AEP STUDY CIRCLE
SINCE 2001...
IIT-NEET-CBSE
ACCENTS EDUCATIONAL PROMOTERS

24 YEARS OF LEGACY

X CBSE

CHEMISTRY

CHEMICAL REACTION N EQUATIONS

YOUR GATEWAY TO EXCELLENCE IN

IIT-JEE, NEET AND CBSE EXAMS

CHEMICAL REACTION AND EQUATIONS

CONTACT US:
+91-9939586130
+91-9955930311

www.aepstudycircle.com

aepstudycircle@gmail.com
2ND FLOOR, SATKOUDI COMPLEX, THANA CHOWK, RAMGARH - 829122-JH

CHEMICAL REACTIONS EQUATIONS

Everything around us changes with time. Some changes can be noticed immediately, some others go unnoticed after some time, while some others go unnoticed.

► Some common changes which occurs in things around us are:

[i] Formation of curd from milk.
[ii] cooking of chapatti from wheat flour.
[iii] Cooking of rice.
[iv] burning of cracker, wood, coal, petroleum etc.
[v] Growing of plants [vi] Ripening of fruits.

► Observation helps us to determine whether a chemical reaction has taken place:

[i] Change in Physical state [ii] Change in colour [iii] Change in temperature
[iv] Evolution of gas [v] Position, shape and size [vi] Structure

► In some changes only the physical properties of the substance get changed, and no new substance is formed. such a change is called a **Physical change.**

► In some changes, the composition and chemical properties of the substance gets changed and one or more new substance is formed. Such a change is called **chemical change.**

◙ The properties of the new substance formed are different from those of the original Substance.
Example: When coal is burnt, carbon dioxide is produced. The properties of CO_2 are entirely different from those of carbon.
◙ Chemical change occurs only under certain condition.
◙ The chemical is the result of chemical reaction that takes place.

► **CONCLUSION: Tests of Chemical reaction ---**

◙ **[i] There must be either evolution or absorption of heat i.e., A chemical reaction must be accompanied with change in temperature.**
◙ **[ii] The reaction must occur between fixed quantities of the reactants.**
◙ **[iii] There must be either gain or loss of matter i.e., a chemical reaction should follow the law of conservation of mass.**
◙ **[iv] The product obtained as a result of chemical reaction must have properties different from those of the reactants.**

CHEMICAL REACTION AND THEIR CHARECTERISTICS:

"The change of one or more substance into other substance having different composition and different properties is called chemical reaction".

◙ The symbol / formulae of reacting substance (called reactants) are written on the left-hand side and symbol/ formulae of the substance formed (called product) are written on the right-hand side.

In other words, **the substance which take part in a chemical reaction are called Reactants.**
The substances formed in a chemical reaction are called products.

► In a chemical reaction, the number of reactants decreases whereas that of products increases with time, until the reaction is over.

► Factors on which rate of chemical reaction depends: [i] physical state [ii] temperature [iii] pressure [iv] Concentration of the reactants [v] Catalyst.

◙◙ CHARECTERISTICS:

[A] **EVOLUTION OF GAS**: Reaction in which a gas is evolved are:

[i] Reaction between Iron sulphide and dilute Sulphuric acid produces hydrogen sulphide gas.

$$\underset{\text{Iron sulphide}}{\mathbf{Fe\,S}\ (s)} + \underset{\text{dilute Sulphuric acid}}{\mathbf{H_2SO_4}\ (dil)} \longrightarrow \mathbf{FeSO_4(aq)} + \underset{\text{hydrogen sulphide gas}}{\mathbf{H_2S\ (g)}\uparrow}$$

[B] **CHANGE OF COLOUR**: Reaction in which there is a colour change:

[ii] When red lead oxide is heated, yellow lead monoxide is formed.

$$\underset{\text{red lead oxide}}{\mathbf{2\,Pb_3\,O_4}(s)} \longrightarrow \underset{\text{yellow lead monoxide}}{\mathbf{6PbO}\ (s)} + O_2\ (g)\uparrow$$

[C] **FORMATION OF PRECIPITATE**: When solution of two reagents are mixed, one of the products formed gets precipitated immediately. Colours of precipitate depends upon the reagents used.

