

## Introduction to analytical chemistry

**Matter:** Is anything that has mass and takes up space. (solid, liquid, gas)

- All properties of matter are either physical or chemical properties
- **Physical property:** Any characteristic that can be determined without changing the substance's chemical identity.
- **Chemical property:** Any characteristic that can be determined only by changing a substance's molecular structure.

### Physical Properties

Some examples of physical properties are:

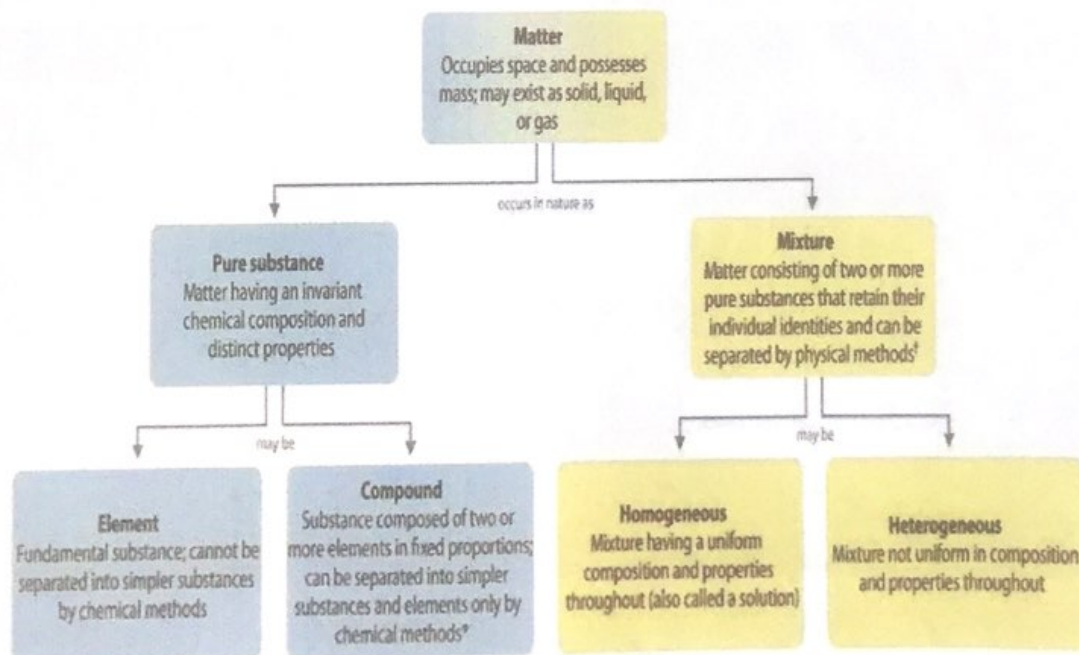
- color
- density
- volume
- mass

### Chemical Properties

- Hydrolysis and oxidation are two such reactions and are both chemical changes.
- Flammability, burning is a chemical reaction

**Matter may have divided into three categories**

1- elements 2- compound 3- mixture

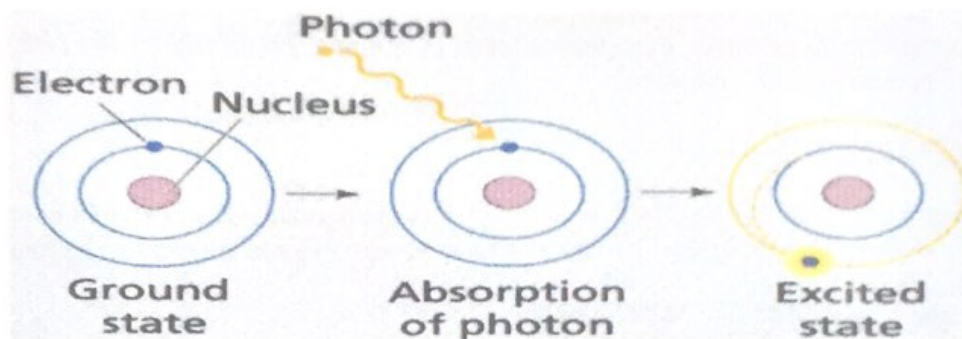


<sup>\*</sup> Chemical methods of separation include electrolysis.

<sup>†</sup> Physical methods of separation include filtration, distillation, and crystallization.

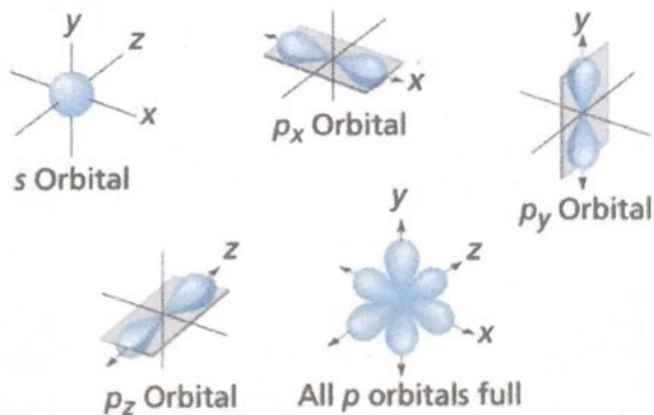
Carbon has three isotopes, of which carbon-12 and carbon-14 are the most well known.  
 ${}^6\text{C}^{12}$ ,  ${}^6\text{C}^{13}$ ,  ${}^6\text{C}^{14}$   
 ${}^8\text{O}^{16}$ ,  ${}^8\text{O}^{17}$ ,  ${}^8\text{O}^{18}$

