# **CHEMICAL REACTION AND EQUATION**

#### **TOPICS TO BE COVERED :-**

- **1.** Introduction
- Chemical Equations
  To make equations more informative
  Types of chemical reaction





### **1. Physical change**

## **2.** Chemical change



## CHEMICAL REACTION

The process in which new substances with new properties are formed.

Chemical Rx<sup>n</sup> has two parts :-

- **1. <u>REACTANTS</u> :-** The substances which take part in a chemical reaction is known as reactant.
- 2. <u>PRODUCTS</u> :- The new substances produced as a result of chemical reaction is known as product.

PRODUCT

Example :- Magnesium burns in presence of oxygen.  $2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$ 

REACTANTS

Characteristics of chemical rx<sup>n</sup> are :-

i. Evolution of a gas.  $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$ ii. Formation of a precipitate.  $Pb(NO_3) + KI \longrightarrow PbI_2$  (Yellow ppt) +  $KNO_3$ iii. Change in colour  $Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$ (Blue) (Pale green) iv. Change in temperature  $CaO + H_2O \longrightarrow Ca(OH)_2 + Heat Energy released$ v. Change in state  $HCl(g) + NH_3(g) \longrightarrow NH_3Cl(s) + H_2(g)$ 







## PRECIPITATION REACTION

#### POTASSIUM IODIDE + LEAD NITRATE

1005



Why should a magnesium ribbon be cleaned before it is burn in air?

Ans :- To remove the layer of magnesium oxide or magnesium carbonate which is form in magnesium ribbon. It is removed by using sand paper.

NOTE :- Magnesium ribbon burns with a dazzling white flame and changes into a white powder. This powder is magnesium oxide.





# CHEMICAL EQUATIONS

The method of representing a chemical reaction with the help symbol or formula of a substance involved in it is known as chemical equation . OR, The method of representing chemical reaction is know as chemical equation.



Balanced Eq<sup>n</sup> :-Those chemical equation in which the number of atoms or masses of different element in the reactant and product are equal. Example :-  $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$  $3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$ 

**Unbalanced Eqn**: Those chemical equation in which the number of atoms or masses of different element in the reactant and product are not equal.

```
Example :- Mg + O_2 \rightarrow MgO
                  Fe (s) + H<sub>2</sub>O (g) \rightarrow Fe<sub>3</sub>O<sub>4</sub> (s) + 4H<sub>2</sub> (g)
```



This is also know as skeletal chemical reaction.

# Why do we need to balanced a chemical equation ?

Ans:-

To satisfy the law of "conservation of mass" which state that "mass can neither be created nor be destroyed in a chemical reaction.



#### **Balancing of a Chemical Equation**

The process of making the number of different types of atoms equal on both sides (reactant and product) of an equation is known as balancing of equation.

Example : - Fe +  $H_2O \longrightarrow Fe_3O_4 + H_2$ 

During balancing, we can't change the formula. Only we put coefficient in front of the formula.

#### List number of atoms of different elements.

Elements	No. of atoms (in reactant)	No. of atoms (in product)
Fe		
н		
0		

This method of balancing a chemical equation is known as hit and trial method.

#### Q U E S T I O N S

- 1. Why should a magnesium ribbon be cleaned before burning in air?
- 2. Write the balanced equation for the following chemical reactions.
  - (i) Hydrogen + Chlorine  $\rightarrow$  Hydrogen chloride
  - (ii) Barium chloride + Aluminium sulphate  $\rightarrow$  Barium sulphate +

Aluminium chloride

- (iii) Sodium + Water  $\rightarrow$  Sodium hydroxide + Hydrogen
- 3. Write a balanced chemical equation with state symbols for the following reactions.
  - (i) Solutions of barium chloride and sodium sulphate in water react to give insoluble barium sulphate and the solution of sodium chloride.
  - (ii) Sodium hydroxide solution (in water) reacts with hydrochloric acid solution (in water) to produce sodium chloride solution and water.

Balance the following chemical equations.

- (a)  $HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + H_2O$
- (b) NaOH +  $H_2SO_4 \rightarrow Na_2SO_4 + H_2O$
- (c) NaCl + AgNO<sub>3</sub>  $\rightarrow$  AgCl + NaNO<sub>3</sub>
- (d)  $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + HCl$

Write the balanced chemical equations for the following reactions.

- (a) Calcium hydroxide + Carbon dioxide  $\rightarrow$  Calcium carbonate + Water
- (b) Zinc + Silver nitrate  $\rightarrow$  Zinc nitrate + Silver
- (c) Aluminium + Copper chloride  $\rightarrow$  Aluminium chloride + Copper
- (d) Barium chloride + Potassium sulphate  $\rightarrow$  Barium sulphate + Potassium chloride

## TO MAKE EQUATIONS MORE INFORMATIVE

## 01. By indicating "the physical state"

The symbol used to indicate solid (s), liquid (l), gaseous (g) aqueous solution (aq). Example :- Zn(s) +  $H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$ 

Precipitate is also represented by solid(S). It is written as ppt. Example :-  $Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(I)$ (lime water) (carbon (white ppt.) (water) dioxide)

## 02. By indicating "Heat change"

On the basis of heat change,

Chemical reactions are two types :- i) Endothermic reaction

ii) Exothermic reaction

#### Endothermic reaction :-

The reaction in which heat is required.

