Republic of Iraq
Ministry of Higher Education & Scientific research
Al-Mustaqbal University
Science College
Biochemistry Department

Introduction in Chemistry

For

First Year Student

Lecture 1

By

Dr. Karrar M. Obaid

2024-2025

An Introduction in Chemistry

Matter: Is anything that it can take place, or it is anything that has mass and volume.

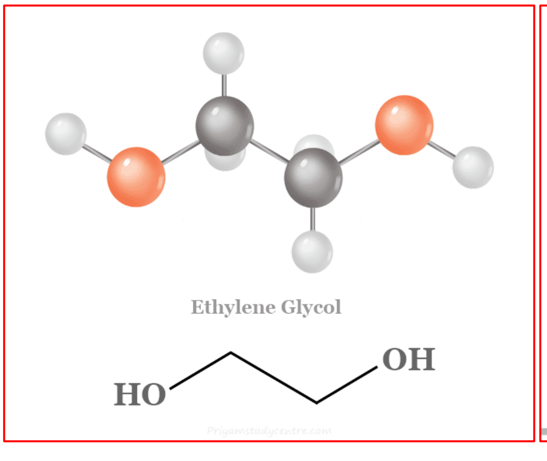
Examples of matter : sand (a solid), water (a liquid), Air (a mixture of gases).

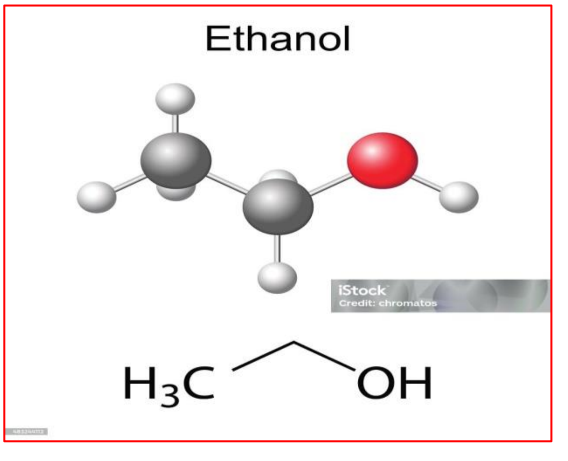
Properties of matter:

1-Physical Properties of Matter: Does not change the identity of the matter. like color, melting point, boiling point etc.….

2-Chemical Properties of Matter: Changes the matter in determining the property, Like combustion.

Note: the properties of matter relate to both the kinds of atoms the matter contains (compositions) and to the arrangements of these atoms (structure).





Even apparently minor differences in the composition or structure of molecules can cause profound differences in properties.

1. Ethanol, for example, is not toxic while ethylene glycol is toxic.

2. Ethanol has a low viscosity while ethylene glycol is viscous.

3. Ethanol has a low boiling point while ethylene glycol has a high boiling point.

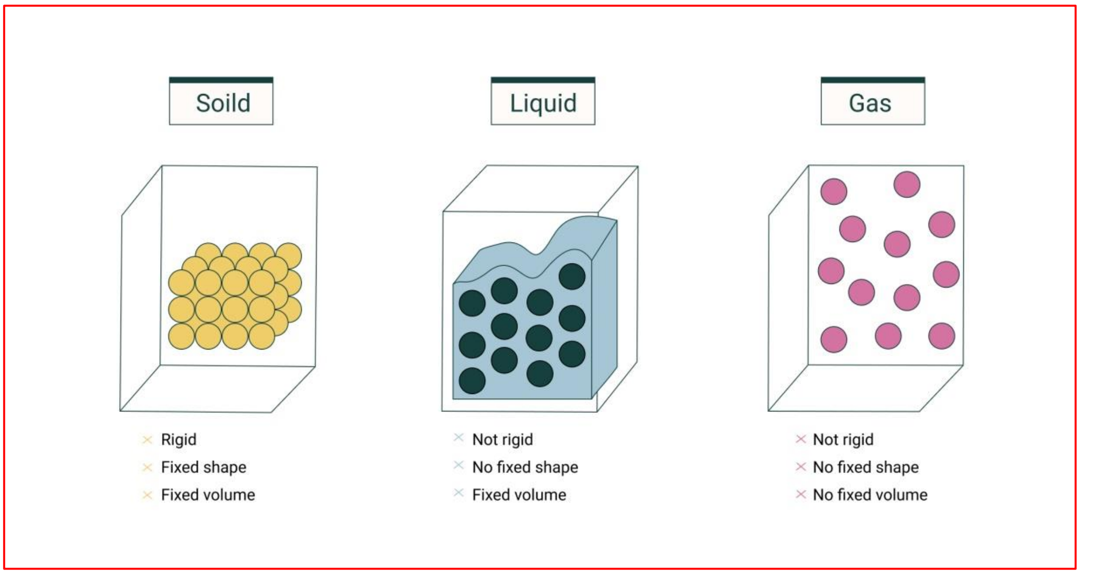
There are four states of matter:

• **Solid:** a state of matter that has a definite shape and volume.

• **Liquid:** a state of matter that has no definite shape but has a definite volume.

• **Gas:** a state of matter that has no definite shape or volume.

• **Plasma:** a state of matter that are gases that have so much energy that electrons of an atom cannot stay in orbitals around one atomic nucleus. The atomic ions and free electrons mix around.



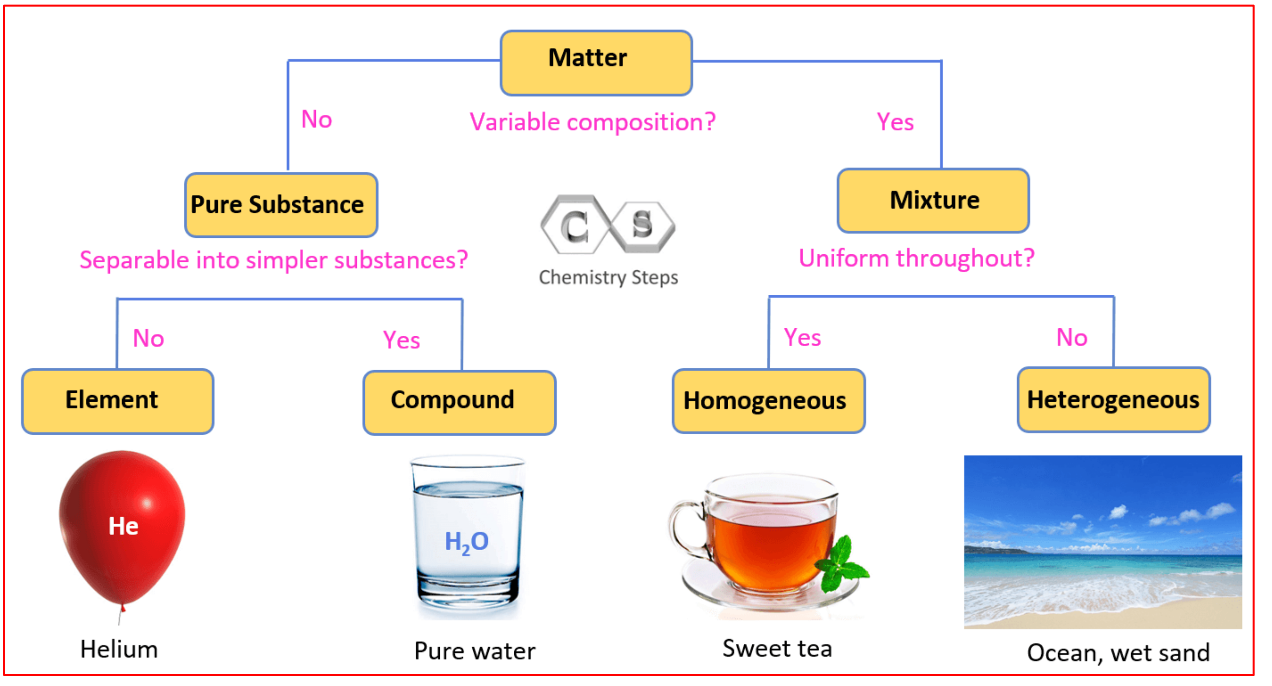
Pure substance: is a substance that has only one component, for example H_2O and NaCl.