### Electrons and energy



Energy levels (also referred to as **electron shells**) are located a certain "distance" from the nucleus. The major energy levels into which electrons fit, are (from the nucleus outward) **K, L, M, and N**. Sometimes these are numbered, with electron configurations being:  $1s^2 2s^2 2p^1$ , (where the first shell K is indicated with the number 1, the second shell L with the number 2, etc.).

Figure : Geometry of orbitals. S-orbitals are spherical, p-orbitals are shaped like a dumbbell .



1S  
 2S 2p  
 3S 3p 3d  
 4S 4p 4d 4f  
 6S 6p 6d  
 7S 7p

### Elements

are substances consisting of one type of atom, for example Carbon atoms make up diamond, and also graphite. It's the substance have the same atomic number as  $_{11}\text{Na}$ ,  $_{8}\text{O}$ ,  $_{6}\text{C}$

Molecule: many atoms of same element or different element

Exp.  $\text{H}_2\text{O}$  M.wt =  $2+16=18$

The earth composed about 103 differs simple chemical substance called element

**properties of the element**: Elements are made up of atoms, the smallest particle that has any of the properties of the element.

A) Nucleuses which consist:

1- proton is located in the center (or nucleus) of an atom, each atom has at least one proton. Protons have a charge of +1, .Elements differ from each other in the number of protons they have, e.g.

Hydrogen has 1 proton; Helium has 2.

2- neutron also is located in the atomic nucleus (**except in Hydrogen**). The neutron has no charge, and a mass of slightly over 1 .

### B) orbital

The electron is a very small particle located outside the nucleus.. Electrons occupy orbitals,

Name	Charge	Location	Mass
Proton	+1	atomic nucleus	$1.6726 \times 10^{-27}$ kg
Neutron	0	atomic nucleus	$1.6750 \times 10^{-27}$ kg
Electron	-1	electron orbital	$9.1095 \times 10^{-31}$ kg

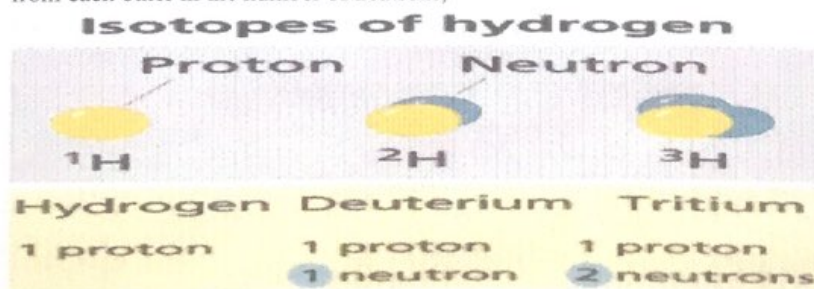
Atomic number = No. of protons = No. of <sup>electrons</sup>neutrons .

Mass number = No. of Proton + No. of neutron

${}_1\text{H}^1$        ${}_2\text{He}^4$  ( 2=atomic No , 4= mass No)       ${}_6\text{C}^{12}$

**Isotopes** atoms of the same element that have differing numbers of neutrons (but a constant atomic number) . Isotopes are also the source of radiation used in medical diagnostic and treatment procedures.

Figure 1. Note that each of these isotopes of hydrogen has only one proton. Isotopes differ from each other in the number of neutrons,



The atomic symbol for the fluorine atom is



### Solution

The atomic symbol provided gives us both the atomic number and the mass number.

Step 1. The atomic number,  $Z$ , is 9. Therefore, there are 9 protons.

Step 2. The number of protons is equal to the number of electrons in an atom. There are 9 electrons.

Step 3. The mass number,  $A$  is equal to 19.

The number of neutrons =  $A - Z$

Since the number of neutrons is equal to  $19 - 9 = 10$ , there are 10 neutrons.

**Isotopes** are atoms of the same element that have a different number of neutrons. Isotopes of the same element have the same chemical properties. The atomic mass is the weighted average of the masses of the isotopes of an element.

**Isotopes** are atoms of the same element having different masses *because they contain different numbers of neutrons*. In other words, isotopes have different mass numbers. For example, all of the following are isotopes of hydrogen.



Electrons are negatively charged particles that are located around the nucleus. Electrons are bound to the positively charged nucleus from opposite electric charges.

If an atom has more electrons than its atomic number, it is a negatively charged ion (**anion**).

If an atom has fewer electrons than its atomic number, it is a positively charged ion (**cation**).

As a whole, a charged atom is called an **ion**.

For a neutral atom, the number of electrons equals the number of protons.

An element is represented symbolically as follows: