What is Matter???

- **Matter:** anything that has volume or mass
- Matter is made up of **atoms and molecules.**

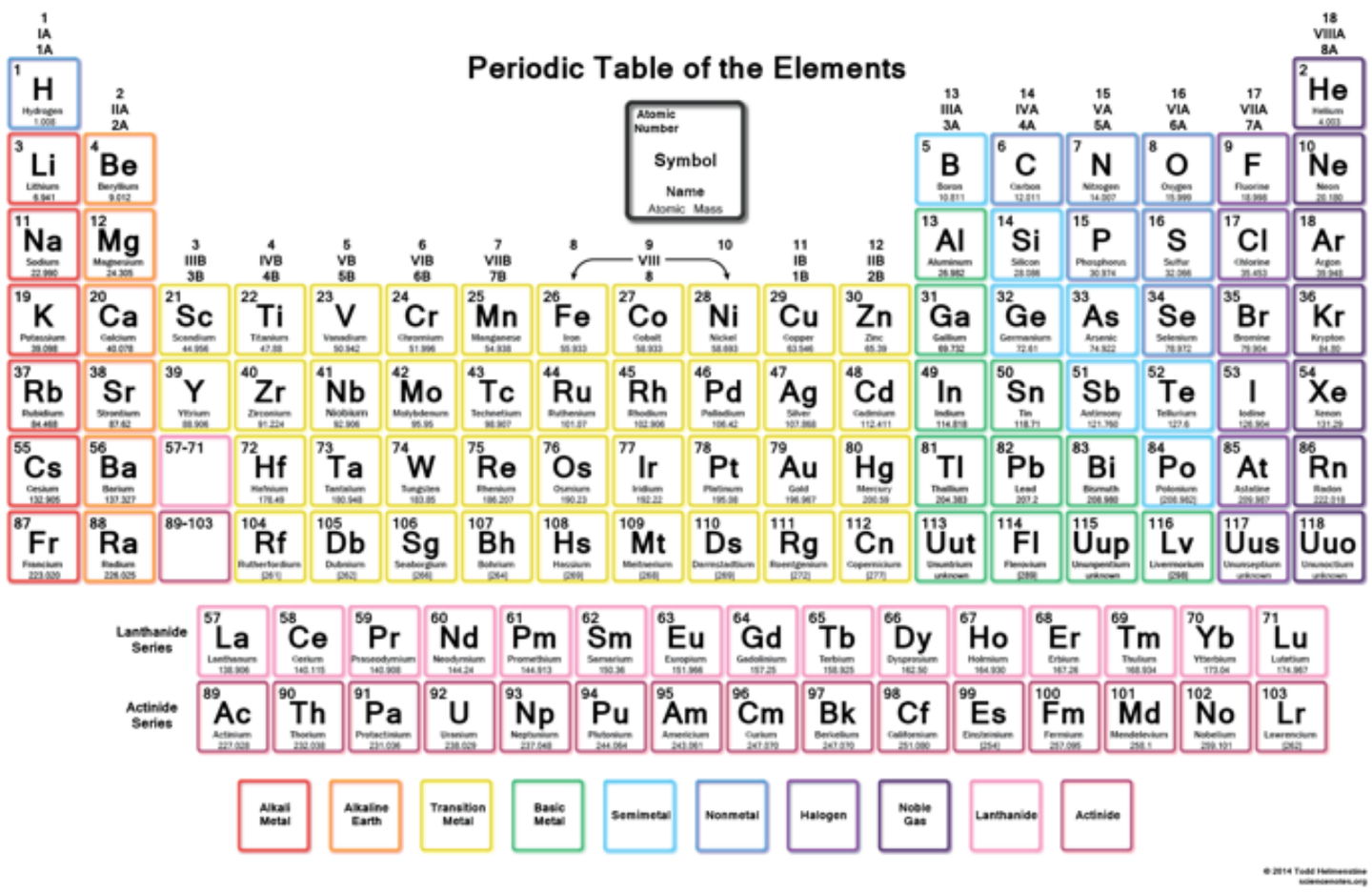
Atom:

smallest unit of matter. Atom is the simplest form of an element. (Ex: 4 Carbon atoms = 4 C)

*__Element:__ a pure substance is made up of only one type of atom (ex: Carbon C) and cannot be broken down.

