

ATOMS AND MOLECULES

INTRODUCTION

Matter is called 'padarth' in Hindi. Kanad was one of the first persons to propose that matter (or padarth) is made up of very small particles called 'parmanu'. John Dalton called these particles by the name of atom. The word 'atom' means 'indivisible' something which cannot be divided further. The particles of matter (atoms or parmanu) normally exist in a combined form. This combined form of atoms is now called 'molecules'.

Conclusion :

All matter is made up of small particles called atoms and molecules. Different kinds of atoms and molecules have different properties due to which different kinds of matter also show different properties.

Laws of chemical combination :

The laws of chemical combination played a significant role in the development of Dalton's atomic theory of matter.

There are two important laws of chemical combination.

(A) Law of conservation of mass

- ◆ Law of conservation of mass was given by Lavoisier in 1774. According to the law of conservation of mass : Matter is neither created nor destroyed in a chemical reaction. The substances which combine together in a chemical reaction are known as 'reactants' whereas the new substances formed as a result of chemical reaction are called 'products'. The law of conservation of mass means that in a chemical reaction, the total mass of products is equal to the total mass of reactants. There is no change in mass during a chemical reaction.

Ex. Lavoisier showed that when mercuric oxide was heated, it produced free mercury and oxygen. The sum of masses of mercury and oxygen was found to be equal to the mass of mercuric oxide

Mercuric oxide → Mercury + Oxygen

100 g 92.6 g 7.4 g

Sol. Mass of the reactant = 100 g

Mass of the products = 92.6 + 7.4 g = 100.0 g = 100 g

Since the total mass of the products formed is equal to the total mass of the reactants undergoing reaction, so the data is in agreement with law of conservation of mass.

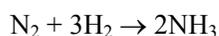
(B) Law of constant proportions

- ◆ This law was discovered by the french chemists, A. Lavoisier and Joseph Proust. A pure chemical compound always contains same elements combined together in same proportion by mass

Ex. Pure water obtained from different sources such as river, well, spring, sea, etc., always contains hydrogen and oxygen combined together in the ratio 1 : 8 by mass.

Limiting reagent : - In a reaction having more than one reactant we must identify the limiting reagent "Reagent which is finished early is known as limiting reagent".

Example : - In Haber's process to manufacture NH₃,



If we take 2 moles of N_2 (56 grams) along with 3 moles of H_2 (6 grams) we can see that only 1 mole of N_2 (28 grams) is sufficient to react with 3 moles of H_2 . It means 1 mole N_2 (28 grams) is in excess & H_2 will be finished when reaction will be completed or H_2 is limiting reagent.

▶ 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).