There are different types of a pure substance:

Elements: A substance that cannot be chemically converted into simpler substances. **Hydrogen and oxygen for example are elements.**

Compounds: A substance that contains two or more elements.

All matter classified to a pure **substance or a mixture**.



The elements hydrogen and oxygen may combine to form the compound water H_2O.

<u>**A mixture**</u>**:** is a composed of two or more pure substances in which each substance retains its own identity.

A mixture may be either:

Homogenous mixture: matter that has the same properties throughout the sample.

Heterogeneous mixture: matter with properties that are not the same throughout the sample.

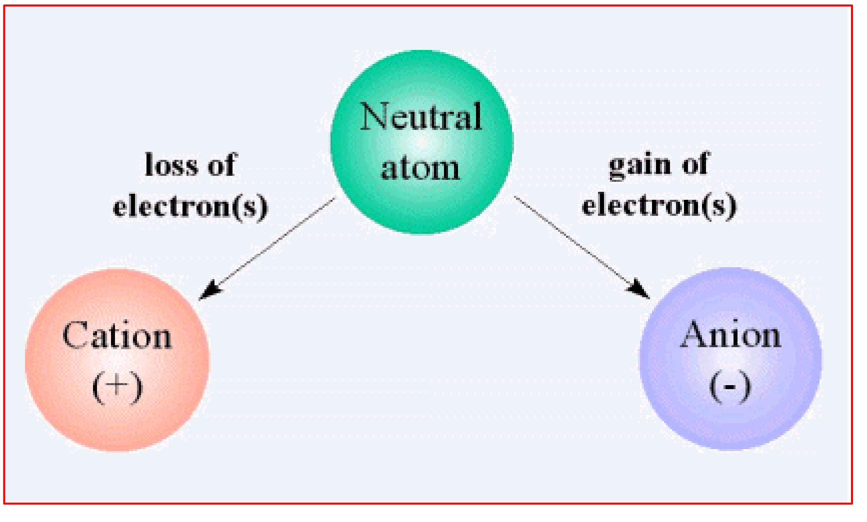
<u>**Molecules**</u> This is the smallest unit of a compound. For example, water is *dihydrogen oxide.*

A diatomic molecule contains only two atoms (H_2,N_2,O_2,HCl,CO).

A polyatomic molecule contains more than two atoms (O_3,H_2O,NH_3,CH_4).

Element	Molecular Formula	Empirical Formula
Water	H_2O	H_2O
Glucose	$C_6H_{12}O_6$	CH_2O
Hydrogen Peroxide	H_2O_2	HO
Butane	C_4H_{10}	C_2H_5
Benzene	C_6H_6	CH

<u>**Ion:**</u> an atom or group of atoms that carries a positive or negative electric charge as a result of having lost or gained one or more electrons. Positive ion (cation)- occurs when an atom loses an electron , it has more protons than electrons. Negative ion- occurs when an atom gains an electron, it will have more electrons than protons.



Positive charge $\longrightarrow$ **Cation**.

Negative charge $\longrightarrow$ **Anion**

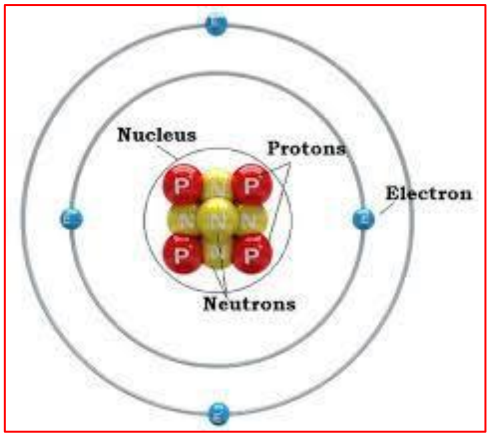
A ***monatomic ion*** contains only one atom