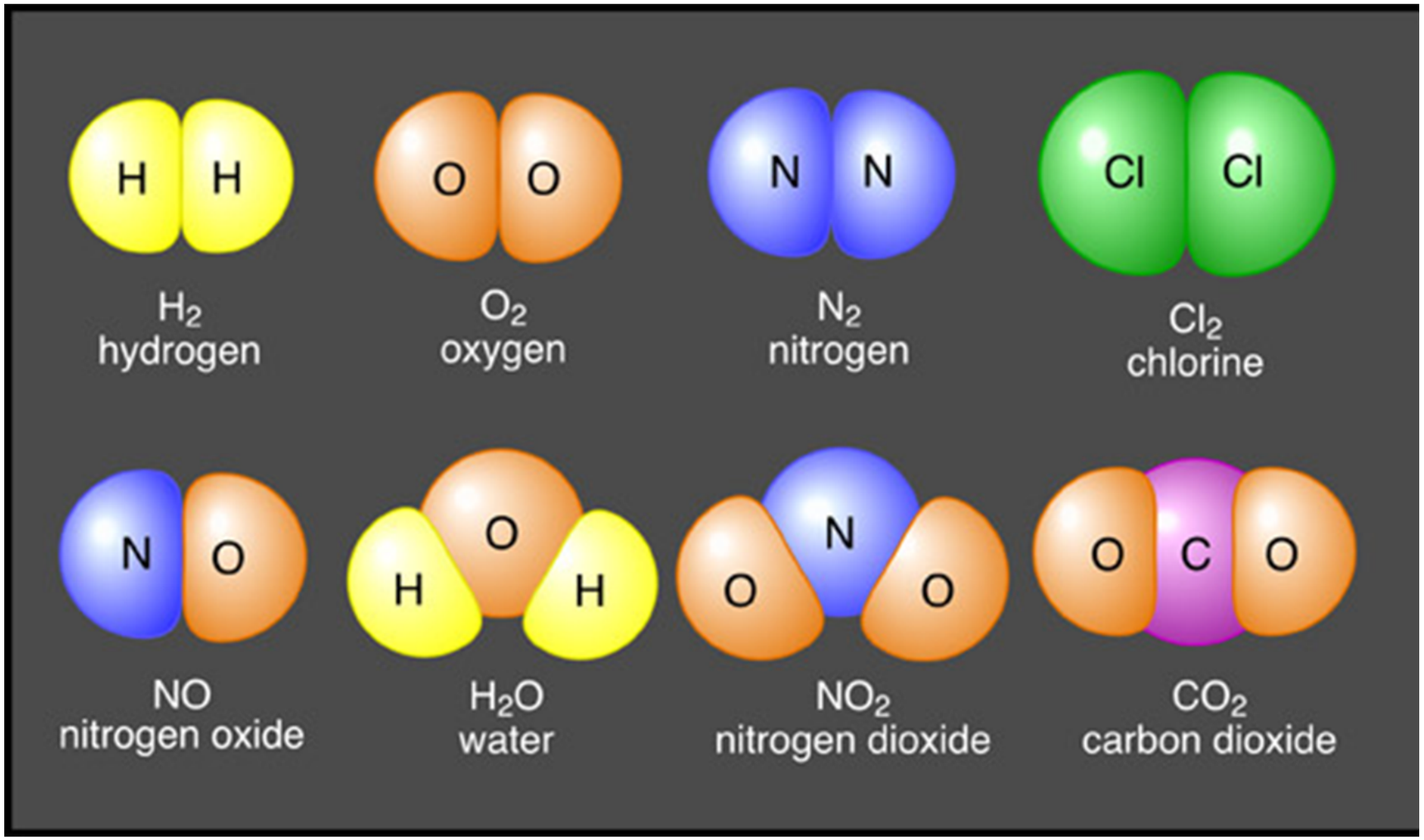
> Ex: A block of pure gold contains nothing but gold atoms (Au)

