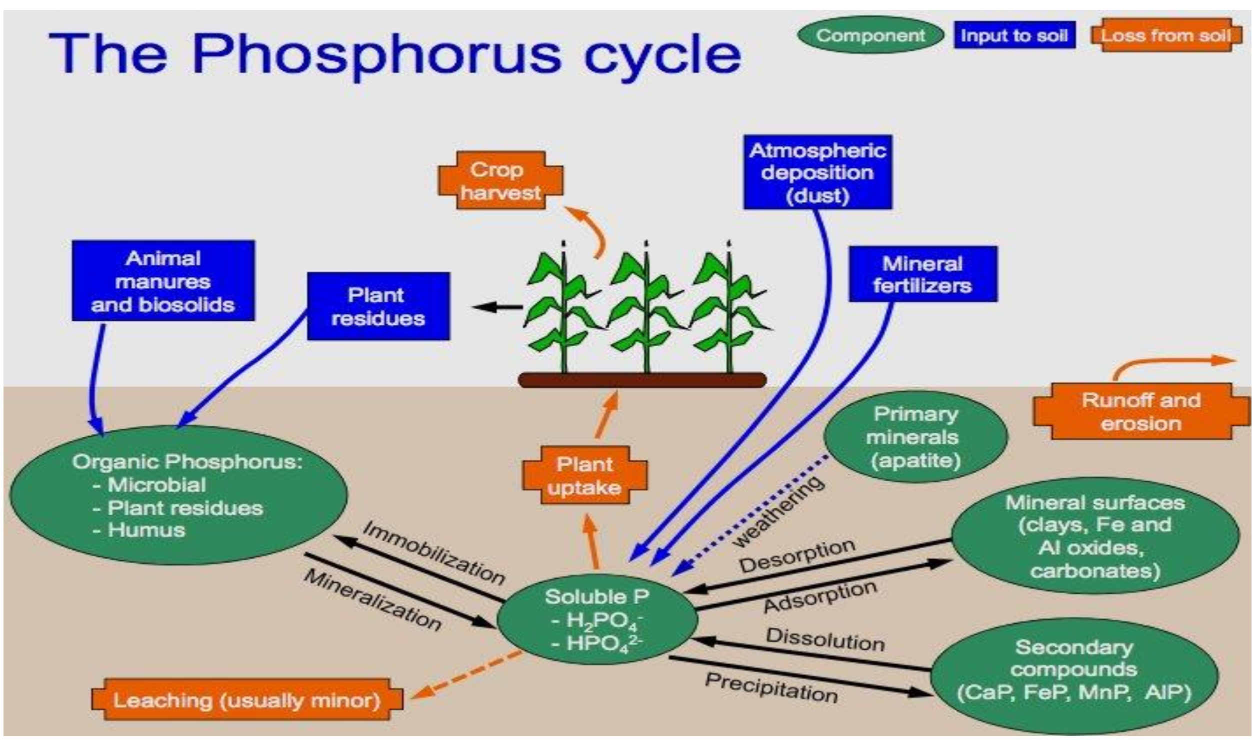
Nutrient Cycling

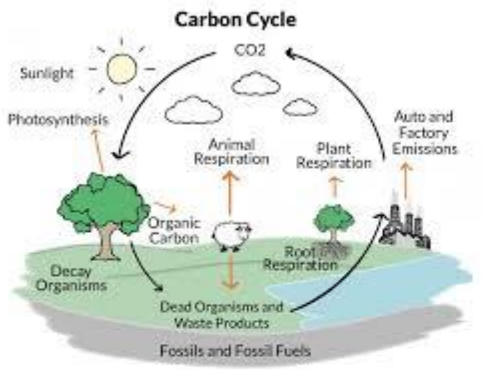
- Main source of nitrogen is from anaerobic, denitrifying bacteria



    -

- Phosphorus is need for all living things. It shows the amount of mater in the food chain.



- Carbon Cycle
    - 

Air & Water Pollution

- The atmosphere helps in the transportation of water after evaporation takes place.
- Cause of different form of pollution
    - Air pollution
        - Fumes from car exhausts
        - Ammonia
        - Livestock
    - Water Pollution
        - Run off from the environment
    - Land & Soil Pollution
        - Landfills
        - Plastic
    - Noise and Light Pollution
        - Parties
        - Camps
        - Highways
        - Speakers