Example :-  $N_2$  (g) +  $O_2$  (g) + heat  $\rightarrow 2NO(g)$ H<sub>2</sub>O <u>electricity</u> H<sub>2</sub> +  $O_2$ 

Photosynthesis, electrolysis and all decomposition reaction are example of endothermic reaction.

Note :- The energy required may be in form of heat, light or electricity.





Exothermic reaction :-

The reaction in which heat is released. Example :- C (s) +  $O_2$  (g)  $\rightarrow CO_2$ (g) + Heat

Respiration is an example of exothermic reaction.

Note :- Heat change may be indicate by heat or heat energy or just energy.



The release of energy during cellular respiration



$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$$

## 03. By indicating "condition"

Condition as temperature, pressure, catalyst, etc at which reaction take place.

Photosynthesis:-

$$\begin{array}{c} 6 \text{ CO}_2 \\ \text{Carbon Dioxide} \end{array} + \begin{array}{c} 6 \text{ H}_2 \text{O} \\ \text{Water} \end{array} \xrightarrow[Chlorophyll]{} \begin{array}{c} Sunlight \\ \hline Chlorophyll \end{array} \xrightarrow[Carbohydrate]{} \begin{array}{c} C_6 \text{H}_{12} \text{O}_6 \\ \text{Carbohydrate} \end{array} + \begin{array}{c} 6 \text{ O}_2 \\ \text{Oxygen} \end{array}$$

$$CO(g) + 2H_2(g) \xrightarrow{300 \text{ atm: } 300^{\circ}C} CH_3OH(I)$$

atm :- atmospheric pressure ZnO +  $CrO_3$  :- Zinc Oxide and chromium oxide

# TYPE OF CHEMICAL REACTION

Some of the important chemical reactions are :-

- 1. Combination reaction.
- 2. Decomposition reaction.
- 3. Displacement reaction.
- 4. Double displacement reaction.
- 5. Oxidation and reduction (or redox) reaction.

#### **01.** Combination reaction

Definition:-

Those reaction in which two or more substances combine to form a single substance, are called combination reaction.

#### $A + B \rightarrow AB$

Example :-  $2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$   $2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$   $CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(aq)$  $NH_3(g) + HCl(g) \longrightarrow NH_4Cl(s)$ 



A solution of slaked lime {Ca(OH)<sub>2</sub>} is used for whitewashing walls which slowly react with carbon dioxide to form calcium carbonate {CaCO<sub>3</sub>} that gives shiny finish to the walls. It takes 2-3 days to form. Ca(OH)<sub>2</sub>(aq) + CO<sub>3</sub>(g)  $\rightarrow$  CaCO<sub>3</sub>(s) + H<sub>2</sub>O(l)

#### **02. Decomposition reaction**









## $2H_2O \rightarrow 2H_2 + O_2$

NaCl  $\_$  electricity  $\rightarrow$  Na (s) + Cl (g)

$$\begin{array}{ccc} CaCO_{3}(s) & \xrightarrow{\text{Heat}} & CaO(s) & + & CO_{2}(g) \\ (Limestone) & & (Quick lime) \end{array}$$

It is example of thermal decomposition.



 $2AgCl(s) \xrightarrow{Sunlight} 2Ag(s) + Cl_2(g)$ 

Silver bromide also behaves in the same way.

 $2AgBr(s) \xrightarrow{Sunlight} 2Ag(s) + Br_2(g)$ 



We have seen that the decomposition reactions require energy either in the form of heat, light or electricity for breaking down the reactants.



## Q U E S T I O N S

- 1. A solution of a substance 'X' is used for whitewashing.
  - (i) Name the substance 'X' and write its formula.
  - (ii) Write the reaction of the substance 'X' named in (i) above with water.
- 2. Why is the amount of gas collected in one of the test tubes in Activity 1.7 double of the amount collected in the other? Name this gas.

#### **03. Displacement reaction**



Those reaction in which one element takes the place of another element in a compound are know as displacement reaction.

 $A + BX \rightarrow AX + B$ 

A more reactive element displace less reactive element. Therefore A should be more reactive then B





Figure 10.2 Displacement of copper

# **Practice Questions** 1. Fe + CuSO<sub>4</sub> $\rightarrow$ 2. $Zn + 2HCI \rightarrow$ 3. Na + ZnSO<sub>4</sub> $\rightarrow$ 4. Pb + CuCl<sub>2</sub> $\rightarrow$ 5. Mg + FeSO<sub>4</sub> $\rightarrow$ 6. Al + AgNO<sub>3</sub> $\rightarrow$ 7. Mg + Zn(NO<sub>3</sub>)<sub>2</sub> $\rightarrow$ 8. 2Na + H<sub>2</sub>SO<sub>4</sub> $\rightarrow$ 9. Ag + NaCl

10.  $3Ca + Al_2O_3 \rightarrow$ 

**Reactivity Series of Metal** 

Potassium Sodium Calcium Magnesium Aluminium Zinc Iron Tin Lead Copper Silver Gold

Less Reactive

#### 04. Double displacement reaction

Definition:-

Those reaction in which two compounds react by an exchange of ions to form two new compounds are know as d0uble displacement reaction.

#### $AX + BY \rightarrow AY + BX$

Exchange of ions takes place in double displacement reaction. A double displacement reaction usually occurs in salt solution and one of the products, being insoluble, precipitate out.

#### Example :- $BaCl_2 + (NH_4)_2SO_4 \longrightarrow BaSO_4 \downarrow + 2NH_4Cl$

Barium Ammonium chloride sulphate Barium sulphate (White ppt) Ammonium

**Precipitation reaction:** Any reaction in which an insoluble solid (called precipitate) is formed that separates from the solution is called a precipitation reaction



## **Practice Questions**

- 1.  $Na_2SO_4 + BaCl_2 \rightarrow$
- 2. AgNO<sub>3</sub> + NaCl  $\rightarrow$
- 3.  $Pb(NO_3)_2 + KI \rightarrow$
- 4.  $Na_2CO_3 + CaCl_2 \rightarrow$
- 5.  $K_2SO_4 + Ba(NO_3)_2 \rightarrow$
- 6. HCI + NaOH  $\rightarrow$
- 7.  $AI_2(SO_4)_3 + Ca(OH)_2 \rightarrow$
- 8. FeSO<sub>4</sub> + NaOH  $\rightarrow$
- 9.  $ZnSO_4 + BaCl_2 \rightarrow$
- 10.  $CuSO_4 + NaOH \rightarrow$

## **05. Oxidation and reduction reaction**

#### **Oxidation:-**

The addition of oxygen to a substance and removal of hydrogen from a substance is known as oxidation .

#### Reduction:-

The addition of hydrogen to a substance and removal of oxygen from a substance is known as reduction .



- Oxidation and reduction is also known as redox reaction. Red  $\rightarrow$  Reduction + ox  $\rightarrow$  oxidation

Oxidising agent :- The substance which gives oxygen for oxidation and removes hydrogen is called oxidising agent.

Reducing agent :- The substance which gives hydrogen for reduction or removes oxygen is called reducing agent.

Removal of O<sub>2</sub> [reduction]

$$CuO + H_2 \rightarrow Cu + H_2O$$
  
Addition of O<sub>2</sub> [oxidation]

Oxidation:- H<sub>2</sub> Oxidising agent:- CuO Reduction:- CuO Reducing agent:- H<sub>2</sub>

#### $ZnO + C \rightarrow Zn + CO$

Oxidation:- Oxidising agent:-Reduction:- Reducing agent:-  $MnO_2 + 4HCI \rightarrow MnCl_2 + 2H_2O + Cl_2$ 

Oxidation:-Reduction:- Oxidising agent:-Reducing agent:-

## Conclusion :-

- 1. The substance which gets oxidised is the reducing agent
- 2. The substance which gets reduced is the reducing agent.



#### ► Definition:

Rancidity is the condition produced by the **oxidation of fats and oils** in food, leading to a **bad taste and smell**.

#### ► Cause:

•Exposure to air (oxygen).

•Sometimes exposure to light or moisture also accelerates rancidity.

#### ► Prevention Methods:

**1.Storing food in airtight containers** – reduces exposure to oxygen.

**2.Refrigeration** – slows down the oxidation process.

**3.Adding antioxidants** – like BHA or BHT which prevent oxidation.

**4.Vacuum packing** – removes oxygen from the packaging.

**5.Storing in dark bottles** – prevents light-induced oxidation.

## **Example:**

•Chips are often packed with **nitrogen gas** to prevent rancidity.



#### ► Definition:

Corrosion is the process where **metals deteriorate** when exposed to **moist air or water**, forming unwanted compounds like **rust**.

#### **Examples:**

•Iron  $\rightarrow$  forms rust (Fe<sub>2</sub>O<sub>3</sub>·xH<sub>2</sub>O) when exposed to air and moisture.

•Silver  $\rightarrow$  turns black due to the formation of silver sulfide.

-Copper  $\rightarrow$  forms a green coating of basic copper carbonate

► Prevention Methods:

**1.Painting or coating with oil/grease** – prevents contact with air and moisture.

**2.Galvanization** – coating iron with a layer of zinc.

**3.Alloying** – mixing metal with other metals to resist corrosion (e.g., stainless steel).

**4.Electroplating** – coating with a less reactive metal.

**5.Sacrificial protection** – using a more reactive metal (like zinc) to corrode in place of iron.