Elements are organised in the Periodic Table by their **atomic number**



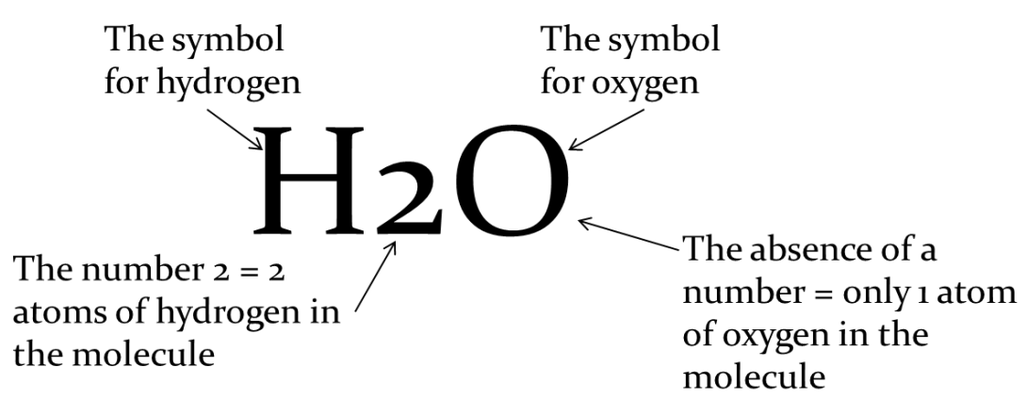
Combining atoms to make molecules

- **Molecule:** a group of two or more atoms that are chemically bonded.
- Ex: A molecule of water (H^2O) is made from a chemical bond between 2 atoms of Hydrogen and one atom of Oxygen