Chapter Ten

Combustion

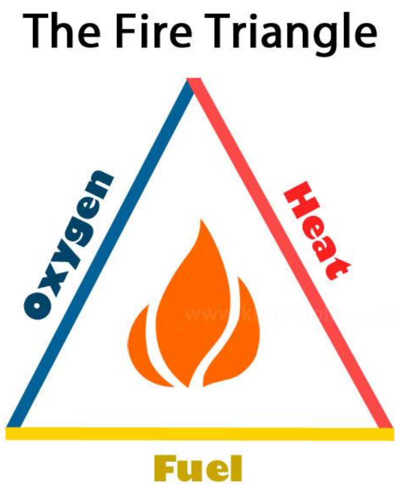
Definitions

Flash Point: The lowest temperature at which the vapors of that material will ignite

Ignition Temperature: The lowest temperature at which a combustible substance when heated in air takes fire and continues to burn

Complete and Incomplete Combustion

Combustion, otherwise known as burning, involves the reaction of a hydrocarbon and oxygen to produce carbon dioxide and water.



If there is sufficient oxygen, carbon dioxide is produced. This is known as complete combustion.

If there is not enough oxygen, carbon monoxide is produced. This is known as incomplete combustion

.Chemical Equations

Complete: $C_xH_y + O_2 \rightarrow CO_2 + H_2O$

Incomplete: $C_xH_y + O_2 \rightarrow CO + H_2O$

Enthalpy

Definitions

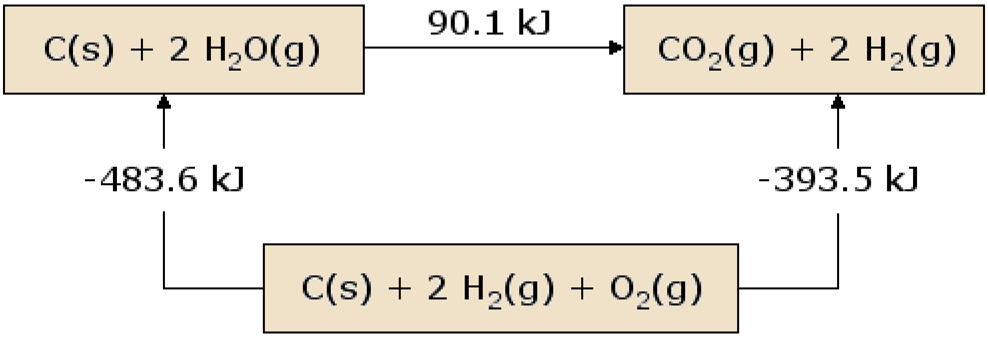
Standard Average Bond Enthalpy: The amount of energy required to break a specific type of bond per mole of the substance.

Standard Enthalpy Change of a Reaction: The enthalpy change that will occur in the system when matter is transformed by a chemical reaction.

Standard Enthalpy of Formation: Enthalpy during the formation of 1 mole of the substance from its constituent elements

Hess's Law

Regardless of the multiple stages or steps of a reaction, the total enthalpy change for the reaction is the sum of all changes.



<u>Source of Energy</u>

Energy can come from an external heat source, or by formation of chemical bonds, which releases energy.

<u>Calculating Enthalpy Change</u>

$$\Delta H = Energy\ given\ in\ formation\ of\ Products\ -\ Energy\ used\ in\ Breaking\ Apart\ Reactant$$

<u>Thermochemical Equations</u>

(Balanced equation) $\Delta H\ =\ xyz.kJ$

Using Experimental Data

$\Delta H = mc\Delta T$

ΔH: Enthalpy change

M: Mass

C: Specific Heat Capacity (Heat it takes to increase the temperature of 1 gram of the substance by 1℃)

ΔT: Change in temperature

Exothermic and Endothermic

<u>Definitions and Examples</u>

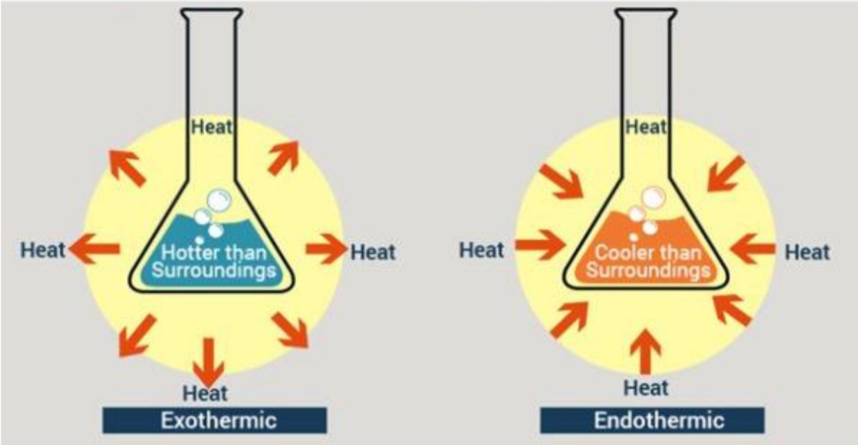
An **exothermic reaction** is a reaction that releases heat energy as the reaction happens

