Topic Synopsis

Laws of Chemical Combination

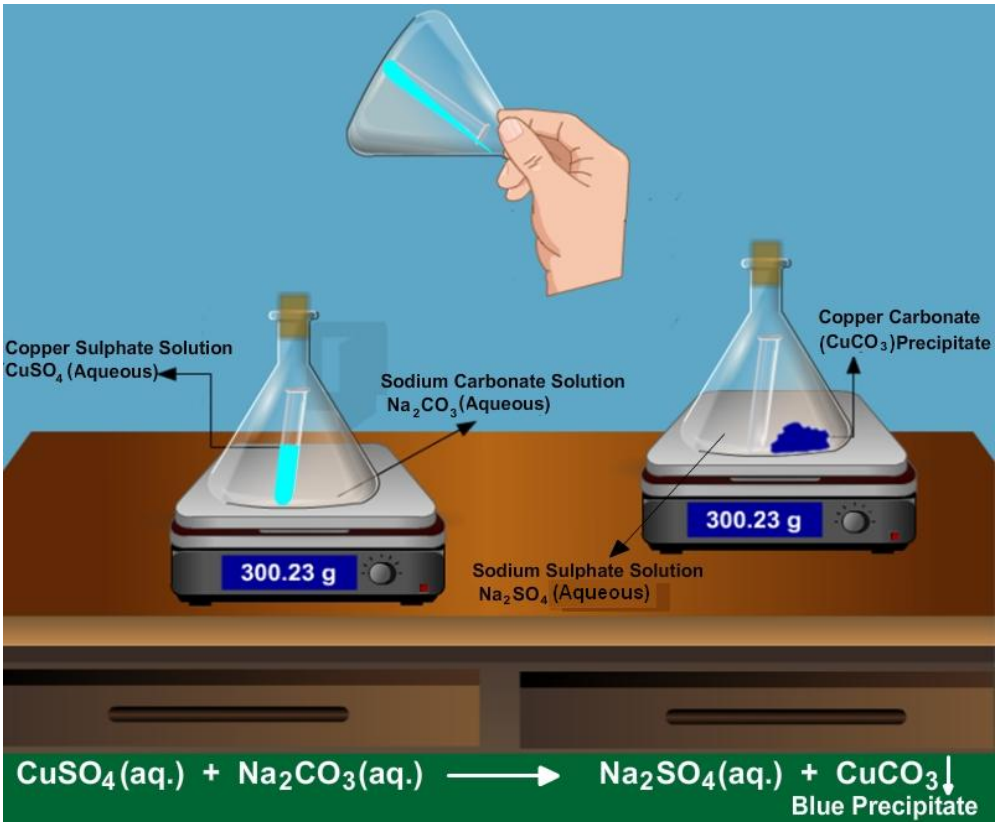
1. Laws of Chemical Combination: On the basis of experimental studies, scientists in the 18^{th} and early 19^{th} centuries formulated some laws with regards to chemical combinations which are still well-accepted for general chemical reactions. These laws were also pondered by Dalton before he had formulated his theory about atoms.

- There are basically five laws of chemical combination. However, our present scope of study is confined to only two laws of chemical combination, which are as follows:

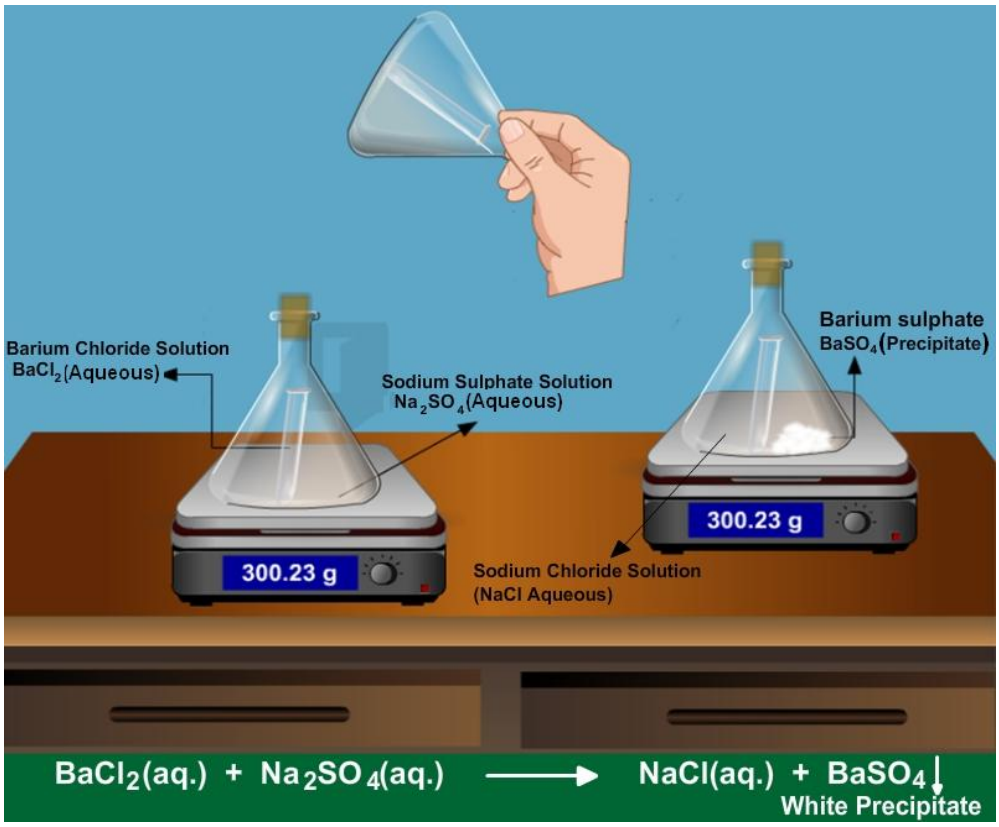
1 **Law of Conservation of Mass** $ByAntoineL.Lavoisierin1774$**:** This law states that during any chemical or physical change the mass of the product$s$ formed is the same as that of the mass of the reactants taken at the start of the reaction. In other words it can be stated as “During any physical or chemical change, mass can neither be created nor be destroyed”.