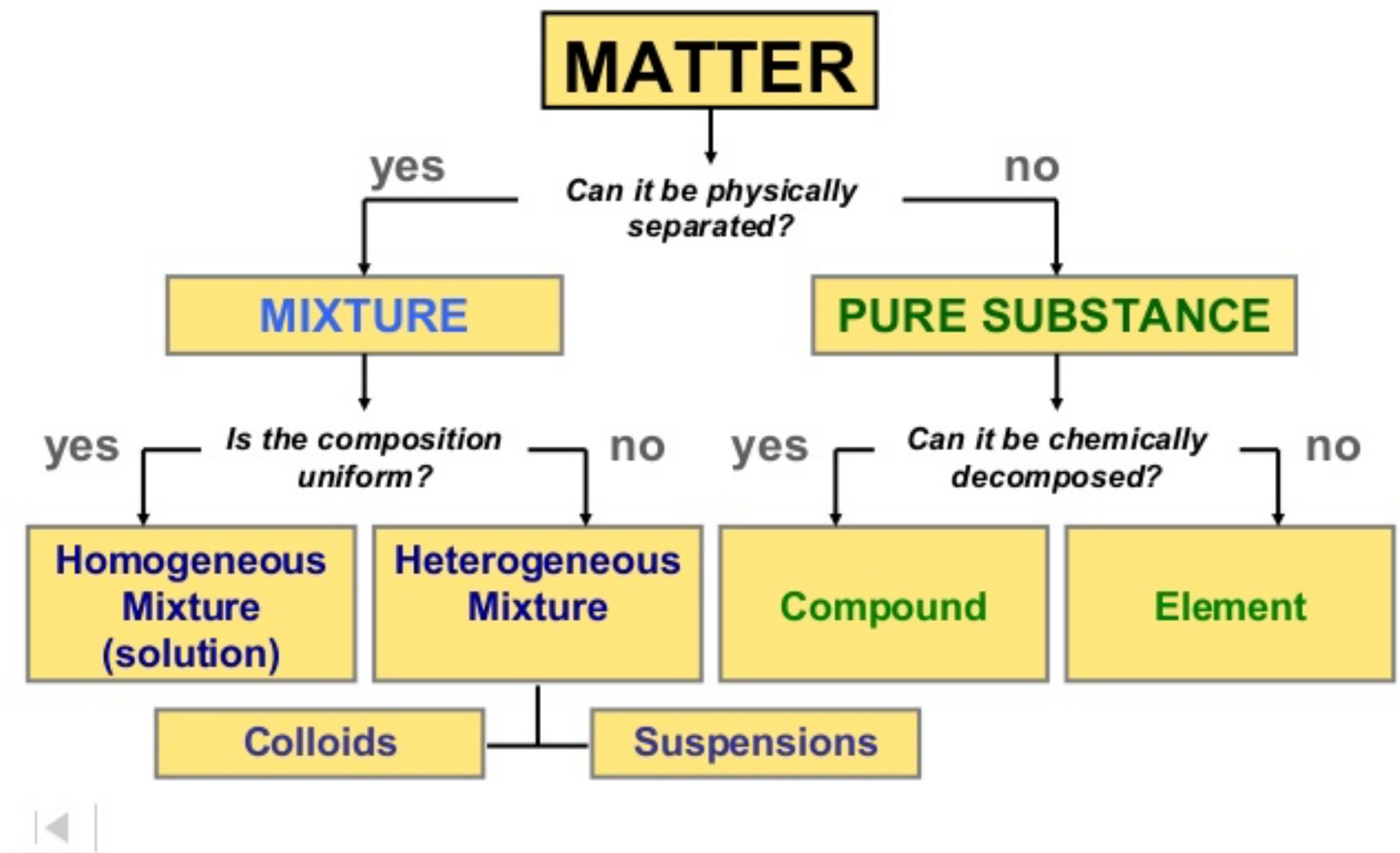


Chemical Formulas

- Molecules are represented by their chemical formulas.
- This shows the nature and the number of each atom that composes the molecule.
- Each atom is represented by its symbol from the periodic table.
- The number of each atom is written directly after the symbol. (the number 1 is not written)



Matter is divided into two categories:



Courtesy Christy Johannesson www.nisd.net/communicationsarts/pages/chem

Pure Substances

- Made up of only **ONE** type of particle regardless of whether they are atoms or molecules.
- Pure substances are made up of:

1. Elements (made up of atoms)
2. Compounds (made up of molecules)

Compound: a pure substance made of one type of molecule containing two or more different atoms bonded together.

(Ex: NaCl-table salt made of sodium and chlorine)

- Compounds can be separated into their individual elements.
- E.g. Water (H^2O) can be broken down into hydrogen and oxygen using a process called electrolysis

Pure Substances Summarised

Atoms	Elements	Molecules	Compounds
• Building blocks of life • Simplest form of the element • Examples ❖ 2 nitrogen atoms (2 N) ❖ 3 Oxygen atoms (3 O) ❖ 4 hydrogen atoms (4 H)	• Is a substance that cannot be broken down. • Made up of identical atoms • Examples ❖ Element nitrogen (N) ❖ Element oxygen (O) ❖ Element Hydrogen (H)	• Two or more atoms bonded together chemically • Examples ❖ A molecule of water (H_2O) ❖ 2 molecules of carbon dioxide (2 CO_2) ❖ A molecule of oxygen (O_2)	• Two or more different elements bonded together • Examples ❖ H2O ❖ CO ❖ CO2 ❖ C6H12)6 ***A molecule is NOT always a compound ***A compound IS ALWAYS a molecule.

Mixtures

- two or more different substances that are not chemically combined with each other (contains at least two types of particles)

They Can be separated by physical means (ex. filtration).

Substances in a mixture keep their individual properties.

Heterogeneuos Mixtures: made up of at least two substances that CAN be distinguished. (Can see the layers)

Examples: Water and Sand

Oil and Water

Homogeneous Mixtures: made up of at least two substances which CANNOT be distinguished to the naked eye.

Examples: tap water, salt water, air, orange juice without pulp, and skim milk.

Would the following be considered a heterogeneous or homogeneous mixture?

1) water	homogeneous
2) air	homogeneous
3) vegetable soup	heterogeneous
4) coffee (with & without milk)	homogeneous
5) beach sand	heterogeneous
6) salsa	heterogeneous

Two types of homogeneous mixtures

Solutions: homogeneous mixture in which it is **impossible** to distinguish the different parts

ex: water (H^2O) and Salt

Solute: substance that dissolves in another substance (Salt)

Solvent: substance that can dissolve a solute (water)

Colloid: a homogeneous mixture with at least two different substances that can be distinguished under magnification

*mayonnaise (egg yolk and oil)

Properties of Matter

- **Properties**: information used to identify a substance or a group of substances.
- Properties help us tell substances apart even though they may look the same.

Physical properties: properties we can simply observe or measure without modifying the nature of the substance.

Ex: color, smell, physical state, melting point, boiling point, mass, texture, taste, ductility, malleability, volume, density, electrical conductivity, solubility.

Chemical properties: describe how the substance reacts with other substances.
Ex: Combustible, reacts to water or acid, resists corrosion (rust), reacts to contact with flame, reacts to lime water.