An **endothermic reaction** is a reaction that absorbs heat energy as the reaction happens

Examples:

Exothermic reactions	Endothermic reactions
Combustion Respiration Neutralisation Dissolving acids Dissolving alkalis Rusting Oxidation of metals Nuclear	Thermal decomposition Dissolving some ionic salts in water, like ammonium chloride, potassium nitrate and copper(II) sulphate etc… Photosynthesis Action of light on silver bromide

<u>Diagram of Reactions</u>



Identifying Type of Reaction

If $\Delta HH \geq 0$ then the reaction is endothermic and vice versa

In terms of bond enthalpies, when bonds are broken, energy is required, but when they are made they release energy. If the new bonds release more energy than the previous bonds broken, then it is exothermic; vice versa.

If $\Delta H < 0$ then the reaction is exothermic and vice versa

Use in Industry

- Exothermic reactions are used to heat up steam in order to move turbines and generate electricity
- Endothermic reactions are used in cold packs to treat bruises.

Heat

Calorimetry

Calorimetry is the process of measuring the amount of heat released or absorbed during a chemical reaction. By knowing the change in heat, it can be determined whether or not a reaction is exothermic or endothermic.

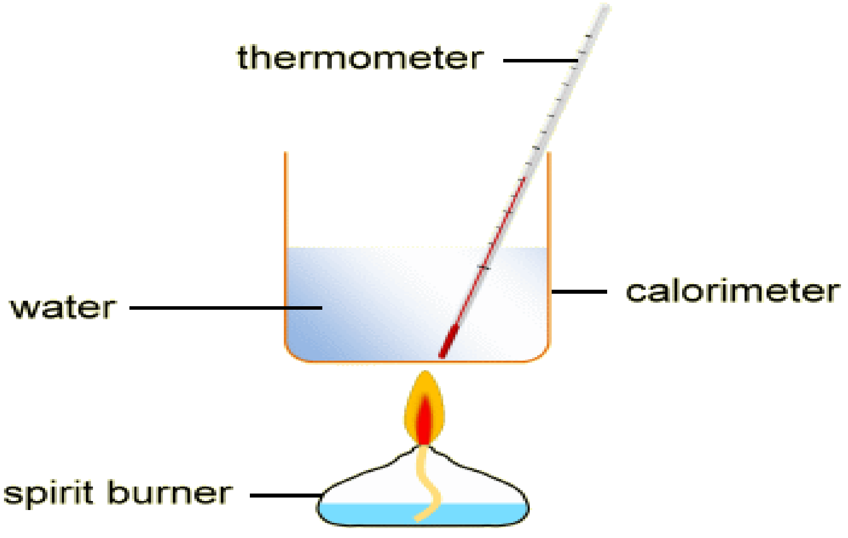
Assumptions of Calorimetry

The substance is pure

No heat is absorbed by the calorimeter

A concentration of 1 mol/dm^3 is used

Calorimeter Experiments



https://www.youtube.com/watch?v=SagNcyN1yUQ

Entropy

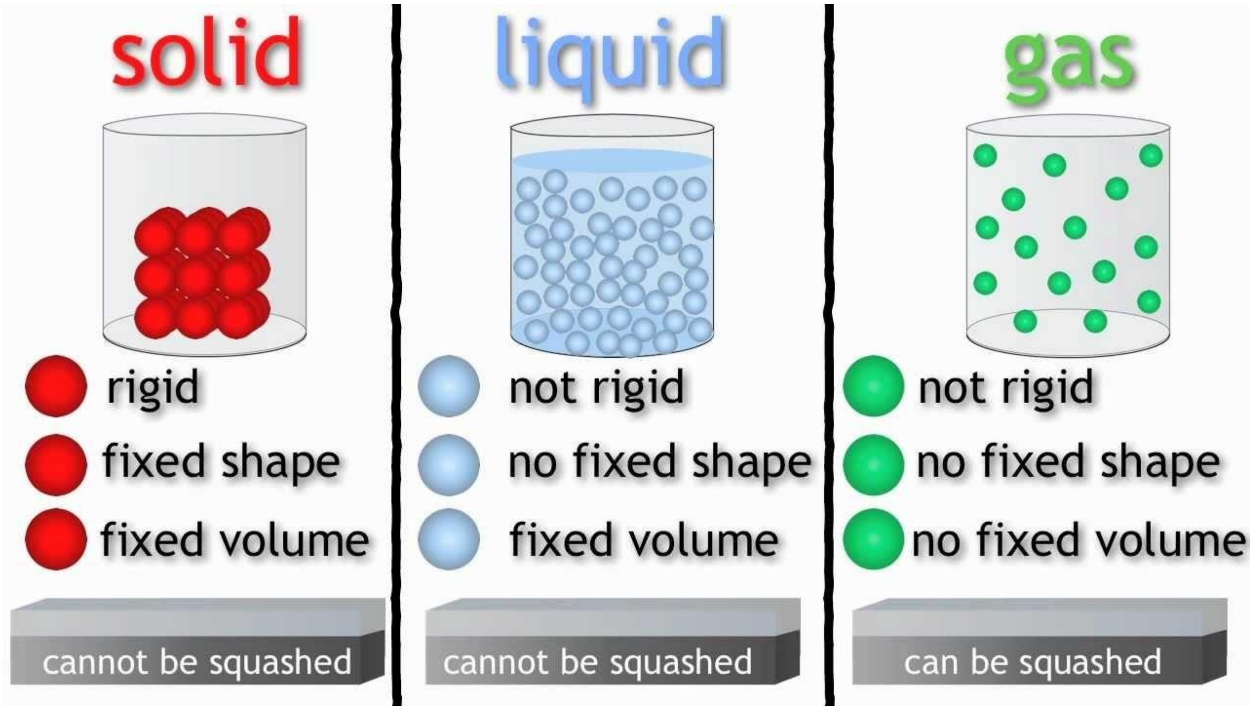
Definition