[i] $AgNO_3$ + NaCL(aq) ⟶ Ag CL(s) + $Na NO_3$ (aq)
Silver nitrate Sodium chloride silver chloride (White ppt) Sodium nitrate

Energy changes

During a chemical change, energy is either evolved or absorbed. The energy evolved or absorbed may be in the form of heat, light, electricity, sound etc.

► [I] When coal (or carbon) is burnt, heat and light are produced.

$C(s)$ + $O_2(g)$ → $CO_2(g)$ + Heat + Light
Carbon/coal Oxygen (From the air) Carbon dioxide

In this reaction, heat and light are evolved.

(II) During the burning of a candle.

(III) During the burning of LPG.

► When a small quantity of water is added to quicklime, a large amount of heat is evolved.

$CaO(s)$ + H_2O (l) → $Ca(OH)_2$ (s) + Heat
Quicklime Water slaked lime

This reaction takes place when lime is added to water for preparing the lime suspension for whitewashing.

► Limestone $CaCO_3$ is burnt to obtain lime (or quicklime). In this reaction, heat is absorbed.

$CaCO_3$ (s) + Heat → $CaO(s)$ + $CO_2(g)$
Limestone Quicklime (Or, lime) Carbon dioxide

{This reaction is an endothermic reaction}.

Change of physical state

In certain reactions, the physical state of products is different from that of the reactants. That is, there is a change of state during a chemical reaction.

► When a mixture of hydrogen and oxygen is ignited with an electric spark at room temperature, liquid water is formed.

$2H_2(g)$ + $O_2(g)$ → (Electric spark, Room temp) $2H_2O$ (l)
Hydrogen gas oxygen gas water (liquid)

► When ammonia (NH_3) gas is allowed to come in contact with hydrogen chloride (HCl) gas, solid ammonium chloride is obtained.

NH3(g) + HCl(g) → (Room temp) $NH_4Cl(g)$
Ammonia hydrogen chloride ammonium chloride (White powder)

CHEMICAL EQUATION

► All chemical reactions are represented by Chemical equation.

"A chemical reaction is a symbolic notation that uses formulae instead of word to represent a chemical reaction".

or

"A chemical equation is a short hand representation of a chemical reaction using the symbols and formulae of substances involved in the reaction".

During a chemical reaction, certain substances react together to from some new substances. A reaction is described in terms of the names and quantities of the reactants, and products.

For example, the chemical reaction during the burning of carbon (or coal) may be describe by the statement, "*carbon is burnt is excess of air (or oxygen) to produce carbon dioxide*."

Carbon + Oxygen (excess) → Carbon dioxide

Such worded equations are long, and not convenient for describing chemical reactions. These long-worded equations can be shortened by using symbols and formulae of the substance involved in the reaction.

For example, the reaction of zinc metal with dilute sulphuric acid to produce zinc sulphate and hydrogen may be written as,

Zinc (metal) + dil. Sulphuric acid → Zinc sulphate + Hydrogen

This worded equation may be written in terms of symbols and formulae as,

$Zn + \text{dil. } H_2SO_4 \rightarrow ZnSO_4 + H_2$

Thus, $Zn + \text{dil. } H_2SO_4 \rightarrow ZnSO_4 + H_2$ is the chemical equation for the reaction between zinc and sulphuric acid.

Thus,

A shorthand representation of a chemical reaction in terms of symbols and formulae of the substances involved is called a chemical equation.

►Chemical equation for a chemical reaction is written as follows:

◙ **Step 1: Identify the reactants and the products of the chemical reaction.**

◙ **Step 2: Write down the formulae or symbols of the reactants on the left – hand side with a sign of plus (+) between them. The formulae or symbols of the products formed in the reaction are written on the right – hand side with a sign of plus (+) between them. The reactants and products are separated by → or =.**

☻ Such a chemical equation is called a skeleton equation.

◙ **Step 3: Count the number of atoms of each element on both the sides. If the numbers of atoms of each element on both the sides are equal, then the equation is called a balanced chemical equation.**

If the numbers of atoms of any one or more of the elements on both the sides are not equal, then these are made equal by adjusting the coefficients before the symbols and formulae of the reactants and products.

