Structure of the Atom

➢ Introduction:

The building blocks of any matter are atoms or molecules. But there are variations in the atoms of each kind of element. So now the questions arise:

1) **Why the atoms of each element differ from each other?**
2) **Does an atom contains smaller constitutes inside it? Are they really indivisible?**

➢ Charged Particles in Matter:

From various experiments it has been identified that an atom in divisible and contains charged particles.

- **Electron (e^-)** is a sub atomic particle; it was identified by J.J. Thomson in 1900.
- **Canal rays** are the radiations in the gas discharged which were discovered by E. Goldstein in 1886.
- **Protons (p^+)** are the positively charged sub-atomic particles.

➢ The Structure of an Atom:

Many scientists came forward with their explanation the arrangement of electrons and protons in an atom. Here are the models mentioned below stated by them:

1) **Thomson's model of an Atom:**
   - J.J. Thomson's model states that an atom is the positively charged sphere and the electrons are spread all over the sphere.
   - He compared this with the watermelon and the Christmas pudding.
   - As the negative and positive charges are equal in magnitude so an atom is electrically neutral.
2) **Rutherford's model of an Atom:**

   Earnest Rutherford's main aim was to know the arrangement of electrons in an atom. So he designed and experiment.

   Aims of the experiment:
   - In this experiment he selected a gold foil that was about 1000 atoms thick.

- The fast moving alpha particles (α) which are doubly-charged helium particles having considerable amount of energy.
- He expected that α- particles would be deflected by the sub-atomic particles in a gold atom.

Observations of the experiment:

- Maximum α- particles moved straight.
- Some were deflected by small angles.
- One out of every 12000 α- particles appeared to rebound.

Conclusions from the experiment:

- Due to more empty space inside the atom α- particles passed straight through the atom.
- Because of the presence of very less positive charge only very few α- particles were deflected.
- The deflection of α- particles by 180^0 shows that the positive charges in the gold atom were concentrated in a very small volume.

Features of the experiment:

- The nucleus is a positively charged center in an atom. It stores the entire mass of the atom.
- The electrons revolve around the nucleus in a curricular path.
- The nucleus has a very small size in comparison with an atom.

Drawbacks of Rutherford's model of the atom:

- The arrangement of the electrons wasn't clear.
- This revolution of electrons in a circular path shows it to be unstable.

3) **Bohr's Model of Atom:**

He discovered the orbits or the shells where electrons move he named it as energy levels.

These orbits or shells are represented by the letters: K, L, M, N... or the numbers, n = 1, 2, 3....

His postulates are stated below:

- The discrete orbits of electrons are only allowed inside an atom.
- Electrons don't radiate energy while revolving in discrete orbits.

➢ **Neutrons:**

Another sub-atomic particle what resides in the nucleus of an atom and has no charge is neutron. It discovered by J. Chadwick in 1932. The mass of an atom is calculated by the sum of protons and neutrons in the nucleus.

➢ **Distribution of Electrons in different Orbits(Shells):**

Bohr and Bury suggested the distribution of electrons in different orbits by stating the below mentioned rules:

- The formula $\mathbf{2n^2}$ shows the maximum number of electrons present in a shell. Where n is the index number of that shell, for example:
  For first orbit or K shell: $2n^2 = 2 \times 1^2 = 2 \times 1 = 2$
  For second orbit or L shell: $2n^2 = 2 \times 2^2 = 2 \times 4 = 8$, and so on.
- The outermost shell of an atom must always accommodate maximum 8 electrons.
- The shells of the atoms are filled in a step-wise manner.

➢ **Valency :**

The electrons that are present in the outermost shell of an atom are known as the **valence electrons**.

The outermost shell must accommodate maximum 8 electrons but when it doesn't fulfill the need it could either lose some of the electrons or could gain them from other atoms to make it 8 or maybe 0.**This combining capacity of an atom is called it's valency.**

➢ **Atomic number:**

The total number of protons in a nucleus determines the atomic number of that particular element's atom.

- **Mass number:**

  The sum of the nucleons (protons and neutrons that are present in nucleus) determine the mass number of an atom. The mass of an atom resides in it nucleus.

The mass number of an atom is written above the element's symbol whereas the atomic number is written below its symbol. Ex:

$$_{7}{}^{14}N$$

- **Isotopes:**

  Some of the atoms that have same atomic numbers but different mass numbers are called Isotopes. For example: Hydrogen has 3 atomic species: Protium – $_1{}^1H$, Duterium – $_1{}^2H$ **or D** and Tritium – $_1{}^3H$ **or T.**

  Applications:

  - An isotope of uranium is used as a fuel in nuclear reactors.
  - An isotope of cobalt is used in the treatment of cancer.
  - An isotope of iodine is used in the treatment of goitre.

- **Isobars:**

  The atoms of different elements that have same mass numbers but different atomic numbers are called Isobars.