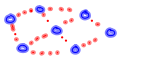
Matter and It's Properties

Matter → Anything that has mass & takes up space

All of the organisms that we study in biology are made up of matter

PHASES OF MATTER

Liquid → Indefinite shape, Definite volume



GAS → Indefinite shape, Indefinite volume

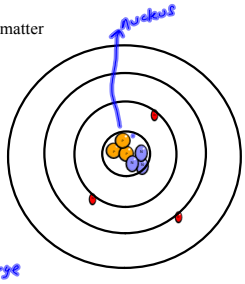
SOLID → Definite shape, Definite volume

phase change

↳ go from 1 phase of matter to another

ex!
- Evaporation → L to G
- condensation → G to L
- melting → S to L
- Freezing → L to S
- Sublimation → S to G
- Deposition → G to S

Atom → The building blocks of matter

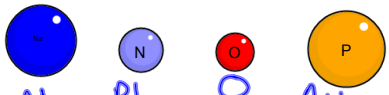


- Protons (p^+), + charge, found in nucleus
- neutrons (n), neutral charge, found in nucleus
- electrons (e^-), − charge, found in orbits

Protons and electrons are equal so the overall charge of an atom is zero

** The number of protons identifies the atom**

Element → A pure substance that cannot be broken down into other substances by physical or chemical means



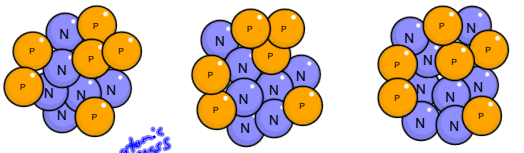
Na, Pl, O, Au

Zn, C, Ne, P

Isotopes

- Atoms of the same element that have different numbers of neutrons

Proton (p^+ don't change) Neutron



Carbon-12 nucleus — $p^+ = 6$ $n = 6$

Carbon-13 nucleus — $p^+ = 6$ $n = 7$

Carbon-14 nucleus — $p^+ = 6$ $n = 8$

(other isotopes of C)

Changing the number of neutrons does not change the charge of the atom, but it does change the stability of the nucleus. In some cases the nucleus decays or breaks apart and is radioactive

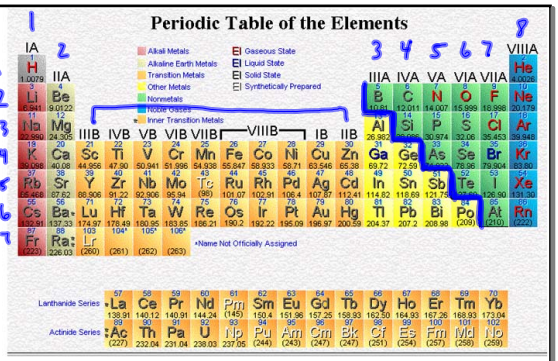
Ex. Carbon-14

		p^+	n	e^-
Cl	Chlorine - 36	17	19	17
Mg	Magnesium - 25	12	13	12
B	Boron - 11	5	6	5
Ca	Calcium - 41	20	21	20

Compound → A pure substance formed when two or more elements combine, Bonded together

H_2O C_2H_5OH NO_2 CO_2 $NaCl$ HCl CH_4 NO_3

- Compounds are always formed in a specific combination of elements in a fixed ratio H_2O H-2 O-1
- Compounds are chemically and physically different than the elements that make them up NaCl Na = reactive metal Cl = poisonous gas
- Compounds cannot be broken down into simpler substances by ~~PHYSICAL~~ means (crushing, tearing, etc.)