The measure of a system's thermal energy per unit temperature that is unavailable for doing useful work. Because work is obtained from ordered molecular motion, the amount of entropy is also a measure of the molecular disorder, or randomness, of a system.

Chapter 11

States of Matter & Kinetic Theory

- There are many different states of matter each have different properties



- Kinetic Molecular Theory states that gas particles are in constant motion and exhibit perfectly elastic collisions. This can be used to explain Charles' and Boyle's Law. The average energy of a collection of gas particles is directly proportional to absolute temperature.

Collision Theory

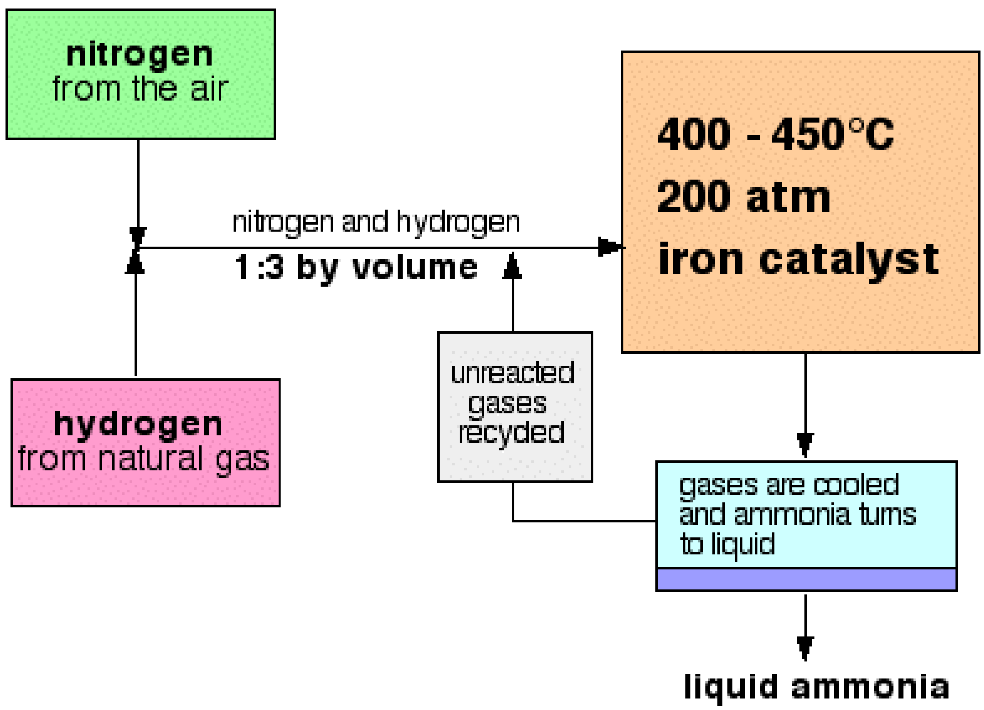
- Collision theory is normally used to predict rates of chemical reaction, particularly for gases. The theory is based on the assumption that for a reaction to occur it is necessary for the reaction species to come together.
- There are three main points listed in collision theory
  - Molecules must collide to react
  - Collision must have the correct orientation
  - Collision must have enough energy

Equilibrium

- Definitions
  - **Thermal Dissociation:** The breaking apart of a molecule's bond due to the introduction of heat. Or it is the breaking down of a large substance into smaller substance.
  - **Reversible Reaction**: It a chemical reaction where the reactants from product in turn can be reversed and give back reactants.
  - **Thermal Decomposition**: Is a simple single step reaction where a molecule splits into two products. It normally takes place due to ionization of a substance of heat.