"The process by which the numbers of atoms of each element on both sides are made equal is called balancing of chemical equation".

◙ **Step 4:** In the end, the chemical equation is made molecular, if required.

► ☻ A chemical equation be made more informative

A chemical equation can be made more informative by adding additional information to the chemical equation. ----

❑ **Reaction conditions**: The information regarding temperature, pressure and catalyst etc., is provided above the arrow (→ or =) separating the reactants and products. A reaction taking place at t^oC and p atm pressure, and in the presence of a catalyst can be described as follows.

$$\text{Reactants} \xrightarrow[\text{Catalyst}]{t^oC \text{ and p atm}} \text{Products}$$

For example, nitrogen and hydrogen react to form ammonia under the conditions; temperature = 450° C, pressure = 200 – 900 atm, and in the presence of a catalyst (a mixture of iron and molybdenum). The chemical equation for this reaction is written as follows.

$$N_2 + 3H_2 \xrightarrow[Fe + Mo]{450^o\ C,\ 200 - 900\ atm} 2NH_3$$

❑ **Physical states of reactants and products**: Information regarding the physical states of the reactants and products, can be provided by using the letters (s), (l), (g) and (aq) for solid, liquid, gas and a solution in water, respectively, at the end of the formula of the substance involved. For example, solid sodium metal reacts with water at room temperature to produce hydrogen gas, and a solution of sodium hydroxide in water. Then, the complete chemical equation is,

$$2Na\ (s) + 2H_2O\ (l) \rightarrow 2NaOH\ (aq) + H_2\ (g)$$

❑ **Heat absorbed or evolved**. Chemical reactions proceed with the evolution or absorption of heat. The reactions in which heat is absorbed are called *endothermic reactions*. The reactions in which heat is given out are called *exothermic reactions.* This information is provided by adding a heat term on the product – side (right-hand side) of the chemical equation. For example,

❖ When carbon is burnt in air (or oxygen) heat is evolved. Then, the chemical equation is ,

$$C(s) + O_2\ (g) \rightarrow CO_2\ (g) + \text{Heat (393 kJ)}$$

❖ The reaction between carbon (C) and sulphur (S) to produce carbon disulphide (CS_2) proceeds with the absorption of heat, i.e., it is an endothermic reaction.

$$C(s) + 2S\ (g) \rightarrow CS_2\ (g) - \text{Heat (92 kJ)}$$

The reactions with + **Heat** term on the products side are called **exothermic reactions**, while those with – **Heat** term on the product side are called **endothermic reactions**.

❑ **Concentration of the Reactants and Products**: This information is added to the chemical equation by adding the word dil. (for dilute) or conc. (for concentrated) before the formulae of the reactants and products. For example, in the reaction between zinc and dilute sulphuric acid, the term dil. is added before the formula of sulphuric acid.

$Zn(s) + \text{dil. } H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

❑ **Rate of reaction**: This information is not commonly added to the chemical equation. Sometimes, however, the term fast or slow may be added over the arrow, if the reaction is fast or slow. For example, the reaction between HCl and NaOH in solution is a fast reaction. So,

$$HCl\ (aq) + NaOH\ (aq) \xrightarrow{\text{Fast}} NaCl(aq) + H_2O(l)$$

☻ Information conveyed by a balanced chemical equation

A chemical equation gives the following two types of information.

◙1. **Qualitative information**: A chemical equation provides the following qualitative information about the reaction. It tells us the, (I) Names of the reactants which take part in the reaction.

(II) Name of the products formed in the reaction.

◙ 2. **Quantitative information**: A chemical equation gives the following quantitative information. It tells us about,

(I) The number of molecules or molecules or atoms of reactants and products taking part in the reaction.

(II) The number of moles of each substance involved in the reaction.

(III) The mass of each substance involved in the reaction.

(IV) Mass – mass, mass – volume, volume – volume relationship between the reactants and products.

❑❑ BALANCING OF CHEMICAL EQUATIONS

The method by which the number of atoms of each element on both the sides of the arrow (→) in a chemical reaction are made equal, is called **balancing of chemical equation**.

