Chemical Reactions and Equations

➢ Introduction:

In our day-to-day life we experience many chemical reactions like cooking the food, respiration, rusting of iron and many more. Along with these chemical reactions chemical equations also takes place. Following observations that could make us understand about the chemical reactions:

- Change in state
- Change in color
- Evolution of a gas
- Change in temperature

➢ Chemical Equations:

The scientific written format of a chemical reaction is known as a chemical equation. It could be written in words therefore its called word-equation. Ex-

Magnesium + Oxygen → Magnesium oxide
(reactants) (product)

- The reactants are written on the left-hand side (LHS) with a plus sign (+) between them.
- The products are written on the right-hand side (RHS) with a plus sign (+) between them.
- The arrowhead points towards the products, and shows the direction of the reaction.

❖ Writing a chemical equation:

- A chemical equation represents a chemical reaction.
- The chemical equations generally use the symbols of the elements rather than their names. Ex: **$Mg + O_2 \rightarrow MgO$**

- The mass of the elements in a chemical equation isn't same on both sides LHS and RHS then it is unbalanced and we call such equations as a **skeletal chemical equation** for a reaction.

❖ **Balanced Chemical equation:**

- The law of conservation of mass states the mass can neither be created nor be destroyed in a chemical reaction. So it needs to be balanced on both sides.
- The total mass of an element on the reactant side has to be equal to that of total mass on the product side.
- The number of atoms for each element must remain the same before and after the chemical reaction then it is said as a **balanced chemical equation.**

  Example:

  $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

Elements	No. of atoms in reactants(LHS)	No. of atoms in products(RHS)
Zn	1	1
H	2	2
S	1	1
O	4	4

❖ **Balancing a chemical equation:**

Here we will take a skeletal (unbalanced) chemical equation and will be balancing it by following certain steps:

$Fe + H_2O \rightarrow Fe_3O_4 + H_2$

- **Step I:** List out the number of elements in a tabular form in both LHS and RHS like this:

Elements	No. of atoms in reactants(LHS)	No. of atoms in products(RHS)
Fe	1	3
H	2	2
O	1	4

- **Step II:** Now choose a compound which contains maximum number of atoms of an element it could be either from reactants' side or products' side.
  Here we'll be choosing **Fe_3O_4** as the Oxygen has the highest number of atoms on RHS. Whereas on LHS Oxygen only have 1 atom **H_2O.**

Atoms of Oxygen	In reactants	In products
(i) Initial	1 (in **H_2O**)	4 (in **Fe_3O_4**)
(ii) To balance	1 x 4	4

$$\mathbf{Fe + 4(H_2O) \rightarrow Fe_3O_4 + H_2}$$

- **Step III:** From last step we balanced **O** now **Fe** and **H** are still unbalanced so we can pick anyone amongst them first to balance its atoms. Let's start with **H** by following same method as followed in the above step.

Atoms of Hydrogen	In reactants	In products
(i) Initial	8 (in **$4H_2O$**)	2 (in **H_2**)
(ii) To balance	8	2 x 4

$$\mathbf{Fe + 4(H_2O) \rightarrow Fe_3O_4 + 4H_2}$$

- **Step IV:** It's now time to now choose the last unbalanced element and balance it also in the same way that is **Fe.**

Atoms of Iron	In reactants	In products
(i) Initial	1 (in **Fe**)	3 (in **Fe_3O_4**)
(ii) To balance	3 x 1	3

$$3Fe + 4(H_2O) \rightarrow Fe_3O_4 + 4H_2$$

- **Step V:** Finally the equation is balanced now compare the number of all the elements from LHS and RHS and see that everything is balanced.

$$3Fe + 4(H_2O) \rightarrow Fe_3O_4 + 4H_2$$

Elements	No. of atoms in reactants(LHS)	No. of atoms in products(RHS)
Fe	3	3
H	8	8
O	4	4

- **Step VI:** At the end write the physical state of the compound using the symbols like the gaseous (g), liquid (l), aqueous (aq) and solid states (s) of reactants and products. The word aqueous (aq) is written if the reactant or product is present as a solution in water.

$$3Fe(s) + 4(H_2O)\ (g) \rightarrow Fe_3O_4\ (s) + 4H_2\ (g)$$

*{Here, **H_2O** is used as a steam and that's why it is in the gaseous state not the aqueous state.}*

➢ **<u>Types of Chemical reaction:</u>**

There are various kinds of chemical reactions they involve the breaking and making of bonds between atoms to produce new substances.

1) Combination Reaction:

It is such kind of reaction which includes multiple reactants and only single product is obtained after the chemical reaction.

$$\mathbf{CaO}\ (s) + \mathbf{H_2O}\ (l) \rightarrow \mathbf{Ca(OH)_2}\ (aq)$$

Quick lime + Water → Slacked Lime

- The reactions that release heat along with the formation of the products are known as **exothermic reactions.**
  Ex: Burning of natural gas
  $\mathbf{CH_4}\ (g) + \mathbf{2O_2}\ (g) \rightarrow \mathbf{CO_2}\ (g) + \mathbf{2H_2O}\ (g)$

2) Decomposition Reaction:

Those reactions where the reactant is been broken down in multiple products by the process of heating, boiling or electrolysis.

$$\mathbf{2FeSO_4}(s) \xrightarrow{(heat)} \mathbf{Fe_2O_3}(s) + \mathbf{SO_2}(g) + \mathbf{SO_3}(g)$$

- In the **thermal decomposition reactions** the heating process is used to obtain the products.
  $\mathbf{CaCO_3}\ (s) \xrightarrow{heat} \mathbf{CaO}(s) + \mathbf{CO_2}\ (g)$
- Reactions in which energy is absorbed are known as **endothermic reactions.**

3) Displacement Reaction:

In these kinds of reaction the highly reactive metal displaces the least reactive metal. Ex: in this reaction iron displaces copper.

$$\mathbf{Fe(s) + CuSO_4\ (aq) \rightarrow FeSO_4\ (aq) + Cu(s)}$$

Iron + Copper sulphate → Iron sulphate + Copper

4) Double Displacement Reaction:

In these kinds of reactions the exchange of ions takes place between the reactants.

$$Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$$

Sodium sulphate+ Barium chloride → Barium sulphate +Sodium chloride

5) Oxidation Reaction:

In the reaction where oxygen is added with an element then it is said as the oxidation reaction. Ex:

$$2Cu + O_2 \xrightarrow{heat} 2CuO$$

6) Reduction Reaction:

In a reaction if a substance loses oxygen then it is said as the reduction reaction. Ex:

$$CuO + H_2 \xrightarrow{heat} Cu + H_2O$$

7) Redox Reaction:

In those reactions where one reactant gets oxidised while the other gets reduced such reactions are called redox reactions. Ex:

$$CuO + H_2 \xrightarrow{heat} Cu + H_2O$$

Here, the copper oxide is losing oxygen and is being reduced whereas the hydrogen is gaining oxygen and is being oxidised.

- **Corrosion:**

It is the oxidation reaction that takes place with metals. When a metal is attacked by substances around it such as moisture, acids, etc., it is said to corrode and this process is called corrosion.

- **Rancidity:**

It is the oxidation reaction that takes place with eatable products. When fats and oils are oxidised, they become rancid and their smell and taste change.

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