- **Chemical equilibrium** is a state in which the rate of the forward reaction equals the rate of the backward reaction. In other words there is no net change in concentration. Otherwise this is known as dynamic equilibrium.
- A physical equilibrium is a system whose physical state does not change when dynamic equilibrium is reached in a system
- A Catalyst is used to find an alternative pathway to reaction with a lower activation energy.
- Le Chatelier Principle is used to predict the behavior of a system due to changes in temperature, concentration and pressure.
    - If the temperature in a system changes the behavior will change. If the system is exothermic then an addition of heat will favor the front direction. In endothermic reverse is applicable.
    - If pressure is increased then it depends where the most gas molecules are present.
    - If the concentration of the products or reactants are increased respectively you will get a change in the rate of reaction for that side.

- The Haber Process



Rate of Reaction

- Rate of Reaction - Is the speed at which reactants are converted into products
    - There are multiple different factors that impact the rate of a reaction however the most common include temprature, pressure/ Concentration, and catalyst.
        - Temperature affects the rate of reactions as it increases the speed at which particles collide; otherwise known as the kinetic energy. An increase in KE means a higher percentage of particles have the minimum activation energy. Another way in which temp can impact a reaction is that it increases the random motion of

particles. This means collision can happen more often; hence being successful more often

- An increase in concentration and pressure means that there are more particles in a given volume. More particles in the same volume mean that there is a higher chance of a collision to take place. It is more likely for a reaction to take place.
- Catalyst even impacts the rate of reaction by using an alternative pathway that has lower activation energy. A lower activation energy means more particles have the ability to pass the activation energy barrier. A catalyst increases the percentage of particles with suitable activation energy by introducing a new pathway with less activation energy.
- Surface Area is an important factor. A higher surface area means there is more area for the reaction to take place on.
- Common Experimental Procedures

Temperature -

Measure out 50 cm3 of sodium thiosulfate and pour into the conical flask.

Draw a cross on the piece of paper and then place the conical flask on top of it.

Use the thermometer to measure the temperature of the sodium thiosulfate. Record this value in the Results table below.

Measure out 5 cm3 of hydrochloric acid and pour into the conical flask. Start the stop clock straightaway.

Looking from above, time how long it takes for the cross to ‘disappear’. Record this time in seconds in the Results table

Pour the solution away as quickly as possible and rinse out and the flask.

Repeat steps 1 to 6 using sodium thiosulfate from one of the water (or ice) baths.

Continue until you have done the experiment with sodium thiosulfate from all of the different water baths.

Concentration

Method

A Set up a gas syringe as shown in the diagram so that it is at the right height for the bung to go into the boiling tube in the beaker.

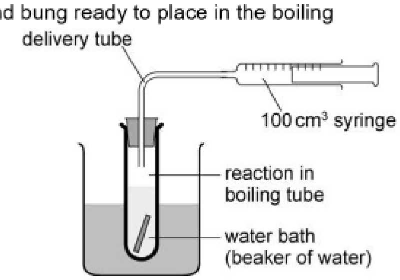
B Pour 20 cm^3 of 2.0 mol/dm^3 hydrochloric acid into a boiling tube.

C Put the boiling tube in the water bath and have the delivery tube and bung ready to place in the boiling tube.

D Drop a 5 cm strip of magnesium ribbon into the acid and immediately put the bung in the boiling tube. Your partner should start the stopclock at the same time.

E Measure the volume of hydrogen gas formed in 20 seconds and record the result in the table. During this time, shake the reaction mixture.

F Repeat the experiment using different concentrations of acid. These can be made by mixing 2.0 mol/dm^3 hydrochloric acid with water, using the quantities shown in the table.



Catalyst

- The minimum quantity of energy that the reacting species must possess in order to undergo a specified reaction.
-