◙ Necessity to balance a chemical equation:

Explanation: In a balanced chemical equation, the number of atoms of each element on both the sides should be equal. This is because; no matter is lost or gained during a chemical reaction, (law of conservation of matter). Therefore, **balancing of a chemical equation is necessary because no matter (hence, no atom) is lost or gained during a chemical reaction.**

◙ Method of balancing a chemical equations:

Chemical equations are balanced by adjusting the coefficients placed before the symbols of formulae of the reactants and products. There are two commonly used methods for the balancing of chemical equations:

(I) Hit – and – trial method (II) Partial equation method

◙ Hit – and – trial method:

This method is also called trial – error method, or inspection method. In this method, coefficients before the formulae or symbols of the reactants and products are adjusted in such a way that the total number of atoms of each element on both the sides becomes equal. This is called **material balance** or **mass balance**.

The following order is found helpful in the balancing of chemical equations by hit and trial method.

(I) **Start balancing from the element (other than oxygen and hydrogen) which appears least in the chemical equation.**

(II) **Balance oxygen**

(III) **Balance hydrogen**

(IV) **Check to be sure that the chemical equation is balanced**.

Illustration: **Balancing of a chemical equation by the hit – and – trial method involves a number of steps. The steps involved in the reaction involving the burning of methane gas in the excess of air (or oxygen) to form carbon dioxide gas and water are illustrated below: -**

Methane + oxygen (from air) → Carbon dioxide + water

Step 1: The skeleton equation for this reaction in terms of symbols and formulae is,

$CH_4(s)$ + $O_2(g)$ → $CO_2(g)$ + $H_2O(l)$

Step 2: Write the number of atoms of each element on both the sides of the arrow (→) in the above equation as follows:

Element	No. of atoms on the	
	Left (reactant side)	Right (produce side)
C	1	1
H	4	2
O	2	3

As the numbers of atoms of H and O on both the sides are not equal, the skeleton equation is not a balanced chemical equation.

Step 3: Inspection of the skeleton equation shows that both carbon (C) and hydrogen (H) occur twice, and oxygen (O) appears thrice. So, a start is made by balancing carbon or hydrogen atoms.

Carbon is already balanced. There are 4 hydrogen atoms on the left side, and 2 hydrogen atoms on the right side. So, hydrogen (H) can be balanced by placing a coefficient of 2 before H_20 on the right – hand side. Then, the resulting chemical equation is,

$CH_4(s)$ + $O_2(g)$ → $CO_2(g)$ + $2H_2O(l)$

Step 4: Now, there is one carbon and four hydrogen atoms on either side of the equation.

Thus, carbon and hydrogen are balanced. In this partly balanced chemical equation, there are four oxygen atoms on the right – hand side, while there are two on the left – hand side. Oxygen atoms may be balanced by multiplying O_2 on the left side, by 2. The resulting equation is,

$CH_4(s)$ + $2O_2(g)$ → $CO_2(g)$ + $H_2O(l)$

Now, the numbers of atoms of each element on both the sides of this equation are,

Element	No. of atoms on the	
	Left (reactant side)	Right (produce side)
Carbon	1	1
Hydrogen	4	2
Oxygen	2	3

The number of atoms of each element on both sides of the equation are equal.

$CH_4(s)$ + $2O_2(g)$ → $CO_2(g)$ + $2H_2O(l)$

∴ the above chemical equation is a balanced chemical equation.

►EXAMPLE 1.1: Balance the following unbalanced equation.

$Fe(s)$ + $H_2O(g)$ → $Fe_2O_3(s)$ + $H_2(g)$

Solution: The given unbalanced equation is

$Fe(s)$ + $H_2O(g)$ → $Fe_2O_3(s)$ + $H_2(g)$

Step 1: Examine the number of atoms of all the elements on both the sides of the chemical equation.

Element	No. of atoms	
	On reactant side	On produce side
Fe	1	2
H	2	2
O	1	3

Step 2: To balance Fe atoms, the Fe on the LHS is multiplied by 2.

Step 3: Hydrogen atoms are balanced.