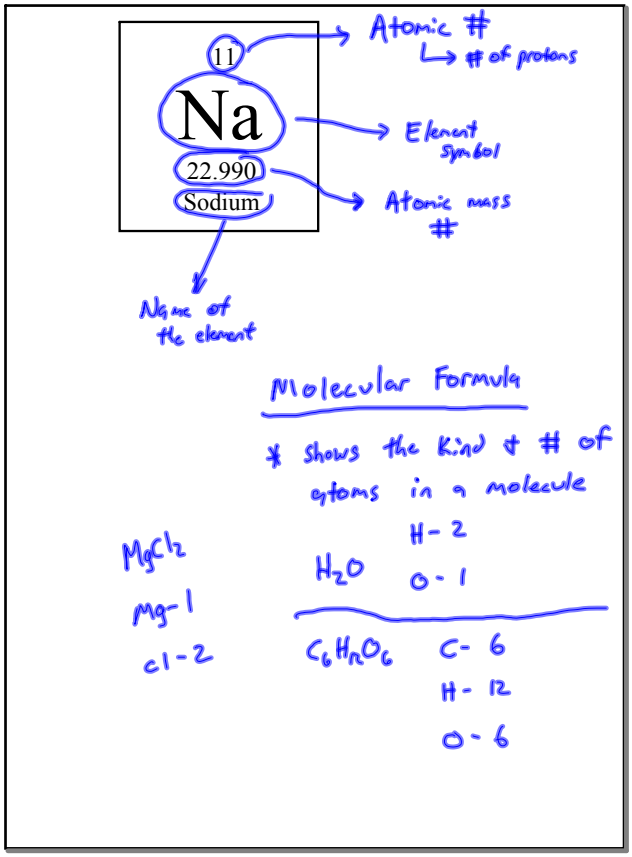


Periods - The horizontal rows on the periodic table

Groups - The vertical columns on the periodic table

Metals - found on the LEFT and MIDDLE parts of the table

Nonmetals - found on the RIGHT side of the table



Chemical Bonds

- A force that holds two elements together when they combine

* Electrons are involved in chemical bonding

  - Exist in energy levels around the nucleus

    - 1st energy level hold 2 electrons

    - All other energy levels hold 8 electrons

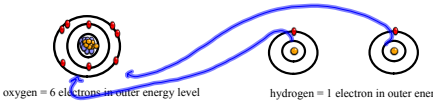
*** A partially filled energy level is not as stable as a completely full or completely empty energy level***

Two types of chemical bonds include covalent and ionic bonds

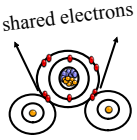
Covalent Bonds

- A chemical bond that forms when atoms share electrons in their outer energy levels

Ex. Hydrogen and Oxygen to form water (H_2O)



H_2O
CO_2
NO_3



* Molecule - a compound in which the atoms are held together by covalent bonds

- Covalent bonds can be single, double, or triple bonds

Ionic Bonds

Atoms are neutral

Atoms are stable when their outer energy levels are full or empty with electrons

SOME ATOMS ACCEPT OR DONATE ELECTRONS TO FILL OR EMPTY THEIR ENERGY LEVELS

Between a metal and a nonmetal

Ion - an atom that has lost or gained one or more electrons

- carry an electric charge

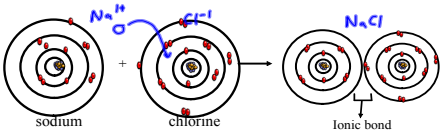
Ex. Na and Cl — Giving & receiving

→ sodium has 1 electron in its outer energy level and chlorine has 7 electrons in its outer energy level

Na^{1+} Cl^{1-} 1 e^-

Sodium will lose and electron
Chlorine will gain an electron

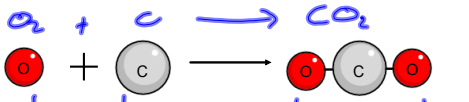
Ionic Bond - An electrical attraction between two oppositely charged atoms or groups of atoms



Chemical Reactions

The process by which atoms or groups of atoms in substances are reorganized into different substances

- Chemical bonds are formed and broken during a chemical reaction



Reactants
- Left of the arrow
- what goes into a chemical reaction

Products
- Right of the arrow
- what you get out of a reaction

$MgCl_2 \longrightarrow Mg + Cl_2$

Balancing Chemical Equations

In a chemical reaction, matter cannot be created or destroyed (conservation of mass)

The number of atoms on the reactant side must equal the number of atoms on the product side

