ALMUSTAQBAL UNIVERSITY COLLEGE

Biomedical Engineering Department

Stage : Second year students

Subject : General chemistry - Lecture 2

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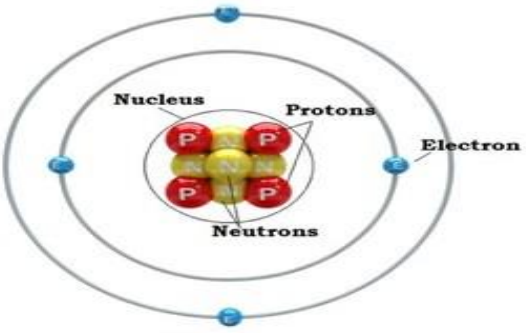
ATOMS AND ELEMENTS

Materials → Molecules → Atoms

An atom is the basic structure from which all matter is composed.

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



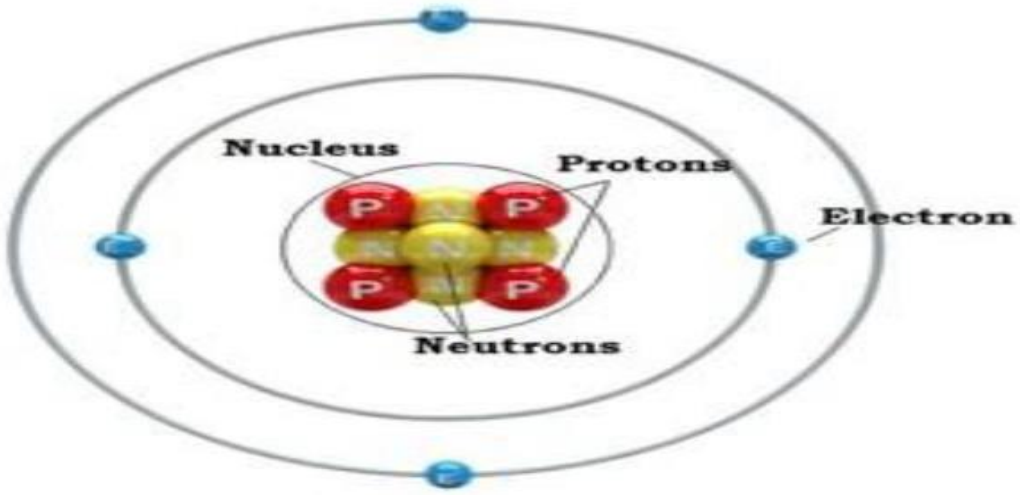
• Atoms = protons (p) + neutrons (n) + electrons (e)

	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}

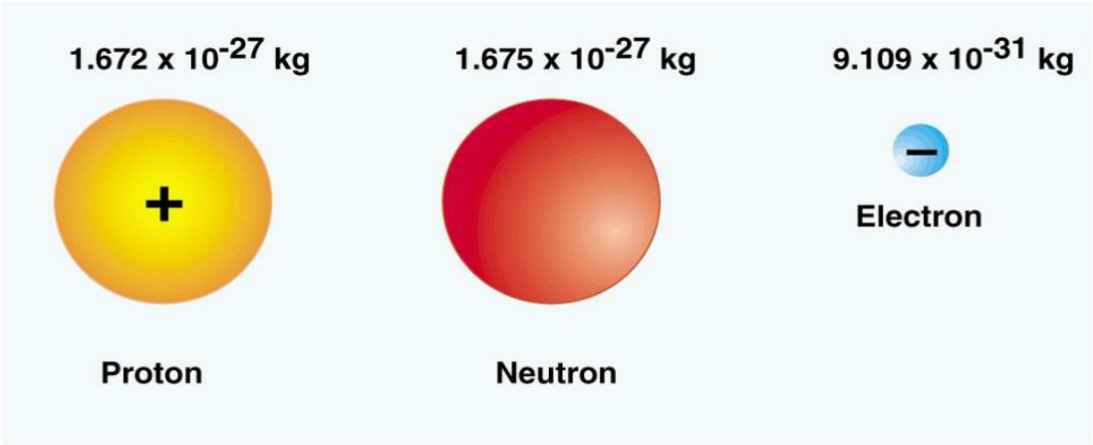
• Fundamental charge = e = -1.602 $\times 10^{-19}$ C (Coulomb)

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) .