Some Examples:

i If the total initial mass of the reactants taken [copper sulphate ($CuSO_4$) aqueous solution and sodium carbonate (Na_2CO_3) aqueous solution] is 300.23 grams then in a chemical reaction which leads to the formation of copper carbonate [$CuCO_3$ $solid$] and sodium chloride $NaCl$ aqueous solution as products, the total mass of the products would be 300.23 $sameasthatofthetotalmassofreactantstaken.$



ii If the total initial mass of the reactants taken [barium chloride ($BaCl_2$) aqueous solution and sodium sulphate (Na_2SO_4) aqueous solution] is 300.57grams then in a chemical reaction which leads to the formation of barium sulphate [$BaSO_4$ $solid$] and sodium chloride $NaCl$ aqueous solution as products, the total mass of the products would be 300.57$sameasthatofthetotalmassofreactantstaken.$



iii Thermal decomposition of 100 g of calcium carbonate $reactant$ gives 56 g and 44 g of calcium oxide and carbon-dioxide, respectively, as products.

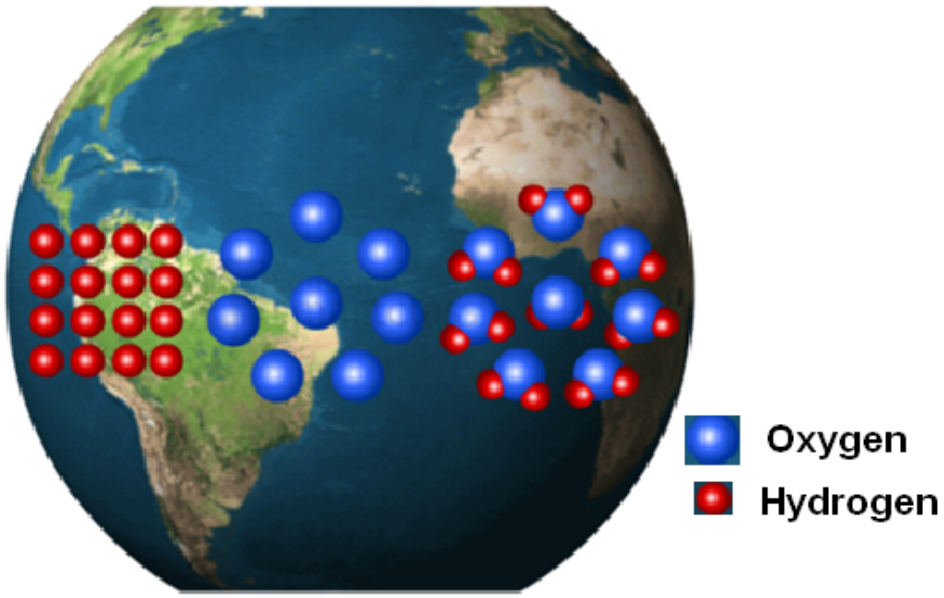
2 **Law of Constant Proportion or Law of Definite Proportion** $ByJosephProustin1779$**:**

It can be stated as, when a compound is formed from two or more elements, the constituent elements are always present in a definite proportion by mass, irrespective of its source or method of preparation.

- All samples of a given chemical compound have the same elemental composition.

Some Examples:

1 Water taken from any source in the universe consists of molecules formed by two atoms of hydrogen $redballs$ and one atom of oxygen $blueballs$ in the same ratio by mass which is 1:8, thus, if 9 g of water is decomposed, 1 g of hydrogen and 8 g of oxygen are always obtained.



2 The molecules of ammonia consist of atoms of nitrogen and hydrogen elements. These constituent elements always combined together in the ratio 14:3 by mass to form molecules of the ammonia compound, irrespective of its method of preparation or the source from which it is obtained.

2. Dalton's Atomic Theory: The English chemist John Dalton proposed the atomic theory in the year 1808. His theory is considered to be the first fundamental theory about atoms which is based on scientific studies. Dalton proposed that matter consists of very small particles which he named atoms. His theory was supported by scientific studies.

- The main postulates of the theory are as follows:

1 All matter $forexample, elements$ are made up of very small indivisible spherical particles called atoms.

2 All atoms of a particular element are identical in all respects like their shapes, masses and other properties, but they are different from the atoms of other elements.

For example,

i When small pieces of sodium and iron are added to different glass beakers having 500 ml of water, it is observed that atoms of sodium element react vigorously, that is, at faster rate as compared to the atoms of iron element.

ii When the pieces of sodium and magnesium are placed in a flame, they impart different colours to the flame. Hence, in general, the atoms of different elements have different properties.

3 Atoms of one element cannot be converted into atoms of other elements.

4 Atoms of one element can combine with the atoms of other element in integral ratio. The combination of atoms in different integral ratios leads to the formation of different compounds.

5 An atom can neither be created nor be destroyed.

6 Atoms cannot be further broken down into smaller particles.

- It should be noted that Dalton's theory does not propose anything about the positive and negative charges on an atom.
- Dalton's atomic theory can be considered as the first milestone in explaining the inner structure of matter, as it inspired scientists to carry out further studies on atoms.