Physical and chemical properties can be either:

characteristic or non-characteristic

Characteristic property	Non-characteristic property

Characteristic or Non-Characteristic

CP	NCP

Magnetism

Shape

Density

Mass

Temperature

Solubility

Melting Point

Volume

Colour

Boiling Point

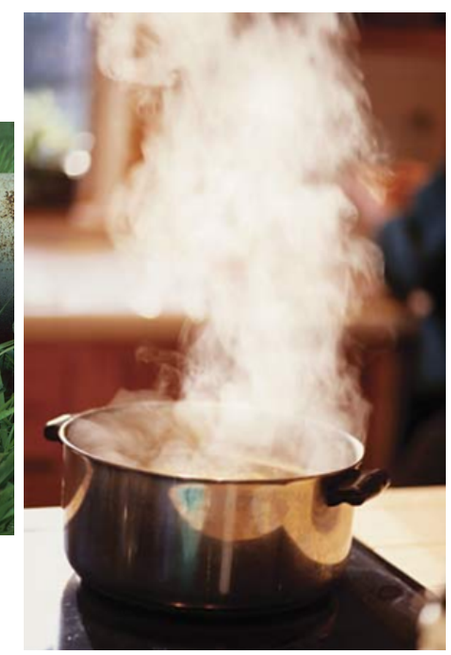
Changes in Matter

- Matter around us goes through many changes.
  - Ex. Water evaporates, bread is toasted for your breakfast
- Changes are divided into two categories:
  - Physical changes
  - Chemical changes

Physical Changes

- **<u>Physical change</u>** is when the appearance of a substance is changed but not the nature of the substance.
- Does not affect the characteristic properties.
  - Ex: Ice, water, and steam are all water in different states

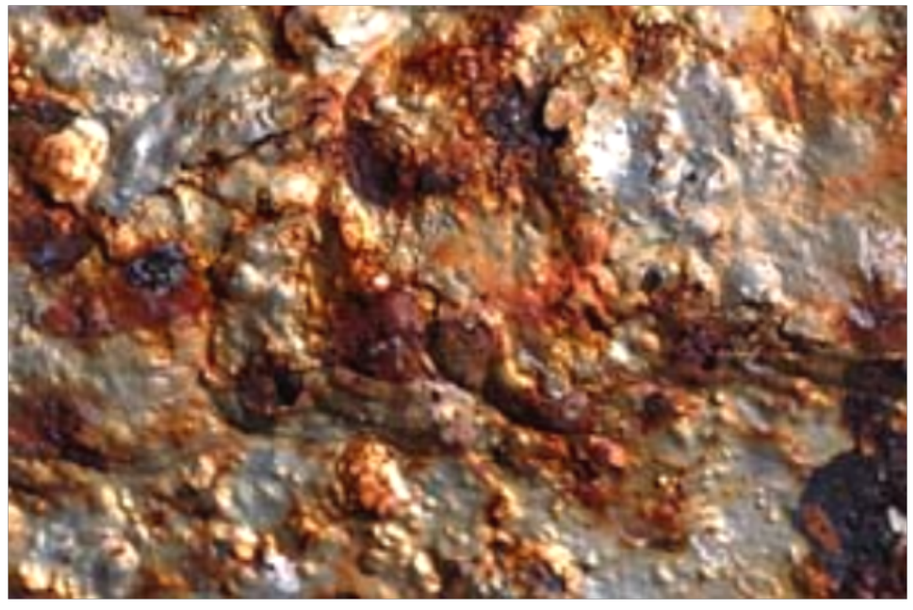




Ex: Cutting bread, tearing paper, phase changes

Chemical Changes

- **Chemical change** happens when two or more substances (reactants) react with each other to produce a new product
- The nature of the substance is modified as are the characteristic properties
  - E.g. Iron + Oxygen = Iron oxide (rust)



Signs of a Chemical Change

1) Change in colour

2) Formation of a gas (bubbles appear in a liquid, or the presence of "smoke")

3) Formation of a precipitate (when two liquids are mixed and a solid forms, which settles to the bottom)

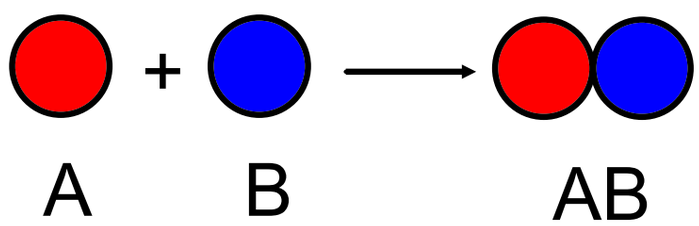
4) Change in heat (gets warmer or cooler)

5) Light is produced

Chemical Transformations

- A chemical transformation occurs when substances called *reactants,* interact to produce new substances called *products having very different characteristic properties.*