- Catalyst does impact the rate of a reaction by finding an alternative pathway of energy for the reactants
- Catalyst does impact the rate of a reaction by finding an alternative pathway of energy for the reactants
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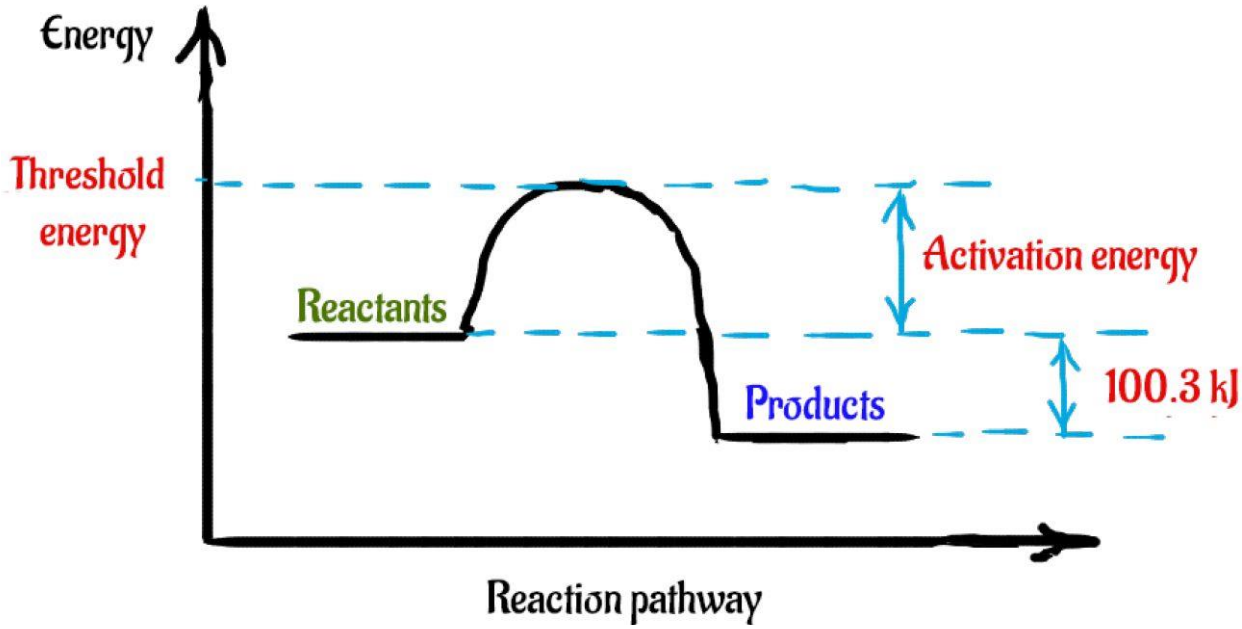


Alkanes

- Alkanes are a type of hydrocarbon with single bonds and saturated.
    - They all have a general molecular formula of $C_n H_{2n+2}$
    - In the structural formula keep in mind they have single bonds
    - Empirical formula is not the simplest ratio.
    - A list of the different Alkanes

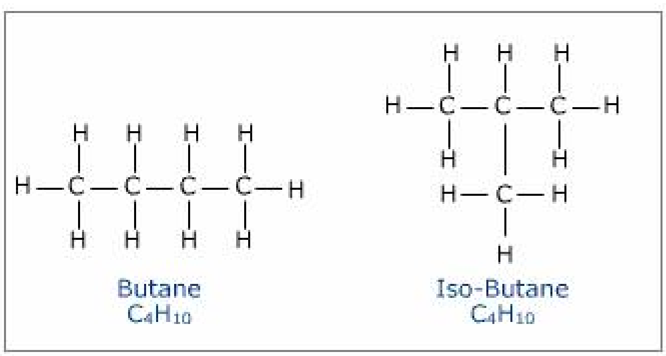
Table 18.1 The First Ten Straight-Chained Alkanes

NAME	MOLECULAR FORMULA	STRUCTURAL FORMULA
methane	CH_4	CH_4
ethane	C_2H_6	CH_3-CH_3
propane	C_3H_8	CH_3-CH_2-CH_3
butane	C_4H_{10}	CH_3-CH_2-CH_2-CH_3
pentane	C_5H_{12}	CH_3-CH_2-CH_2-CH_2-CH_3
hexane	C_6H_{14}	CH_3-CH_2-CH_2-CH_2-CH_2-CH_3
heptane	C_7H_{16}	CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3
octane	C_8H_{18}	CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3
nonane	C_9H_{20}	CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3
decane	$C_{10}H_{22}$	CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3

    - Alkanes can often take different shapes while having the same mass. This is known as isomers.

Number of C Atoms	Number of Isomers
4	2
5	3
6	5

        - An example of this can be seen with butane



        - Isomers have different properties
- There are multiple different features of Alkanes

    - Branched alkanes normally exhibit lower boiling points than unbranched alkanes of the same carbon content.
    - Solid alkanes are normally soft, with low melting points
    - Insoluble in water
- As the amount of carbon atoms present increases so does the boiling and melting point.