Step 4: To balance oxygen atoms, place the coefficient 3 before H_2O (on the left).

The partially balanced equation is

$2Fe(s)$ + $3H_2O(g)$ → $Fe_2O_3(s)$ + $H_2(g)$

Step 5: Now, there are six (6) H atoms on the reactant side and only 2 H atoms on the product side. So, balance H atoms by placing the coefficient 3 before H_2 (on the product side). Then, we can write,

$2Fe(s)$ + $3H_2O(g)$ → $Fe_2O_3(s)$ + $H_2(g)$

Inspection of this equation shows that atoms of all the elements are equal on both the sides. Therefore, the above equation is a balanced equation.

►EXAMPLE 1.2: Translate the following statements into chemical equations and then balance them:

(a) Hydrogen gas combines with nitrogen to form ammonia.

(b) Hydrogen sulphide gas burns in air to give water and sulphur dioxide.

(c) Barium chloride reacts with aluminium sulphate to give aluminium chloride and precipitate of barium sulphate.

(d) Potassium metal reacts with water to give potassium hydroxide and hydroxide and hydrogen gas.

Solution: The balanced equations for the given reaction are,

(a) $3H_2$ (g) + $2N_2$ (g) → $2NH_3$ (g)
Hydrogen — nitrogen — ammonia

(b) $2H_2S$ (g) + O_2 (g) → $2SO_2$ (s) + $2H_2O$(g)
Hydrogen sulphide — (from air) — sulphur dioxide — water

(c) $3BaCl_2$(aq) + $Al2(SO_4)_3$(aq) → $3BaSO_4$(s) + $2AlCl_3$(aq)
Barium chloride — aluminium sulphate — barium sulphate — aluminium chloride

(d) 2K(s) + $2H_2O$(l) → 2KOH (aq) + H_2(g)
Potassium — water — potassium hydroxide

►EXAMPLE 1.3: Balance the following chemical equations:

(a) HNO_3 + $Ca(OH)_2$ → $Ca(NO_3)_2$ + H_2O

(b) NaOH + H_2SO_4 → Na_2SO_4 + H_2O

(c) NaCl + $AgNO_3$ → AgCl + $NaNO_3$

(d) $BaCl_2$ + H_2SO_4 → $BaSO_4$ + HCl

Solution: The balanced equations for the given reactions are,

(a) $2HNO_3$ + $Ca(OH)_2$ → $Ca(NO_3)_2$ + $2H_2O$

(b) 2NaOH + H_2SO_4 → Na_2SO_4 + $2H_2O$

(c) NaCl + $AgNO_3$ → AgCl + $NaNO_3$

(d) $BaCl_2$ + H_2SO_4 → $BaSO_4$ + 2HCl

EXAMPLE 1.4: Write the balanced chemical equations for the following reactions:

(a) Calcium hydroxide + Carbon dioxide → Calcium carbonate + Water

(b) Zinc + Silver nitrate → Zinc nitrate + Silver

(c) Lead + copper chloride → Lead chloride + Copper

(d) Barium chloride + Sodium sulphate → Barium sulphate + Sodium chloride

Solution:

(a) $Ca(OH)_2$ + CO_2 → $CaCO_3$ + H_2O
Calcium hydroxide — carbon dioxide — calcium carbonate — water

(b) Zn + $AgNO_3$ → $Zn(NO_3)_2$ + Ag
Zinc — Silver nitrate — zinc nitrate — silver

(c) Pb + $CuCl_2$ → $PbCl_2$ + Cu
Lead — Copper chloride — Lead chloride — copper

(d) BaCl2 + Na2SO4 → BaSO4 + 2NaCl
Barium chloride — sodium sulphate — barium sulphate — sodium chloride

EXAMPLE 1.5: Write the balanced equations for the following chemical reactions:

(i) Hydrogen + Chlorine → Hydrogen chloride

(ii) Magnesium oxide + Carbon → Magnesium + Carbon monoxide

(iii) Sodium + Water → Sodium hydroxide + Hydrogen

Solution: The balanced equations for the given reactions are,

(i) H_2(g) + Cl_2(g) → 2HCl(g)
Hydrogen — chlorine — hydrogen chloride

(ii) MgO(s) + C(s) → Mg(s) + CO(g)
Magnesium oxide — carbon — magnesium — carbon monoxide

(iii) Na (s) + H_2O(l) → NaOH (aq) + H_2(g)
Sodium — water — sodium hydroxide — hydrogen

EXAMPLE 1.6: Take a balanced chemical equation with state symbols for the following equations:

(i) Iron filings react with steam to produce solid Iron (III) oxide and hydrogen gas.