- To represent a chemical transformation we use <u>equations</u>

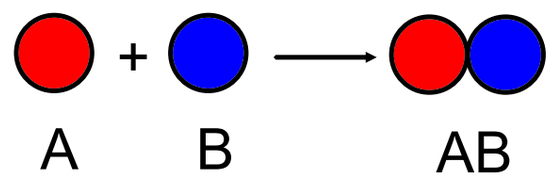


There are four types of chemical reactions:

- **Synthesis**
- **Decomposition**
- **Oxidation**
- **Precipitation**

Synthesis Reaction

- Two or more substances COMBINE to produce a new substance



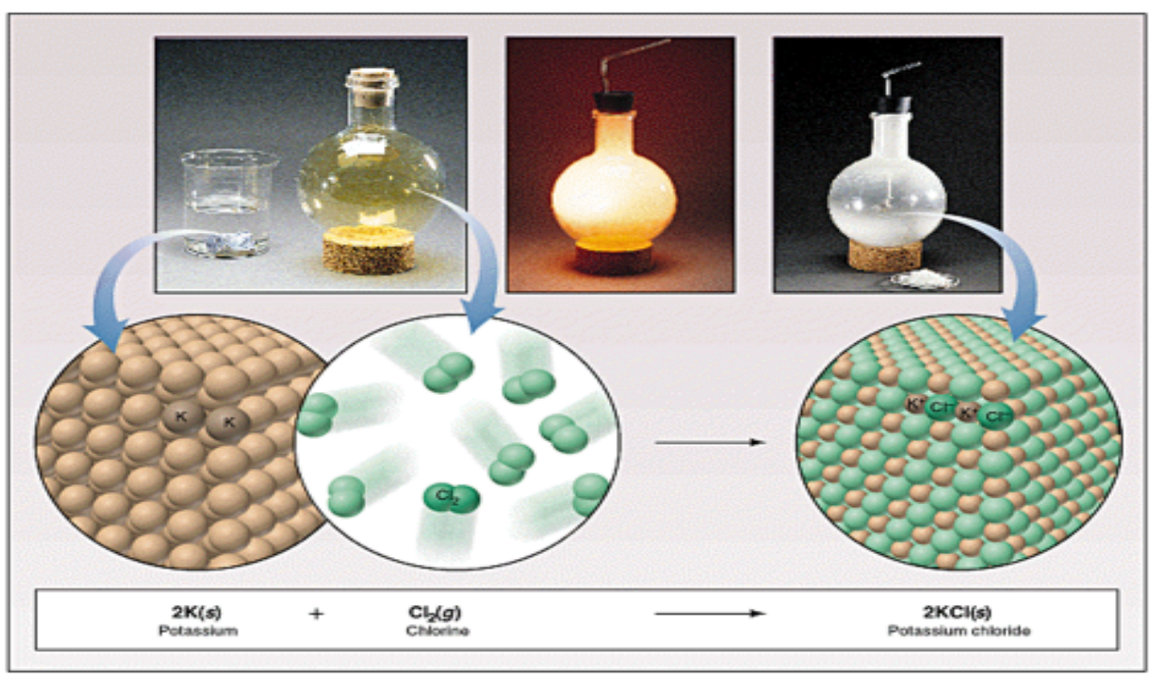
-The resulting product has a greater mass than either of the reactants individually.

EXAMPLES:

$2H^2 + O^2$ ---> $2H^2O$ Hydrogen + Oxygen ---> Water

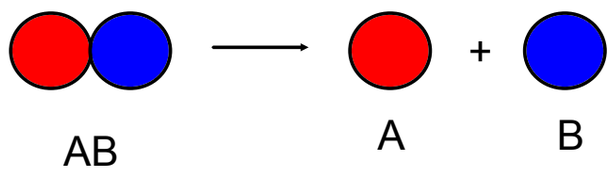
Cl^2 + 2Na ---> 2NaCl Chlorine + Sodium ---> Sodium Chloride (table salt)

Burning Magnesium



Decomposition Reaction

- A compound is broken down into 2 or more substances



- The resulting products have a lower mass (individually) than the initial reactant