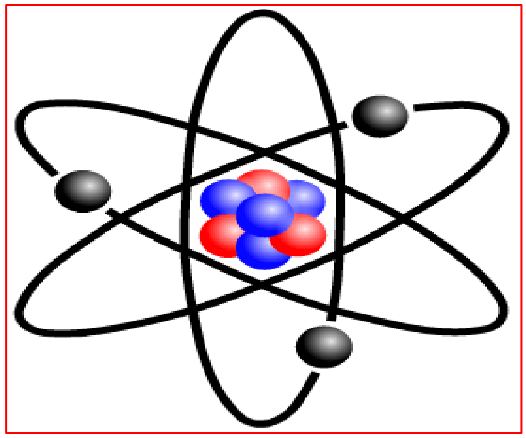
Na^+ , Cl^- , Ca^{+2} , O^{-2} , Al^{+3} , N^{-3}

A ***polyatomic ion*** contains more than one atom

OH^-, CN^- , NH_4^+, CO_3

<u>Atom:</u> Atoms are the basic units of matter and the defining structure of elements.





Atoms are made of three basic subatomic particles:

1. The ***protons*** have a ***positive*** electric charge.

2. The ***electrons*** have a ***negative*** electric charge.

3. The ***neutrons*** have ***no electric*** charge.

Protons and ***neutrons*** are **heavier** than electrons and found in the center of the atoms, which is called ***nucleus***.

<u>Nucleus</u>*:* small, dense center of atom and contains almost all the mass of the atom and contains protons and neutrons.

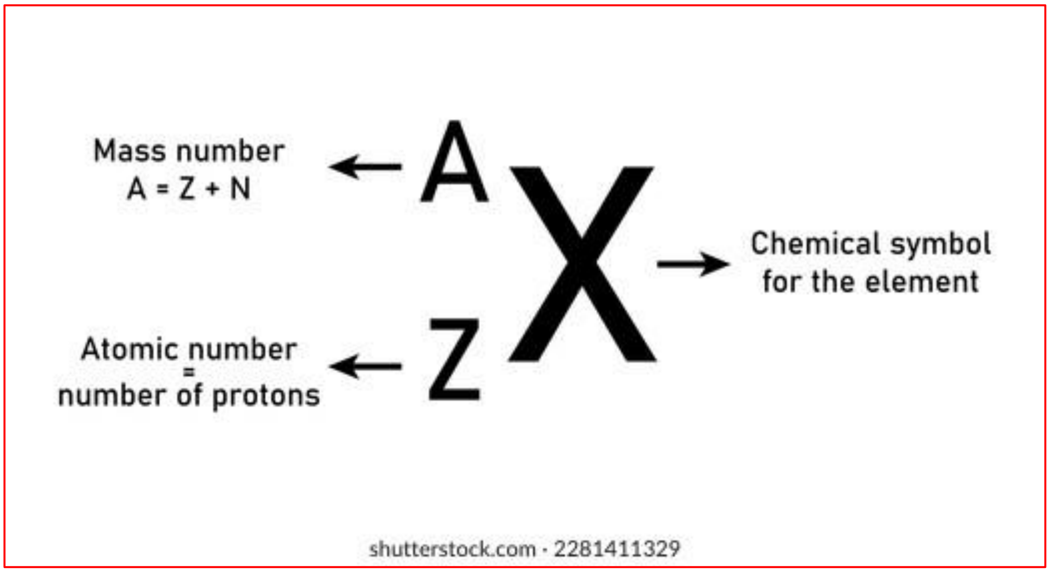
<u>Electrons</u> are very **lightweight** and **exist** in a cloud orbiting the nucleus.

Protons and neutrons have approximately the ***same mass*** and different with electrons where one proton weighs more than electron by **1800** times.

Atoms always have **an equal number** of ***protons*** and ***electrons***, and the number of ***protons*** and ***neutrons*** is usually **the same** in the nucleus as well. If the number of protons and electrons are equal, that atom is electrically **neutral**.

Atoms can attach to another one or more by **chemical bonds** to form **chemical compounds** such as **molecules**.