(ii) Sodium hydroxide solution (in water) reacts with hydrochloric acid solution (in water) to produce sodium chloride and water.

Solution: (i) 4Fe(s) + $6H_2O$ (g) → $2Fe_2O_3$ + $6H_2$(g)
Iron filings — steam — iron(III) oxide — hydrogen

(ii) NaOH (aq) + HCl(aq) → NaCl (aq) + H_2O (l)
Sodium hydroxide — hydrochloric acid — sodium — water

EXAMPLE 1.7: Write the balance chemical equations for the following reactions and identify the type of reaction:

(a) Potassium bromide (aq) + Barium iodide (aq) → Potassium iodide (aq) + Barium bromide (aq)

(b) Zinc carbonate (s) → Zinc oxide (s) + Carbon dioxide (g)

(c) Hydrogen (g) + Chlorine (g) → Hydrogen chloride (g)

(d) Magnesium (s) + Hydrochloric acid (aq) → Magnesium chloride (aq) + Hydrogen (g)

Solution:

(a) $2KBr\ (aq) + BaI_2(aq) \rightarrow 2KI\ (aq) + BaBr_2\ (aq)$

This reaction is a **double – displacement reaction**.

(b) $ZnCO_3(s) \rightarrow ZnO(s) + CO_2\ (g)$

This reaction is a **decomposition reaction**.

(c) $H_2\ (g) + Cl_2(g) \rightarrow 2HCl\ (g)$

This reaction is a **combination (or synthesis) reaction**.

(d) $Mg\ (s) + 2HCl\ (aq) \rightarrow MgCl_2\ (aq) + H_2\ (g)$

This reaction is a **displacement reaction**.

EXAMPLE 1.8: Write a chemical equation for each of the following reactions:

(i) Zinc metal reacts with aqueous hydrochloric acid to produce a solution of zinc chloride and hydrogen gas.

(ii) When solid mercury(II)oxide is heated, liquid mercury and oxygen gas are produced.

Sol:

(i) $Zn(s) + 2HCl\ (aq) \rightarrow ZnCl_2\ (aq) + H_2\ (g)$

(ii) $2HgO(s) \xrightarrow{Heat} 2Hg\ (l) + O_2\ (g)$

❑❑TYPES OF CHEMICAL REACTIONS:

Chemical reaction

A chemical process (or change) in which certain substance react together to form some new substance with different properties is called a chemical reaction. For example

$$\underset{\text{Hydrogen}}{2H_2(g)} + \underset{\text{oxygen}}{O_2(g)} \rightarrow \underset{\text{water}}{2H_2O(l)}$$

► The properties of water are altogether different from those of hydrogen and oxygen.

► **Chemical reactions can be grouped into various types on the basis to their nature.**

Some common types of chemical reactions are

- ❑ **Combination reactions**
- ❑ **Decomposition reactions**
- ❑ **Displacement reactions**
- ❑ **Double – displacement reactions**
- ❑ **Oxidation – reduction reactions**
- ❑ **Precipitation reactions**
- ❑ **Exothermic and endothermic reactions.**

{A} COMBINATION REACTION

"A reaction in which two or more substances combine together to form a new substance, is called a combination reaction".

