ALMUSTAQBAL UNIVERSITY COLLEGE

Biomedical Engineering Department

Stage : Second year students

Subject : Chemistry 1 - Lecture 2

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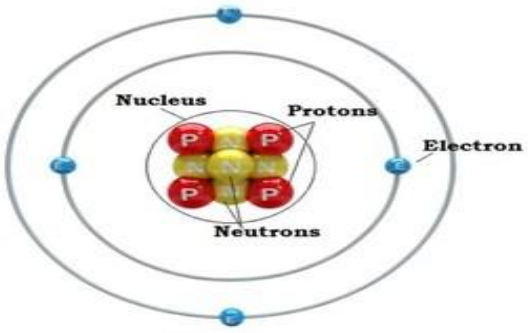
ATOMS AND ELEMENTS

Materials → Molecules → Atoms

An atom is The smallest and simplest particle of an element.it is the basic structure from which all matter is composed.

Atoms are composed of tiny **subatomic particles** called *Protons*, *Neutrons* , and *Electrons*.
An **atom** is composed of two regions:
- The nucleus, which is in the center of the atom and contains protons and neutrons, and
- The outer region of the atom, which holds its electrons in orbits around the nucleus.

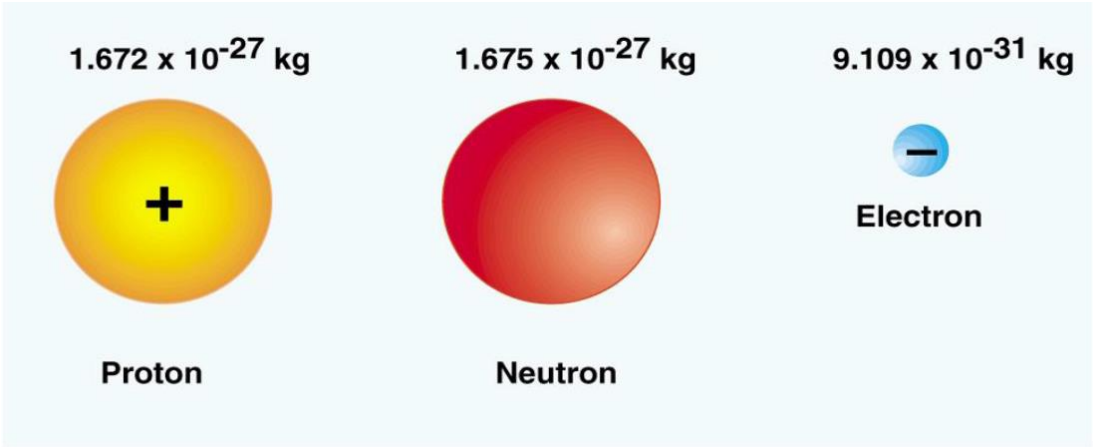
* A **proton** is a positively charged particle in an atom
* An **electron** is a negatively charged particle in an atom
* A **Neutron** is a neutral (neither negative nor positive) particle in an atom



• Atoms = Protons (p) + Neutrons (n) + Electrons (e)

	Mass (kg)	Charge (coulomb)
Proton	1.673×10^{-27}	$+1.602 \times 10^{-19}$
Neutron	1.675×10^{-27}	0
Electron	9.109×10^{-31}	-1.602×10^{-19}

• Fundamental charge = 1.602×10^{-19} C (Coulomb)



Model of Proton, Neutron and Electron

The proton and neutron have roughly the same mass and have approximately 1837 times the mass of the electron. The proton and electron have equal, but opposite, electrical charges. A neutron does not have an electrical charge (with a zero charge) .

Atoms of different elements differ from one another, according to how many protons they contain, by a value called the elements **atomic number** (***Z***).
Thus, if we know the number of protons in an atom, we can identify the element. Any atom with 6 protons, for example, is a carbon atom because carbon has Z = 6.
Atoms are neutral overall and have no net charge because the number of positively charged protons in an atom is the same as the number of negatively charged electrons. Thus, the atomic number also equals the number of electrons in every neutral atom of a given element .