We use the following symbol to describe the atom :



Atomic number (Z): is the number of protons in the nucleus of the atom.

$$Z = \#P = \#E$$

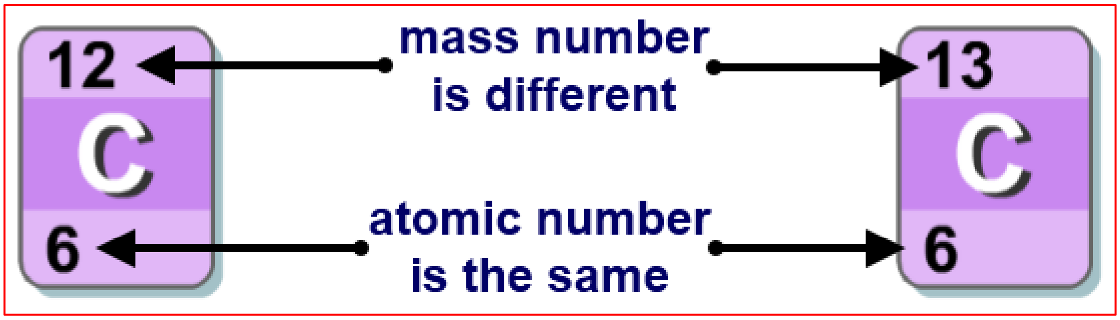
Note: Adding a **proton** to an atom makes a **new** element.

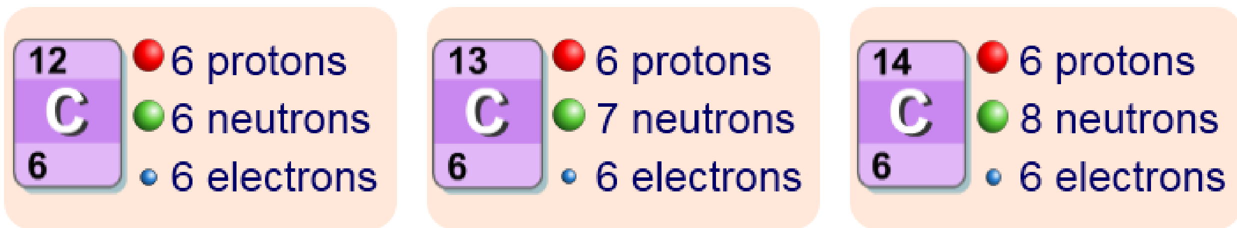
Mass number: is the sum of protons and neutrons in the nucleus.

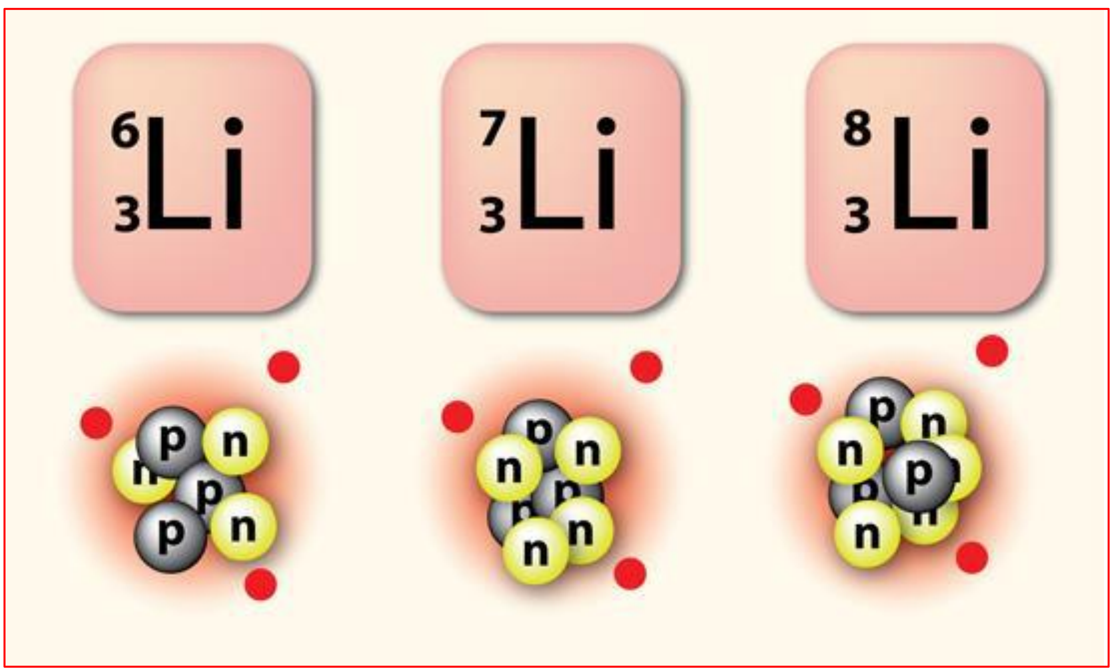
$$A = \#P + \#N$$

Note: **Atomic number** and **Atomic weight (mass number).**

<u>Isotopes;</u> Atoms that have the same number of protons and different number of neutrons, (atoms with same atomic number and different atomic weight). For example:







Average Atomic Mass

The calculation of the average atomic mass of an atom is performed using the relative abundance data from the isotope of each atom The average atomic mass of an element is the sum of the masses of its isotopes, each multiplied by its natural abundance (the decimal associated with percent of atoms of that element that are of a given isotope).

$$\frac{\textbf{[(\% abundance of isotope) (mass of isotope)] + [(\% abundance of isotope) (mass of isotope)] + [...]}}{\textbf{100}}$$

For example

the natural abundance for chloro isotopes is 75.78% ^{35}Cl (34.968853amu*) and 24.22% ^{37}Cl (36.9659033amu*). Calculate the atomic mass of Cl

Solution

$$^{35}_{17}Cl, \quad ^{37}_{17}Cl$$

75.78%, 24.22%

$$\text{Average atomic mass} = \frac{[(75.78)(34.968853)] + [(24.22)(36.9659033)]}{100}$$

= 35.45

Example 2

The natural abundance for boron isotopes is 19.9% ^{10}B (10.013 amu*) and 80.1% ^{11}B (11.009 amu*). Calculate the atomic mass of boron.

$$\textbf{Average atomic mass} = \frac{[(19.9\%)(10.013)] + [(80.1\%)(11.009)]}{100}$$

= 10.811 (note that this is the value of atomic mass given on the periodic table)

****amu*** is the atomic mass unit, which is defined as 1/12th the mass of a carbon-12 atom. This value provides a reference point for measuring relative atomic masses.

*The average atomic mass also known as the molar mass or relative atomic mass (**RAM**).

Tables of Isotopic Masses and Natural Abundances

These tables list the mass and percent natural abundance for the stable nuclides.

Element	Isotope	Isotopic mass (u)	Abundance (%)
Hydrogen	$^{1}_{1}H$	1.007825	99.985
	$^{2}_{1}H$	2.0141102	0.015
Carbon	$^{12}_{6}C$	12.0	98.90
	$^{13}_{6}C$	13.003355	1.10
Nitrogen	$^{14}_{7}N$	14.003074	99.634
	$^{15}_{7}N$	15.000109	0.366
Oxygen	$^{16}_{8}O$	15.994915	99.762
	$^{17}_{8}O$	16.999131	0.038
	$^{18}_{8}O$	17.999159	0.200
Phosphor	$^{31}_{15}P$	30.973763	100
Sulfur	$^{32}_{16}S$	31.972072	95.02
	$^{33}_{16}S$	32.971459	0.75
	$^{34}_{16}S$	33.967868	4.21
	$^{36}_{16}S$	35.967079	0.02
Chlorine	$^{35}_{17}Cl$	34.968852	75.77
	$^{37}_{17}Cl$	36.965903	24.23
Iron	$^{54}_{26}Fe$	53.939612	5.8
	$^{56}_{26}Fe$	55.934939	91.72
	$^{57}_{26}Fe$	56.935396	2.2
	$^{58}_{26}Fe$	57.933278	0.28
Bromine	$^{79}_{35}Br$	78.918336	50.69
	$^{81}_{35}Br$	80.916290	49.31