LAW OF CHEMICAL COMBINATION

The laws are as follows;
1. Law of conservation of mass (matter)
2. Law of definite proportion or constant composition
3. Law of multiple proportion
4. Law of reciprocal proportion

LAW OF CONSERVATION OF MASS (MATTER)

This law states that matter is neither created nor destroyed during the course a chemical reaction, but changes from one form to another. It is also known as the law of indestructibility of matter.

Verification of law of conservation of mass
The law can be verified by putting some silver trioxonitrate(v) solution into a conical flask. Then carefully lower into the conical flask a small test tube containing appreciable amount of concentrated hydrochloric acid by means of a thread, weigh the conical flask and its contents. Allow the contents to mix carefully.
A white precipitate is seen to be formed as reaction takes place. Then weigh the conical flask and its content again. You will see that the mass is exactly the same before and after the reaction, it means that there is neither any loss or any gain in mass during the reaction, the formation of the white precipitate of silver chloride helps to show that matter has only been converted from one form to another.

The equation for the reaction
\[ \text{AgNO}_3 + \text{HCl} \rightarrow \text{HNO}_3 + \text{AgCl} \]
White precipitate.

LAW OF CONSTANT COMPOSITION AND MULTIPLE PROPORTION

This law states that all pure samples of the same chemical compound contain the same elements combined in the same proportions by mass.

In order to prove this law, the following steps are taken.
1. Some samples of copper(ii)oxide are prepared by various method
2. The different samples of CuO are then reduced to pure copper each by passing dry hydrogen gas through each of them.

The reduction is represented by the equation \[ \text{CuO} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O} \].
3. The mass of pure copper in each samples can then be calculated.
4. The percentage composition of copper in each of the samples can be calculated by using the relationship:

\[
\text{\% of copper in copper(II) oxide} = \frac{\text{mass of copper}}{\text{mass of copper oxide}} \times \frac{100}{1}
\]

5. Using the formula above, you will be in a position to draw a conclusion by comparing the results obtained from your calculations.

**WORKED EXAMPLES**

2.5g of a sample of an oxide of copper produced on reduction 2g of pure copper. 2.45g of another sample of an oxide of copper produced 2.0gram of pure copper on reduction show that these results are in accordance with the law of constant composition.

**Solution**

Organize your work in a tabular form.

<table>
<thead>
<tr>
<th></th>
<th>SAMPLE A</th>
<th>Sample B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of CuO</td>
<td>2.50</td>
<td>2.45</td>
</tr>
<tr>
<td>Mass of Cu</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>In CuO</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| \% of Cu in CuO  | \[
\frac{2.00 \times 100}{2.50 \times 1} \]
= 80.00%     | \[
\frac{2.00 \times 100}{2.45 \times 1} \]
= 81.60%     |

Since the percentage of metal in both oxides is very close to being the same, we may conclude that the results are in accordance with the law of constant composition, allowing for experimental error.

**LAW OF MULTIPLE PROPORTION**

This law states that when two elements A and B combine to form more than one compound. The masses of A which combine with a fixed mass of B are in proportions of small whole numbers.

The Law of Multiple Proportion

This law deals with compounds formed by atoms that have variable combining power.

The law of multiple proportion states that when two elements combine to form more than one compound, the different masses of one element which combine with a fixed mass of the second element are in a simple ratio.

In the verification of this law, it is necessary to prepare pure samples of copper(ii)oxide and copper(ii)oxide and to analyse them to determine the ration of oxygen that will combine with a fixed mass of copper in the two oxide.
The samples of copper(1)oxide and copper(2)oxide are placed in porcelain boat and placed in a combustion tube. A current of dry hydrogen is passed through the combustion tube until the oxide are weighed and the mass of copper and oxygen are determined in the two stages.

<table>
<thead>
<tr>
<th>Calculation</th>
<th>Sample A</th>
<th>Sample B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mass of porcelain boat</td>
<td>4.55g</td>
<td>5.38g</td>
</tr>
<tr>
<td>2. Mass of porcelain boat + copper oxide</td>
<td>6.44g</td>
<td>8.21g</td>
</tr>
<tr>
<td>3. Mass of copper oxide</td>
<td>1.89g</td>
<td>2.83g</td>
</tr>
<tr>
<td>4. Mass of porcelain boat + copper</td>
<td>6.05g</td>
<td>7.90g</td>
</tr>
<tr>
<td>5. Mass of copper in (iv) – (i)</td>
<td>1.50g</td>
<td>2.52g</td>
</tr>
<tr>
<td>6. Mass of oxygen (iii) – (v)</td>
<td>0.39g</td>
<td>0.31g</td>
</tr>
</tbody>
</table>

For sample (a) 1.50g of copper combined with 0.39g of oxygen
\[ \frac{0.39}{1.50} \times \frac{100}{1} = 26g \]

For sample (b) 2.52g of copper combine with 0.31g of oxygen
\[ \frac{0.31}{2.52} \times \frac{100}{1} = 12.3g \]

From these calculations, the masses of oxygen (26g and 12.3g) which combine with a fixed mass (100g) of copper are in simple ratio 2:1

Chemical Equation

A chemical equation represents a chemical reaction in terms of symbols and formulae of the element and compound involved. The substance or ions taking part in the reaction, i.e. reactants are written on the left hand side while the substance formed in the reaction product are written on the right hand side. An arrow indicates the direction of the reaction e.g. considering this equation.

A and B reacts to give C and D as the product

\[ A + B \rightarrow C + D \]

Reactant               Product
Steps in writing a chemical equation

i. The reactants and products are written down as a word equation.
   Example: Hydrogen gas burn in oxygen gas to form water.
   The word equation is
   Hydrogen + Oxygen \[\rightarrow\] Water

ii. The formulae for each reactant and each product is then given
   \[H_2 + O_2 \rightarrow H_2O\]

iii. The physical states of each reactant and products are put in after the formula. The physical state are gas (g), liquid(L), solid (s) and aqueous (aq) (a solution in water)

iv. Balancing of the equation. The above equation is not correct quantitatively as it violates the law of conservation of mass. Although two hydrogen atoms are indicated on both the left and the right sides of the equation. Two oxygen atoms appear on the right side. The number of oxygen atoms are not the same. Hence the equation is not balanced.

BALANCING CHEMICAL EQUATION

For an equation to be meaningful, it must be balanced. When balancing an equation the following must be remembered.

i. Equation must be balanced through the use of co-efficient in front of the formula.

ii. Common gases are written in their free state e.g. diatomic e.g. hydrogen H₂, Oxygen O₂, Nitrogen N₂ and Chlorine Cl₂, Bromine Br₂, Fluorine F₂, and Iodine I₂ respectively. Metals are all monoatomic e.g. Sodium Na, Potassium K, Copper(Cu), Iron (Fe) are represented by their symbols.

iii. Radicals remain unchanged during the reaction

iv. Adjust the number of molecules so that there will be the same number of atoms on each sides of the equation.
   \[H_2(g) + O_2(g) \rightarrow H_2O(c)\] (unbalanced)
   The equation is balanced by using the simplest multiples of the formula. The above equation is balanced when there are four atoms of hydrogen and two atoms of oxygen on both sides of the equation i.e.
   \[2H_2(g) + O_2(g) \rightarrow 2H_2O(l)\] (balanced)

Importance of chemical equations

A lot of information is given by chemical equation. A chemical equation can be used to determine.

i. The stiochiometry of the reaction

ii. Molar mass of each compound

iii. The relative volumes of reactant and products if gaseous

iv. The reactant and product involved

v. The physical state of reactants and product.