Atomic Number (Z) = No. of protons = No. of electrons

The **Atomic Number (Z)** is the number of protons in an atom

The Mass Number (A) is The total number of protons and neutrons in atom

Atomic mass number (A) = atomic number (Z) + No. of neutrons(N)

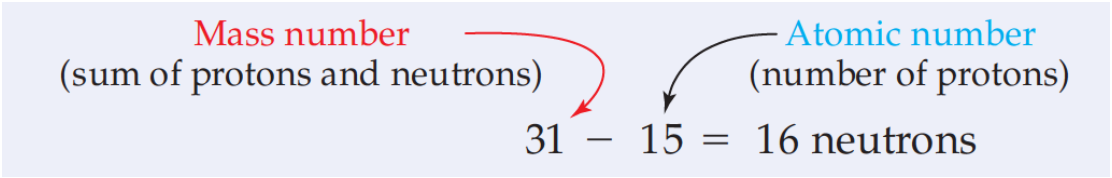
Atomic mass number (A) ≈ Z + N

element	Atomic number(Z)	No. of protons	No. of electrons	No. of nuetrons	Mass Number(A)
H	1	1	1	0	1
C	6	6	6	6	12
Na	11	11	11	12	23
F	9	9	9	10	19
Cl	17	17	17	18	35

Example:
Phosphorus has atomic number (Z= 15) How many protons, electrons, and neutrons are there in phosphorus atoms, which have mass number (A= 31).

ANSWER

The atomic number gives the number of protons, which is the same as the number of electrons, and the mass number gives the total number of protons plus neutrons. A = 31?



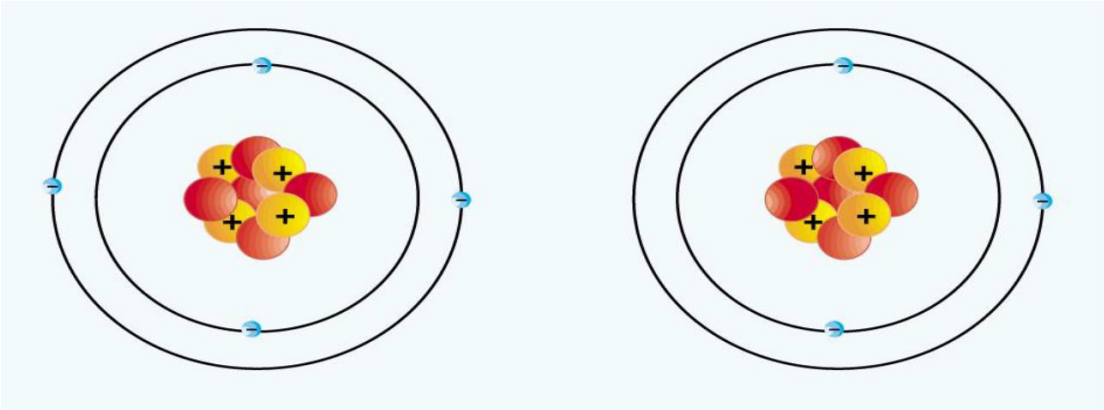
Excercise :
The Nickel element has An atom with atomic number (Z = 28) and has Mass Number of (A= 60) Give the number of electrons and neutrons in the atom.

Excercise:
The cobalt used in cancer treatments has atomic number (Z= 27) and mass Number (A = 60) . How many protons, neutrons, and electrons are in these cobalt atoms?

In an atom, the protons and neutrons gather in the center position that called the **Nucleus**. Because the protons are positively charged, the nucleus has a positive electric charge.
The electrons of the atom move rapidly around the nucleus.

