Dalton's Atomic Theory

On the basis of laws of chemical combination John Dalton, an English school teacher in Manchester, proposed that behaviour of matter could be explained using an atomic theory. He published his work about atomic theory in 1808. The main points of Dalton's atomic theory are:

- All the matter is made up of very small particles called "atoms".
- Atoms cannot be divided.
- Atoms can neither be created nor destroyed.
- Atoms are of various kinds. There are as many kinds of atoms as are elements
- All the atoms of a given element are identical in every respect, having the same mass, size and chemical properties.
- Atoms of different elements differ in mass, size and chemical properties.
- Chemical combination between two (or more) elements consists in the joining together of atoms of these elements to form molecules of compounds.
- The "number" and "kind" of atoms in a given compound is fixed.
- During chemical combination, atoms of different elements combine in small whole numbers to form compounds.

Atoms of the same elements can combine in more than one ratio to form more than one compounds.

Drawbacks of Dalton's atomic theory

Some of the drawbacks of the Dalton's atomic theory of matter are given below :

- One of the major drawbacks of Dalton's atomic theory of matter is that atoms were thought to be indivisible (which cannot be divided). We now know that under special circumstances, atoms can be further divided into still smaller particles called electrons, protons and neutrons. So, atoms are themselves made up of three particles : electrons, protons and neutrons.
- Dalton's atomic theory says that all the atoms of an element have exactly the same mass. it is, however, now known that atoms of the same element can have slightly different masses.
- Dalton's atomic theory said that atoms of different elements have different masses. it is, however, now known that even atoms of different elements can have the same mass.
- It failed to explain how atoms of different elements differ from each other, i.e., it did not tell anything about internal structure of the atom.
- It could not explain how and why atoms of different elements combine with each other to form compound atoms or molecules.
- It failed to explain the nature of forces that hold together different atoms in a molecule.
- It did not make any distinction between ultimate particle of an element that takes part in reactions (atom) and ultimate particle that has independent existence (molecule).

Atoms

- All the matter is made up of atoms. An atom is the smallest particle of an element that can take part in a chemical reaction. Atoms of most of the elements are very reactive and do not exist in the free state. They exist in combination with the atoms of the same element of another element.
- Atoms are very, very small in size. The size of an atom is indicated by its radius which is called 'atomic radius'. Atomic radius is measured in 'nanometres'. The symbol of a nanometre is nm.

  1 nanometre = $\frac{1}{10^9}$ metre

  or 1 nm = $\frac{1}{10^9}$ m

  or 1 nm = 10^{-9} m

  Hydrogen atom is the smallest atom of all. They cannot be viewed by simple optical microscopes. However, through modern techniques such as scanning tunneling microscope it is possible to produce magnified images of surfaces of elements showing atoms.

Atomic Mass

- Atoms are extremely small; the heaviest atoms have masses of about 10^{-22} g. Even an ultra microbalance cannot measure the mass of a single atom. However, relative masses of atoms of different elements can be determined. At first, the mass of the lightest atom, hydrogen.
- In 1961, International Union of chemists selected the most stable isotope of carbon (C - 12 isotope) as standard for comparison the atomic masses of various elements. Atomic mass of an element tells us the number of times an atom of the element is heavier than of the mass of an atom of carbon - 12.
- Atomic mass of an element may be defined as the average relative mass of an atom of the element as compared with mass of an atom of carbon (C - 12 isotope) taken as 12 amu.

  Atomic Mass

  $$= \frac{\text{Mass of 1 atom of the element}}{\frac{1}{12} \text{ of the mass of an atom of carbon} - 12}$$

Ex. The atomic mass of magnesium is 24 u which indicates that one atom of magnesium is 24 times heavier than $\frac{1}{12}$ of a carbon 12 atom.

Atomic Mass of Some Elements

	Element	Symbol	Atomic
1	Hydrogen	H	1 u
2	Carbon	C	12 u
3	Nitrogen	N	14 u
4	Oxygen	O	16 u
5	Sodium	Na	23 u
6	Magnesium	Mg	24 u
7	Aluminium	Al	27 u
8	Phosphorus	P	31 u
9	Sulphur	S	32 u
10	Chlorine	Cl	35.5 u
11	Potassium	K	39 u
12	Calcium	Ca	40 u
13	Iron	Fe	56 u
14	Copper	Cu	63.5 u

Gram atomic mass

Gram atomic mass of an element is defined as that much quantity of the element whose mass expressed in grams is numerically equal to its atomic mass. To find gram atomic mass we keep the numerical value the some as the atomic mass, but simply change the units from u to g. for example, atomic mass of aluminium is 27 u. Its gram atomic mass is 27 g.

- **Gram atomic mass of Isotopes :**

$$\frac{M_1X_1 + M_2X_2}{X_1 + X_2}$$

M_1 & M_2 are relative masses of isotopes and X_1 & X_2 are relative % content

Ex. Chlorine contains two types of atoms having relative masses 35 and 37 and their relative abundance is 3 : 1. In such cases the atomic mass of the element is the average of relative masses of different isotopes of the element.

Atomic mass of chlorine = $\frac{35 \times 3 + 37 \times 1}{4}$ = 35.5