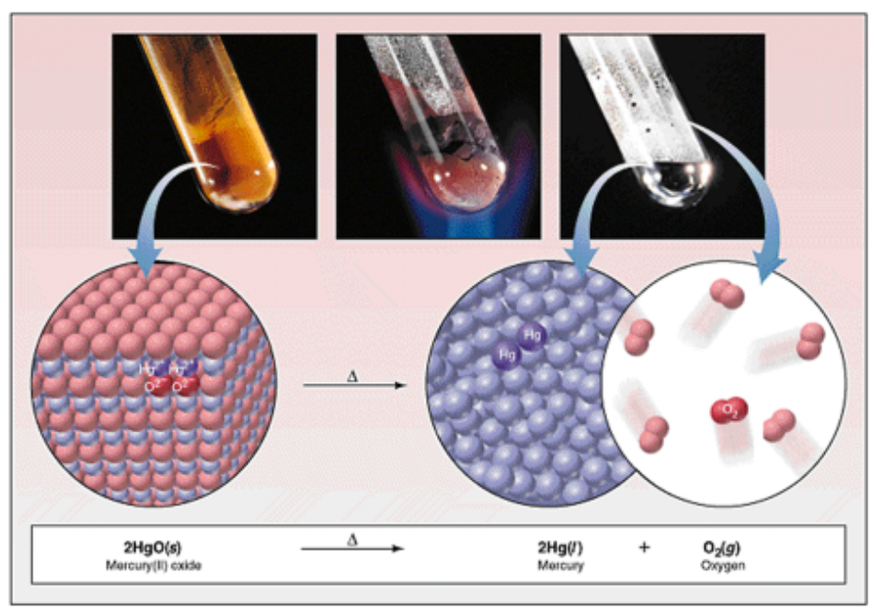
EXAMPLES:

$2H^2O$ --> $2H^2$ + O^2 Water --> Hydrogen + Oxygen

$2NaHCO^3$ --> Na^2CO^3 + CO^2 + H^2O

Sodium Bicarbonate (Baking Soda) --> Sodium Carbonate + Carbon Dioxide + Water

Decomposition of Hydrogen Peroxide (H2O2)



Oxidation Reaction

- Occurs when a substance combines with one or more atoms of oxygen.

- The resulting substance is an OXIDE.

- Oxidation reactions are synthesis reactions that involve oxygen

EXAMPLES:

$4Fe + 3O^2 \text{ ---> } Fe^2O^3$ Iron + Oxygen ---> Iron oxide (rust)

$C^6H^{12}O^6 + 6O^2 \text{ ---> } 6CO^2 + 6H^2O$ + Energy

Glucose (sugar) + Oxygen ---> Carbon Dioxide + Water

Oxidizing Glucose (Gummy Bear Sacrifice)

Precipitation Reaction

- Occurs when two substances in solution combine to form a new substance that is insoluble in the solution

- Insoluble: incapable of being dissolved

- This insoluble substance is called the precipitate (solid)

EXAMPLE:

$$Pb(NO^3)^2\ (aq) + 2KI\ (aq) \text{ ---> } PbI^2\ (s) + 2KNO^3\ (aq)$$

Lead (II) Nitrate + Potassium Iodide ---> Lead (II) Iodide + Potassium Nitrate

Precipitation for Relaxation

Identify each of the following as either a <u>chemical</u> or a <u>physical</u> change.
Why?

a. Melting candle wax. - physical
b. Burning a candle. - chemical
c. Tearing paper. - physical
d. Burning paper. - chemical
e. Dissolving table salt. - physical
f. Cutting pieces of cucumber. - physical
g. Food rotting.- chemical

Identifying Substances in the Lab

-Often we are asked to identify various substances in the lab based on their physical or chemical properties

-Specifically, we are able to identify them by testing for the presence of characteristic properties

Tests for identification

Substance	Test	Reaction
Electrocond-uctivity	Conductivity Meter	If the substance can conduct electricity, the conductivity meter will light up when the prongs are placed on the substance.
Presence of H^2O	Cobalt Chloride Paper (CCP)	Will turn from dark blue to light pink if water is **present** in the solution.
pH level	Red Litmus Paper (RLP) Blue Litmus Paper (BLP)	An acid will turn the BLP red (BRA) A base will turn RLP blue A neutral substance will not cause either to change colour
Presence of Glucose	Glucose Test Paper	If the substance contains carbohydrates (glucose), the glucose test paper will turn from yellow to green when placed in the substance
Presence of Protein	Protein Test Solution	The solution will begin to turn violet around the edges if protein is present
Presence of Fat	Alcohol Test	When alcohol is added to the solution, it will turn cloudy and white if fat is present
Presence of H^2 Gas	Lit Splint Test	When a lit splint (burning) is placed in the presence of H^2 gas, a "popping" sound will be heard
Presence of O^2 Gas	Glowing Splint Test	When a glowing splint (glowing embers) is placed in the presence of O^2 gas the splint will re-ignite
Presence of CO^2 Gas	Lime water Test	When lime water, $Ca(OH)^2$ is added to CO^2 gas, the liquid becomes cloudy/milky and a precipitate is formed

Which of the above tests are characteristic?