The electrons are much more likely be located in certain regions of space surrounding the nucleus than in other regions of space.
Assuming that the electron is rapidly moving around the nucleus .
The probability of finding the electron in any region of space can then be described by a cloud .The density of the cloud at any point is the probability of finding the electron at that point.
The electrostatic attractive force between the positively-charged protons in the nucleus and the negatively-charged electrons around the nucleus holds the atom together.
Atoms containing the same number of protons and electrons have no net charge (**Neutral atoms**).
Atoms that have extra or missing electrons have a net electrical charge and are called **ions.**
Ions can interact with other of opposite charge by electrical attraction.

e.g: $Na^+ \leftrightarrow Cl^-$ → Na-Cl



Beryllium atom (Be)
4 protons , 4 electrons

Beryllium ion (Be^+)
4 protons , 3 electrons

Diagram Comparing a Beryllium atom (Be) and a Positively-Charged Beryllium Ion(Be^+)

Atoms interact with others by sharing or transferring electrons that are farthest from the nucleus.These electrons are called **valence electrons** .

***The Valence electrons determine the chemical properties of the element .**

Value of atomic number (Z) is different for each element

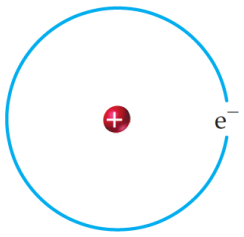
e.g : H (Z = 1) , O (Z = 8) , Fe (Z = 26)

*** The Number of protons describe the identity of the element**

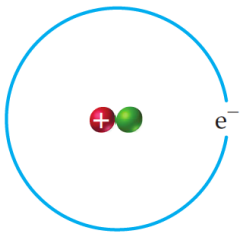
ISOTOPES

When an element has atoms that differ in the number of neutrons in the nuclei, these atoms are called different isotopes of the element. ***All isotopes of one element have identical chemical properties*.** This means that :

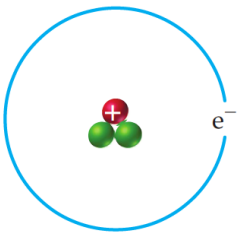
1. It is difficult to separate isotopes from each other by chemical processes.
2. The physical properties of the isotopes, such as their masses, boiling points, and freezing points, are different.
3. Isotopes can be most easily separated from each other using physical processes.



Protium—one proton (●) and no neutrons; mass number = 1

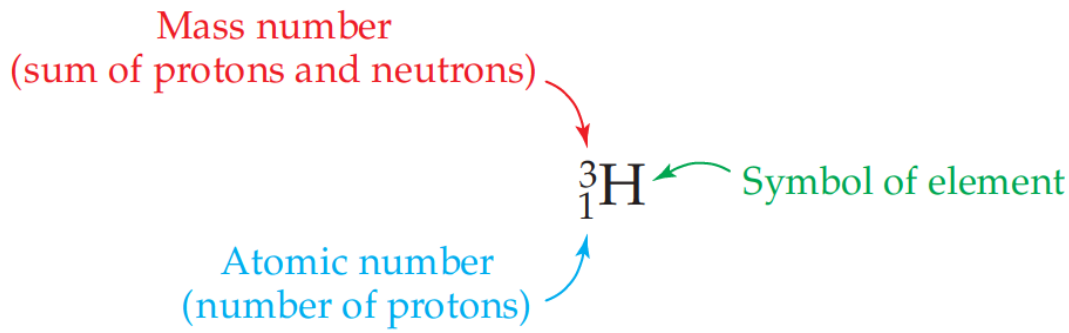


Deuterium—one proton (●) and one neutron (●); mass number = 2



Tritium—one proton (●) and two neutrons (●); mass number = 3

Tritium is represented by the following symbol and other elements are represented in the same manner



Since different isotopes of an element contain different numbers of neutrons in the nuclei of their atoms, isotopes of the same element will have different atomic masses. This was shown above for the three isotopes of hydrogen.

Isotopes are :

1. Atoms of the same element with the same number of protons
2. Have different number of neutrons.
3. Have the same number of electrons and the same chemical behavior.

Hydrogen isotopes :

"protium" H^{-1} ; "deuterium" H^{2} or D and "tritium" H^{3} or T

Uranium isotopes

$_{92}U^{235}$ contains 92 protons + 143 neutrons

$_{92}U^{238}$ contains 92 protons + 146 neutrons