Table of Boiling Points of Linear Alkanes:

Name of Alkane	How many carbons ?	Chem Formula	Boiling Point in °C	State at (20°C)	Melting Point in °C
Methane	1	CH_4	-162	gas	-183
Ethane	2	C_2H_6	-89	gas	-172
Propane	3	C_3H_8	-42	gas	-188
n-**Butane**	4	C_4H_{10}	0	gas	-138
n-**Pentane**	5	C_5H_{12}	36	liquid	-130
n-**Hexane**	6	C_6H_{14}	69	liquid	-95
n-**Heptane**	7	C_7H_{16}	98	liquid	-91
n-**Octane**	8	C_8H_{18}	126	liquid	-57
n-**Nonane**	9	C_9H_{20}	151	liquid	-54
n-**Decane**	10	$C_{10}H_{22}$	174	liquid	-30

Alkene

- Alkenes are unsaturated hydrocarbon chain with a double bond.
- They often end in the suffix - ene
- There are multiple different isomers of Alkenes when they are linear. There are two kinds of isomers which can be seen when looking at Alkenes: location of the double bond and structural.

- Location of the double bond:

Number of Carbon Atoms	Number of isomers	Name of the Isomers
4	2	But-2-ene , but-1-ene
5	2	Pent -1-ene , pent-2-ene
6	3	Hex-1-ene, hex -2-ene , hex-3-ene

- Structural
  - Double bonds have both sigma and PI bonds, unlike single bonds. The PI bonds restrict the movement around the double bond. This results in something known as CIS-trans- isomers.
    - Forms of alkenes that have the same structure except of orientation of components around the PI bond.
    - An example of this can be seen in Butene

cis-2-butene *trans*-2-butene

Name	Chemical formula	Structure
Ethene	C_2H_4	$CH_2 = CH_2$
Propene	C_3H_6	$CH_3CH = CH_2$
Butene	C_4H_8	$CH_2=CHCH_2CH_3$, $CH_3CH=CHCH_3$
Pentene	C_5H_{10}	$CH_2=CHCH_2CH_2CH_3$, $CH_3CH=CHCH_2CH_3$
Hexane	C_6H_{12}	$CH_2=CHCH_2\ CH_2CH_2CH_3$ $CH_3CH=CHCH_2CH_2CH_3$ $CH_3CH_2CH=CHCH_2CH_3$
Heptene	C_7H_{14}	$CH=CHCH_2CH_2CH_2CH_2CH_3$ $CH_3CH=CH_2CH_2CH_2CH_2CH_3$

- The general formula for alkene is C_nH_{2n}
- Generally in commercial industries Alkenes are converted to Alkanes. This is carried out to make food healthier or stay longer.

    - For example vegetable oil of polyunsaturated fat - means multiple double bonds. This is healthier although harder to spread as they are liquid at room temp. So food scientists use hydrogenation to make them saturated hence easy to spread.

Alcohols, Carboxylic Acids & Esters

- Alcohols - Are a type of functional group.
    - The general formula included : $C_nH_{2n+1}OH$
    - They can be created through the hydration of an alkene
    - Single bonded carbon and hydroxide atoms
    - They are a bunch of compounds with one OH group
- Carboxylic
    - Organic compounds which contain the functional group - COOH
    - Often has an ending in "oic" acid. For example Ethanoic acid.
- Esters
    - They are a group of organic compounds which all contain the functional group - COO-.
        - Typical characteristics they include; volatile and have fruity smells.

Crude Oil

Crude Oil can be seen as a mixture of different hydrocarbons which are mixed together. An important step is often separating the different components. After the sand and water are removed fractional distillation is used to separate the remaining components.

- Fractional Distillation with crude oil can be broken down into three steps - Distillation, Cracking and Reforming

  Distillation
        - Crude oil is heated in a furnace at extremely high temps. But the temperature along the vessel varies with the top being the coolest compared to the bottom.
        - As the mixture is heated different hydrocarbons evaporate and condense at different levels.
        - The boiling point is directly proportional to amount of carbon in Hydrocarbon.
        - The ones with the highest boiling point condense towards the bottom, and vice versa.
        - They are piped out of the distillation depending where they condense.

  Cracking –
    - Large saturated hydrocarbon molecules are broken down into smaller, more useful hydrocarbons.

- This can be done through the use of a catalyst; for example EOLITE.
- Or can be done with high temperature and pressure.