The **Atomic Number** is the number of protons in an atom
The **Atomic Mass Number** is the number of protons and the number of neutrons in an atom



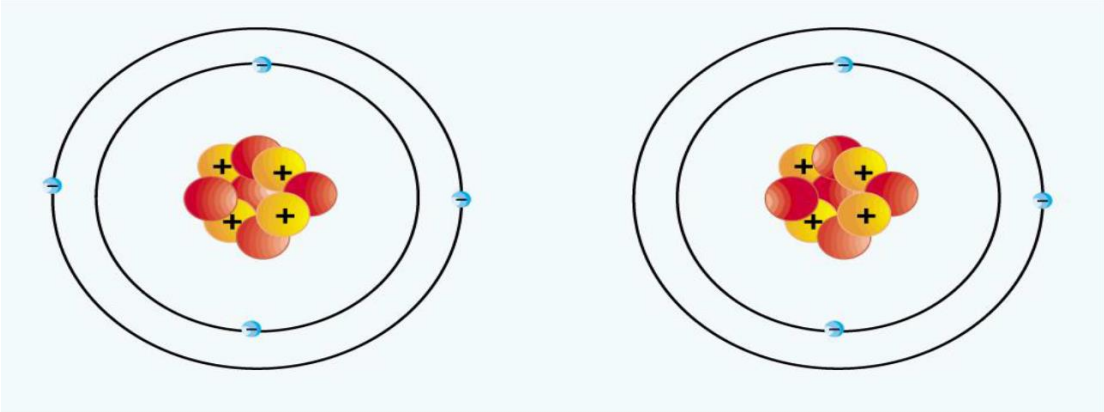
Mass is the amount of matter that an object contains.



Model of Proton, Neutron and Electron

In an atom, the protons and neutrons clump together in the center and are 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.

If we attempt to detect an electron in an atom, it will be found that the electron is much more likely to be located in certain regions of space surrounding the nucleus than in other regions of space.
We might think 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.
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.



Beryllium atom (Be) Beryllium ion (Be^+)

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 sometimes called valence electrons .
The outer electrons(Valence) determine the chemical properties of the element .

ATOMIC NUMBERS (Z)

The **atomic number** is the number of protons (equal to the number of electrons in a neutral atom) in the atom

In neutral atom:

No. of protons = No. of electrons = atomic number (Z)

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

The **atomic mass number** is the sum of the number of protons and neutrons in the atom.

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

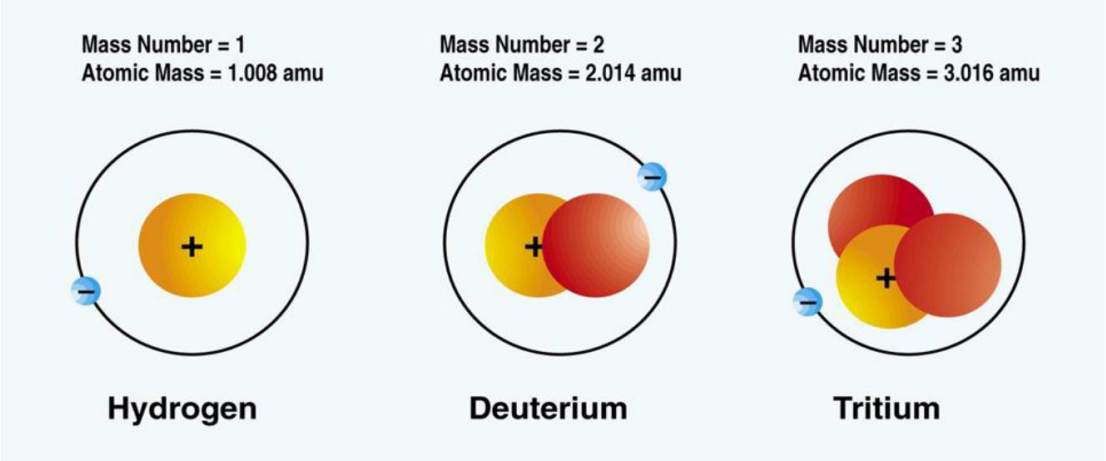
Atomic mass number (A) ≈ Z + N

If you add the number of protons (z) and neutrons (N) for an atom, the sum will be the atom's mass number. This does not show the actual mass of the atom, just information about the atom's nucleus. Most periodic tables show atomic mass, not mass numbers for each 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.



Mass Number and Atomic Mass of Hydrogen, Deuterium, and Tritium
The sum of the number of protons and neutrons in the nucleus of an atom is called the element's mass number. This is not the same as the element's mass.
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.

The symbol for an isotope is the symbol for the element followed by the mass number. Hydrogen is symbolized as H^1, while deuterium is symbolized as H^2.and tritium is H^3.

$$_{\text{atomic number(Z)}}X^{\text{mass number(A)}}$$

Isotops 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 isotops :

"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