$2\ C_6H_{12}O_6$ — you never change these #'s

ex. $H_2 + O_2 \longrightarrow H_2O$

$2\ H_2 + O_2 \longrightarrow 2\ H_2O$ R: H-4 O-2 P: H-4 O-2

$C_6H_{12}O_6 + O_2 \longrightarrow CO_2 + H_2O$

R	P
C - 6	C - 6
H - 12	H - 12
O - 18	O - 18

$C_6H_{12}O_6 + 6\ O_2 \longrightarrow 6\ CO_2 + 6\ H_2O$

$2\ NaF \longrightarrow 2\ Na + F_2$

R: 2 Na, 2 F P: 2 Na, 2 F

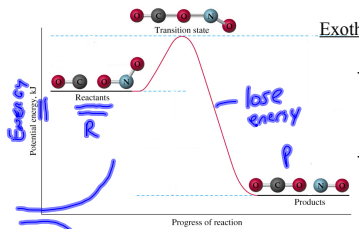
$C_3H_8 + O_2 \longrightarrow CO_2 + H_2O$

R	P
C -	C -
H -	H -
O -	O -

Energy of Reactions

- Chemical Reactions need energy in order to begin

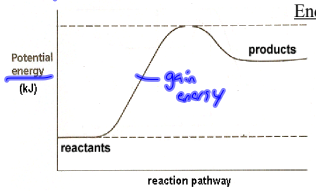
* The minimum amount of energy needed for reactants to form products in a chemical reaction is known as ACTIVATION ENERGY



Exothermic Reaction HOT

- the energy of the reactants is higher than the energy of the products
- heat is given off

hand warmer



Endothermic Reaction (COLD)

- the energy of the reactants is lower than the energy of the products
- heat is absorbed / taken in
- ice pack

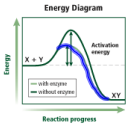
Enzymes

Often in the lab chemical reactions move slowly because the activation energy is high. In living organisms, there are substances that reduce the activation energy that allow chemical reactions to take place in a faster way.

- catalyst - a substance that lowers the activation energy of a reaction
  - catalysts speed up reactions, but do not increase the amount of product that is made

Enzymes - biological catalysts

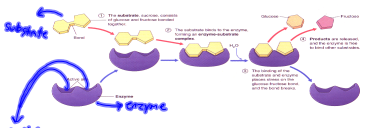
-ase
amylase
catalase
lactase

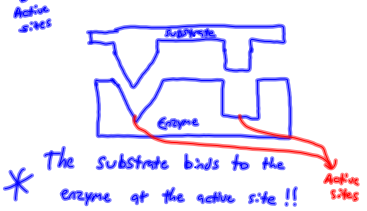


- substrate - the reactants that bind to the enzyme
- active site - the specific location where the substrate binds to the enzyme

** substrates and active sites fit together like a lock and key**

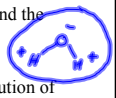
Once the substrates bind to the enzyme, an enzyme/substrate complex is formed. They react and products are formed





Water's Polarity H_2O

- Water is formed by covalent bonding of hydrogen and oxygen
  - sharing electrons
- In water, the electrons spend more time near the oxygen nucleus compared to the hydrogen nucleus....Why?
  - * this results in the oxygen being slightly negative and the hydrogen being slightly positive

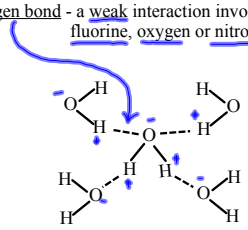


Polar molecule - molecules that have an unequal distribution of charges (oppositely charged regions)

Polarity - having two opposite poles

ex. magnet (opposites attract / likes repel)

Hydrogen bond - a weak interaction involving hydrogen atom and a fluorine, oxygen or nitrogen atom



H-F
H-O
H-N

O
+8
$\rightleftarrows e^- \rightarrow$
H
+1

Mixtures

A combination of two or more substances in which each substance retains its individual characteristics

Homogeneous Mixtures - a mixture that has uniform composition throughout
- same throughout

Also called SOLUTION

1. solute - the dissolved material
   - mix, goodness powder, sugar
2. solvent - the dissolving material
   - H_2O

