ATOMS AND MOLECULES
INTRODUCTION, DALTON'S ATOMIC THEORY

❖ LAWS OF CHEMICAL COMBINATION: -

By studying the result of quantitative measurement of many reactions it was observed that whenever substances react, they follow certain laws. These laws are called the law of chemical combination.

(a) Law of conservation of mass.

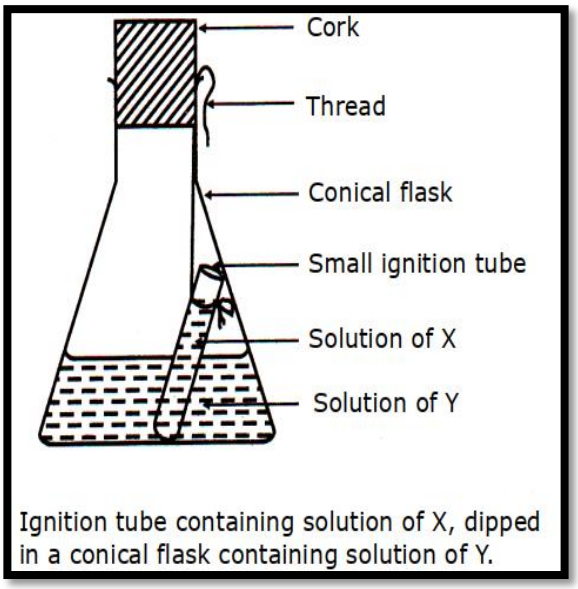
(b) Law of constant proportions.

(c) Law of multiple proportions.

(a) Law of conservation of mass :-

This law was given by the french chemist **A. Lavoisier** in **1774**. This law states that in every chemical reaction, the total mass before and after the reaction remains constant. "That is mass can neither be created nor destroyed in a chemical reaction". 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	92.69 g	7.49 g



Ignition tube containing solution of X, dipped in a conical flask containing solution of Y.

Activity: Demonstration of law of conservation of mass.

- Prepare separately a 5% solution of barium chloride and a 5%solution of sodium sulphate.
- Take about 20ml of barium chloride solution in a conical flask.
- Take sodium sulphate solution in a small test tube. Hang the test tube in the conical flask with the help of a thread. Close the mouth of the flask with cork.
- Weigh the flask along with its contents.
- Now tilt the flask so that the two solutions get mixed.

- Weigh the flask again along with its contents. What do you observe? It is observed that on mixing the two solution a chemical reaction takes place which is indicated by the formation of a white precipitate

  Barium chloride + Sodium sulphate ⟶ Barium sulphate (white ppt) + Sodium Chloride
- The mass of the flask and its contents remains constant. Thus, during a chemical reaction mass is neither created nor destroyed.

This activity can also be carried out with the following pairs:

(a) Silver nitrate and sodium chloride

(b) Copper sulphate and sodium carbonate

Q. In a reaction 5.3 g of sodium carbonate reacted with 6 g of ethanoic acid. The products were 2.2 g of carbon dioxide. 0.9 g water and 8.2 g of sodium ethanoate. Show that these observations are in agreement with the law of conservation of mass.

Sodium carbonate + ethanoic acid ⟶ sodium ethanoate + carbon dioxide + water.

Q. Hydrogen and oxygen combine in the ratio of 1 : 8 by mass to form water. What mass of oxygen gas would be required to react completely with 3 g of hydrogen gas?

Q. Which postulate of Dalton's atomic theory is the result of the law of conservation of mass?

(b) Law of constant Proportions / Law of definite proportions:

This law was given by the french chemist **A. Lavoisier and Joseph Proust.** This law deals with the composition of chemical compounds.

This law is: **A pure chemical compound always contains same elements combined together in same proportion by mass**.

For example: Pure water obtained from different sources such as river, well etc. always contains hydrogen and oxygen combined together in the ratio 1 : 8 by mass similarly carbon dioxide can be obtained by different methods such as by burning of carbon, by heating lime stone. It shows that samples of carbon dioxide obtained from different sources contain carbon and oxygen in the ratio of 3 :8 by mass. Thus in water or CO_2 this proportion of hydrogen and oxygen or carbon and oxygen always remains constant.

Ex. Hydrogen and oxygen combine in the ratio of 1 : 8 by mass to form water. What weight of oxygen gas would be required to completely react with 3 g of hydrogen gas.

Sol. Ratio in which hydrogen and oxygen combine = 1 : 8

1 g of hydrogen combines with oxygen = 8 g

∴ 3 g of hydrogen will combine with oxygen = 8 × 3 = 24 g.

(c) Law of multiple proportions:

It was given by Dalton in 1808. According to it, when one element combines with the other element to from two or more different compounds, the mass of one element, which combines with a constant mass of the other, bear a simple ratio to one another.

Example: Carbon and oxygen when combine, can from two oxides that are CO (carbon monoxide), CO_2 (carbon dioxide).

In CO, 12g carbon combine with 16g of oxygen. In CO2, 12g carbon combine with 32g of oxygen. Thus, we can see the mass of oxygen which combine with a constant mass of carbon (12g) bear simple ratio of 16: 32 or 1: 2.

❖ Introduction of Atoms and Molecules: -

The structure of matter has been a subject of speculation from very early times. According to Greek philosopher Aemocritus, if we go on dividing matter into smaller parts, a stage would be reached when particles obtained cannot be divided further. He called these particles 'atoms' meaning indivisible.

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

❖ Dalton's Atomic Theory: -

On the basis of laws of chemical combination John Dalton proposed atomic theory in 1808. The main points of dalton's atomic theory are:

The main postulates of the Dalton's atomic theory are:

1. All matter is made up of very tiny particles called atoms.
2. Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction,
3. Atoms of a given element are identical in mass size and chemical properties.
4. Atoms of different element have different mass size and chemical properties.
5. Atoms combine in the ratio of small whole numbers to form compounds.
6. The relative number and kinds of atoms are constant in a given compound.
   Dalton's atomic theory was based on the laws of chemical combination.
7. Atoms of same element can combine in more than one ratio to form more than one compound.
   For

Example, hydrogen and oxygen combine to give water and hydrogen peroxide. In water, two atoms of hydrogen combine with one atom of oxygen while in hydrogen peroxide, two atoms of hydrogen combine with two atoms of oxygen.

For example: The postulates of Dalton's atomic theory that "atoms can neither be created nor destroyed", was the result of law of conservation of mass and the postulates of Dalton's atomic theory that "the element consist of atom having fixed mass", and that the number and kind of atom in a given compound is fixed came from the law of constant proportions.

Q. Which postulates of Dalton's atomic theory can explain the law of definite proportions?

❖ Drawbacks of Dalton's Atomic Theory:

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

- According to Dalton's atomic theory, atoms were thought to be indivisible. But it is now known that atoms can be further divided into still smaller particle called electrons, protons and neutrons.
- Dalton's atomic theory said that all the atoms of an element have exactly the same mass. But it is now known that atoms of the same element can have slightly different masses, as in case of isotopes.
- Dalton's atomic theory said that atoms of different elements have different masses. But it is now known that even atoms of different elements can have the same mass as in case of isobars.