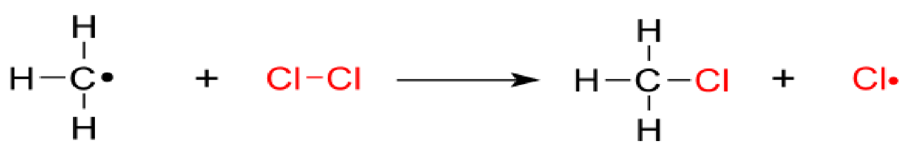
Reforming

- In the presence of hydrogen and a heated catalyst, hydrocarbons, with small carbon chain become more stable Benzene rings.
- Some products of this often include

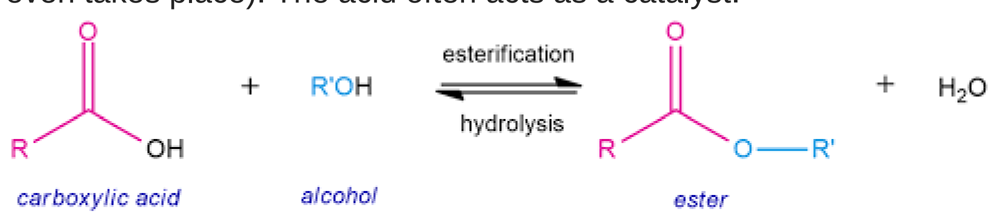
Fraction	Uses
Gases	• Fuel for cars • Heating and cooking in homes
Petrol	• Fuel in cars
Kerosene	• Used in aircraft engines
Diesel Oil	• Used in diesel engines
Bitumen	• Making roads waterproof

Reactions

- Substitution
  - A reaction in which one functional group in a chemical compound is replaced by another functional group.



- Esterification
  - A reactions of acid with alcohol to make an ester (a condensation reaction even takes place). The acid often acts as a catalyst.

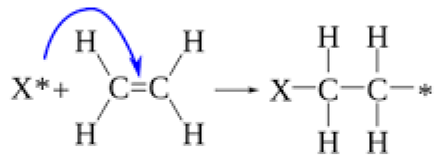


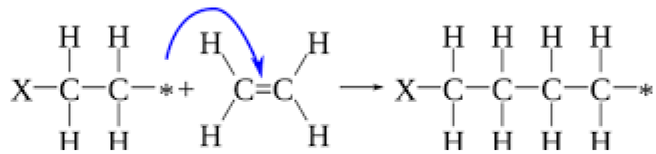
  - This will result in an ester and water

An acid must be present as a catalyst. Often Alcohol is used

- Addition Reaction

- Addition Polymerization and Hydrogenation (two or more molecules combine to form one longer molecule)
  - C_2H_4 (g) + Br_2→ $C_2H_4Br_2$ (l)



  - 

- Hydrogenation
  - The breaking of double bonds into more stable saturated molecules, often through the use of hydrogen.
  - Alkenes + Hydrogen ---> Alkanes
  - Alkynes + Hydrogen ---> Alkenes or Alkanes (depends on the amount of hydrogen)
  - An example is
    - Ethene + Hydrogen → Ethane
  - In industry this is often used on unsaturated oil to make then more spreadable.
- Polymerization
  - **Addition Reactions**: Are reactions in which monomers are joined to create one long chain of monomers.
  - **Condensation Reactions** The joining of two different monomers to form 2 products. A polymer and water.

IUPAC

- Non- Cyclic hydrocarbons
  - Identity the functional groups present.
    - Look for stuff such as number of bonds (single/double/triple). Then select appropriate suffix.
      -

Functional Group	Suffix
alkane	-ane
alkene	-ene
alkyne	-yne

- Find the longest continuous carbon chain that contain the functional group, and count the number of carbon atoms in that chain. Use this information for the prefix.
    -

Carbon atoms	prefix
1	meth-
2	eth-
3	prop-
4	but-
5	pent-
6	hex-
7	hept-
8	oct-
9	non-
10	dec-

- Number the carbons in the longest carbon chain (Important: If the molecule is not an alkane (i.e. has a functional group) you need to start numbering so that the functional group is on the carbon with the lowest possible number). Start with the carbon at the end closest to the functional group.
- Look for any branched groups
    - Name them by counting amount of carbon atoms
    - Name the position of the main carbon using the numbers. If two are present, then list both numbers
    - The branched groups must be listed before the name of the main chain in alphabetical order
- For alkyl halides and halogen atoms it is treated much the same way as branched groups
    - To name them take the name of the halogen atom (e.g. iodine) and replace the “ine” with “o” (e.g. iodo).
    -

Halogen	name
fluorine	Fluoro
chlorine	Chloro

bromine	Bromo
iodine	Iodo

        - If more than one is present when listing the prefix should be used and position shown(e.g. 3,4-diodo- or 1,2,2-trichloro-)
    - Combine all info in the order
        - branched groups/halogen atoms in alphabetical order (ignoring prefixes)
        - prefix of main chain
        - Name ending according to the functional group and its position on the longest carbon chain.
- For naming alcohols, ester and acids please refer to the following link: http://www.chem.uiuc.edu/GenChemReferences/nomenclature_rules.html