Ex.
- cake batter
- salt H_2O
- Kool-aid

Heterogeneous Mixtures - a mixture where the components remain distinct

Ex. chex mix, skittles, m&m's, salad

Acids and Bases

Hydrogen ions (H^+) → H^+ lost 1 e^-

Hydroxide ions (OH^-) → OH^- gained 1 e^-

** Substances that release hydrogen ions (H^+) when dissolved in water are called ACIDS **

** Substances that release hydroxide ions (OH^-) when dissolved in water are called BASES **

pH and Buffers

- The amount of hydrogen ion or hydroxide ion determine the strength of the acid or base

pH = the concentration of the Hydrogen ion (H^+) 1 - 14

neutral pH = 7.0 (water)
acidic pH < 7 → 1-6.9
basic pH > 7 → 7.1 - 14

Buffers - mixtures that can react with acids and bases to keep pH levels within a particular range

Ex. antacid tablets

1 (strong acid) ← 7 (neutral) → 14 (strong base)

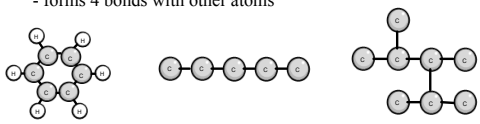
Lower the # on the pH scale the Stronger the acid

Higher the # on the pH scale the Stronger the base

Organic Chemistry

- The element CARBON is a component of almost all biological molecules

* - has 4 electrons in second energy level
- forms 4 bonds with other atoms



Macromolecules - molecules that are formed by joining smaller organic molecules together

Include...
- carbohydrates
- lipids
- proteins
- nucleic acids

Carbohydrates

$C_3H_6O_3$
$C_4H_8O_4$
$C_6H_{12}O_6$
$(CH_2O)_n$

compounds composed of carbon, hydrogen, and oxygen in a ratio of 1 oxygen and 2 hydrogen per carbon

* monosaccharides - simple sugars (n = 3-7)

ex. glucose

disaccharide - two monosaccharides bonded together

ex. sucrose

polysaccharides - longer carbohydrate molecules

ex. glycogen

** Function = store energy
provide structural support (plant cells)

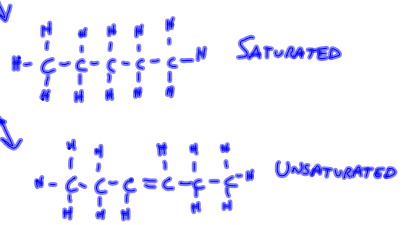
Lipids → FATS

- molecules that are made of mostly hydrogen and carbon that make up the fats, oils, and waxes

1) saturated and unsaturated fats
- lipids have fatty acid tails composed of hydrogen and carbon
- lipids that have tail chains with SINGLE BONDS between carbon atoms are called SATURATED FATS
- lipids that have tail chains with a DOUBLE BOND between carbon atoms are called UNSATURATED FATS

2) Phospholipids
* - do not dissolve in water
- make up the cell membrane
- have a polar phosphate head and a nonpolar fatty acid tail

3) Steroids
- Include substances such as cholesterol and hormones



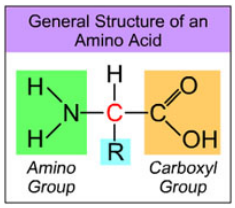
Proteins

- A compound made of small carbon compounds called amino acids

Building Blocks of protein

small compounds made of carbon, nitrogen, oxygen, hydrogen, and sometimes sulfur

amino acid structure



3-D protein structure

x-y-z-y-x-a-b-x

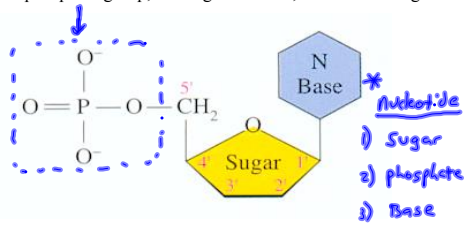
- primary structure - the # of amino acids in a chain
- secondary structure - the folding of an amino acid chain into a three-dimensional shape
  - pleat or helix
- tertiary strucutre - often globular
- 4th level structure - combining with other proteins

* Functions - transport substances, speed reactions, provide structural support, make hormones

Nucleic Acids

- Complex macromolecules that store and transmit genetic information
- made of nucleotides → Building blocks of nucleic acids
  - composed of carbon, nitrogen, oxygen, phosphorous, and hydrogen atoms

Have a phosphate group, a nitrogenous base, and a ribose sugar



* nucleotide
1) Sugar
2) phosphate
3) Base

DNA - deoxyribonucleic acid
RNA - ribonucleic acid