Introduction

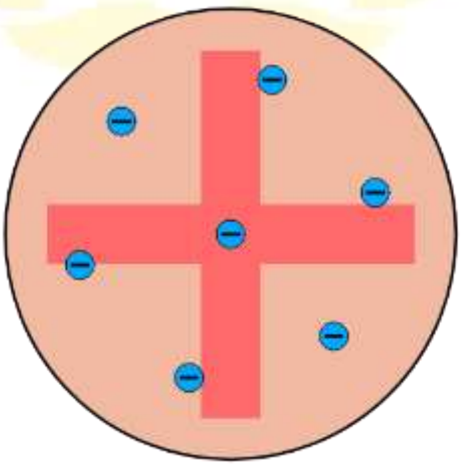
- Matter is composed of atoms and molecules.
- Earlier it was believed that atom is indivisible.
- By the end of the nineteenth century, the scientists revealed the presence of charged particles in an atom.

Structure of atom

- Atoms are composed of 3 subatomic particles- electron, neutron and neutron.
- Electrons have negative charge; protons have positive charge and neutrons are neutral.
- The central hard part of an atom is the **nucleus** which contain protons and neutrons.
- Electron are found moving around this nucleus in fixed circular orbits called shells or energy levels.

Discovery of electrons

- J.J. Thompson proposed the model of an atom to be similar as Christmas pudding or a water melon. This also known as the plum pudding model.
- He proposed that electrons are embedded in the positively charged sphere like the seeds in a watermelon.



- Thompson proposed that:

- An atom consists of a positively charged sphere in which negatively charge electrons are embedded.
- The negative and positive charges are equal in magnitude. Therefore, the atom as a whole is neutral.

Rutherford's model of an atom

- Rutherford performed an experiment in which fast moving α- particles were made to fall on a thin golf foil. He observed that:
  - Most of the α- particles passed without any hindrance.
  - Some α- particles were deflected by the foil by small angles.
  - One out of every 12000 particles bounced back.
- On the basis of above observation, he proposed his model of an atom. Rutherford's model is as follows:
  - There is a positively charged centre in an atom called the nucleus. It contains almost all the mass of an atom.
  - The electrons revolve around the nucleus in circular paths.
  - The size of the nucleus is very small as compared to the size of the atom.

Drawbacks of Rutherford Model

- According to this model, electron revolves around positive nucleus. But if a charged particle is accelerating in a circular path, it would lose energy because of radiation and finally would fall into nucleus. Thus, atom should be highly unstable. But on contrary atom is quite stable.
- This model could not explain about the atomic mass of atom because it proposed only the existence of protons in the nucleus.

Bohr's model of an atom

- Neil Bohr, a Danish physicist, in 1913 solved the drawbacks of Rutherford' model. He proposed the following postulates:
  - Electrons can circulate only in some specified shells known as discrete orbits of electrons.
  - While revolving in discrete orbits the electrons do not radiate energy.
  - He called these orbits as 'stationary orbit'.
  - Each orbit has a fixed amount of energy, thus electrons do not radiate energy as long as they keep revolving in a fixed orbit.
  - The circular paths are called orbit. These orbits are represented by capital letter K, L, M, N, O and so on.
  - Orbit 1 is written as K
Orbit 2 is written as L

Orbit 3 is written as M………so on

Discovery of Neutrons

- In 1932 James Chadwick discovered the neutrons which are the neutral species found in the nucleus of an atom.
- Atoms of all the elements contain neutrons except ordinary hydrogen atom which does not contain any neutron. Symbol for neutron is "n".
- The mass of an atom is given by the sum of the masses of protons and neutrons present in the nucleus.
- This subatomic part is not present in hydrogen atom.
  Mass of a Neutron:-
  The relative mass of neutron is 1u. The mass of neutron is equal to the mass of proton.
  The absolute mass of neutron is 1.6×10^{-24}

  Charge of a Neutron:-
  Neutron has no charge.
  It is electrically neutral.
  Atomic Mass of Carbon = Mass of 6 protons + Mass of 6 neutrons
  = (6 x 1) + (6x 1)
  = 12u

Distribution of electrons in different orbits or shell

Following are the rules to be followed:

- The distribution of electrons in an orbit is governed by the formula $2n^2$ where n is the number of the orbit 1, 2, 3, …..
  Therefore,
- The maximum number of electrons in K-shell i.e., 1st orbit will be

  since n = 1

  Therefore $2n^2 = 2 \times 1^2 = 2$

- The maximum number of electrons in L -shell i.e., 1st orbit will be

  since n = 1

  Therefore $2n^2 = 2 \times 2^2 = 8$

- The maximum number of electrons in M -shell i.e., 1st orbit will be

  since n = 3

  Therefore $2n^2 = 2 \times 3^2 = 18$

- The maximum number of electrons in N -shell i.e., 1st orbit will be

  since n = 1

  Therefore $2n^2 = 2 \times 4^2 = 32$

Valency

- The electrons present in the outermost shell of an atom are known as the valence electrons because they refer to the valency of an atom.
- Every atom has a tendency to complete octet (8 electrons) in the outermost shell to become stable.
- This is achieved by gaining, loosing or sharing of electrons. The number of electrons gained, lost or shared gives the combining capacity of the element.
- For example, Hydrogen/ Sodium / Lithium contains only one electron in the outermost shell. Thus, each one of them can loose one electron to complete its octet. Therefore, their valency will be one.

Atomic Number

- The atomic number is defined as the total number of protons present in the nucleus of an atom.
- It is basically the number of protons that determine the atomic number. It is denoted by Z.
- Example: for hydrogen, Z = 1, because only one proton is present in the nucleus.
- Similarly, for nitrogen, Z = 7, because 7 protons are present in the nucleus.

Mass Number

- The mass number is defined as the sum of the total number of protons and neutrons present in the nucleus of an atom. It is denoted by ‘A’.
- The protons and neutrons reside together in the nucleus. Hence they are called Nucleons. The mass of an atom is basically the mass of its nucleus.
- For example, mass of carbon is 12 u, because it has 6 protons and 6 neutrons (6u + 6u = 12 u).
- While writing the notation for an atom, the atomic number, mass number and symbol of the element are to be written as:

Mass number

SYMBOL OF THE ELEMENT

Atomic number

$^{12}{}_{6}C$

Isotopes

- Isotopes are defined as the atoms of the same element, having the same atomic number but different mass numbers.
- For example, In case of Hydrogen there are three atomic species Protium ($^{1}{}_{1}H$), Deuterium ($^{2}{}_{1}H$ or D), and Tritium ($^{3}{}_{1}H$ or T). the atomic number in each case is 1 but the mass number is 1, 2 and 3.
- Other examples are Carbon ($^{12}{}_{6}C$) and ($^{1}{}_{6}C$) and in case of Chlorine, ($^{35}{}_{17}Cl$) and ($^{37}{}_{17}Cl$), etc.

Applications

Some isotopes have special properties which makes them useful in many fields:

- One of the isotopes of Uranium is used as a fuel in nuclear reactors.
- An isotope of Cobalt is used in cancer treatment.
- An isotope of Iodine is used in the treatment of Goitre.

Isobars

- Isobars are defined as the atoms of different elements with different atomic number but having same mass number.
- For example, atomic number of Argon is 18 and that of Ca is 20, but the mass number of both these elements is 40.