Density

Amount of matter in a given volume of a substance.

- physical characteristic property
- allows you to identify an unknown because it can be measured.
- Every substance has a UNIQUE density

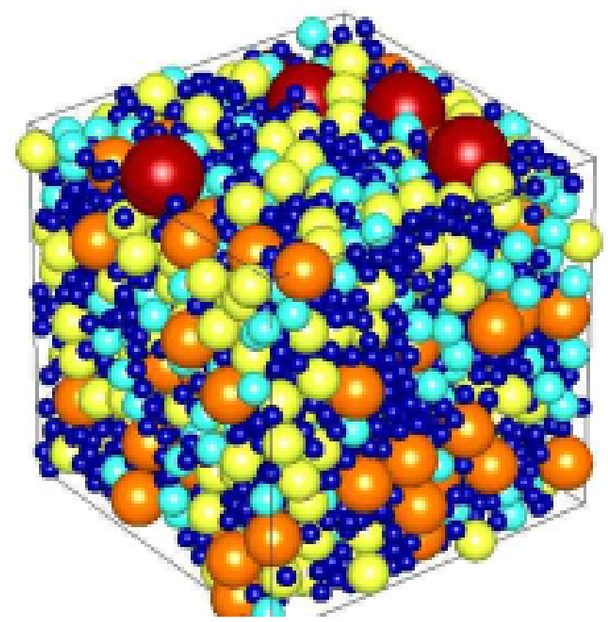
- The density of water is 1 g/mL
- The formula for density is m/v
- NOTE: 1mL = $1cm^3$

Formula for Density

Density is defined as mass per unit volume:

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

Density → D; mass → m; volume → V



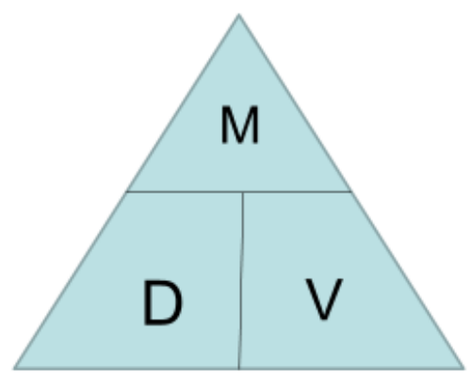
D=M/V	Regular Solid	Irregular Solid	Liquid	Units
Mass	Weigh solid on electronic balance	Weigh irregular solid on electronic balance (may need to use a weighing boat)	Weight liquid in a container (weigh empty container, put liquid in container, weigh it again) Final weight –weight of container= weight of liquid	g or kg
Volume	Length x width x height (use a ruler)	Water displacement. Fill graduated cylinder with enough water to cover object. Place object in cylinder. Final volume –initial volume = volume of object.	Measure liquid in a graduated cylinder or beaker (check meniscus)	Solid cm^3 m^3 Liquid mL L
Density	Divide mass by volume g/cm^3	Divide mass by volume g/cm^3 or g/ml	Divide mass by volume g/ml	

Finding Density

- To find density, you must first find the mass of an object and measure its volume. Then you divide mass by volume to get its density.
- Units for density: g/ml (liquid) or g/cm^3 (solid)
- Ex: Calculate the density of 75 mL of a substance which has a mass of 94.5g at 20^oC.

$$d = \frac{m}{v} = \frac{94.5\ g}{75\ mL} = 1.26\ g/mL$$

Density Triangle



Example

- A recipe calls for 13.8g of olive oil. If oil has a density of 0.92 g/mL, how many mL does a mass of 13.8 g correspond to?

$$d = \frac{m}{v}$$

$$\frac{0.92\ g}{1\ mL} = \frac{13.8\ g}{y\ mL}$$

$$\frac{13.8\ g \times 1\ mL}{0.92\ g} = 15\ mL$$

A mass of 13.8 g corresponds to 15 ml of olive oil.