For Ex:

(a) Sulphur dioxide and oxygen combine to form sulphur trioxide.

$$\underset{\text{Sulphur dioxide}}{SO_2(g)} + \underset{\text{oxygen}}{O_2(g)} \rightarrow \underset{\text{Sulphur trioxide}}{SO_3(g)}$$

(b) Calcium oxide and carbon dioxide combine to form calcium carbonate.

$$\underset{\text{Calcium oxide}}{CaO(s)} + \underset{\text{Carbon dioxide}}{CO_2(g)} \rightarrow \underset{\text{Calcium carbonate}}{CaCO_3\ (l)}$$

◙ **Many combustion (or burning) reactions are also combination reactions.** For example,

$$\underset{\text{Carbon}}{C(s)} + \underset{\text{oxygen}}{O_2(g)} \xrightarrow{Burn} \underset{\text{Carbon dioxide}}{CO_2(g)}$$

$$\underset{\text{Hydrogen}}{2H_2(g)} + \underset{\text{oxygen}}{O_2\ (g)} \rightarrow \underset{\text{water}}{2H_2O}$$

$$2Mg(g) + O_2\ (g) \xrightarrow{Burn} 2MgO(s)$$

► *The combination reactions in which a compound is formed from its constituent elements are called synthesis reactions. For Example:*

❖ Synthesis of hydrogen chloride (HCl)

$$H_2(g) + Cl_2(g) \xrightarrow{\text{Sunlight}} 2HCl(g)$$

❖ Synthesis of water (H_2O)

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

Hydrogen, oxygen, water

❖ Synthesis of magnesium oxide (MgO)

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

Magnesium, from air, magnesium oxide

❖ Synthesis of ammonia (NH_3)

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

Nitrogen, hydrogen, ammonia

► An important industrial application of combination (or synthesis) reaction is the manufacture of hydrogen chloride gas from hydrogen and chlorine.

Hydrogen chloride gas when dissolved in water gives hydrochloric acid.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g) \xrightarrow{+H_2O(l)} HCl\ (aq)$$

Hydrogen, chlorine, hydrogen Chloride, Calculated amount, hydrochloric acid

[B] Decomposition Reaction

A reaction in which a substance is broken down into two or more simpler substance is known as decomposition reaction.

► Decomposition reactions take place only when some energy in the form of heat, light or electricity is supplied to the substance.

Various kinds of decomposition reactions: ----------

❑ **Thermal decomposition**. Decomposition reaction caused by heating is called thermal decomposition.

❑ **Photodecomposition.** Decomposition reaction caused by light is called photodecomposition or photolysis.

❑ Electrolytic dissociation. Decomposition reaction caused by electricity is called electrolytic decomposition or electrolysis.

► **Some typical decomposition reactions are,**

❖ Limestone ($CaCO_3$) when heated strongly gives quicklime (CaO) and carbon dioxide (CO_2)

$$CaCO_3 \xrightarrow{\text{Heat}} CaO(s) + CO_2(g)$$

Limestone, quicklime, carbon dioxide

❖ Potassium chlorate when heated decomposes to give potassium chloride (KCl) and oxygen (O_2)

$$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$$

Potassium chlorate, Potassium chloride, oxygen

❖ Ferrous sulphate crystals are light green in colour. When heated gently, it decomposes to lose water and its colour changes to dirty white.

$$FeSO_4.7H_2O \xrightarrow{\text{Heat}} FeSO_4(s) + 7H_2O(g)$$

Ferrous sulphate crystals (Light green), anhydrous, water, ferrous sulphate (Dirty white)

When anhydrous ferrous sulphate is heated strongly, it decomposes to give ferrous oxide (Fe_2O_3) and oxides of sulphur.

$$2FeSO_4 \xrightarrow{\text{Heat strongly}} Fe_2O_3(s) + SO_2 + SO_3$$

Ferrous sulphate (Dirty white), ferric oxide (Dark brown), oxides of sulphur (Smell of burning sulphur)

❖ Water is decomposed when electricity is passed through acidified water.

$$2H_2O(l) \xrightarrow{\text{electricity}} 2H_2(s) + O_2(g)$$

Water, hydrogen, oxygen

❖ Zinc ore, calamine ($ZnCO_3$) decomposes on heating to give zinc oxide (ZnO). This is an important step in the extraction of zinc.

$$ZnCO_3(s) \xrightarrow{\text{Heat}} ZnO(s) + CO_2(g)$$

Zinc carbonate (Calamine), zinc oxide, carbon dioxide

❖ Lead nitrate ($Pb(NO_3)_2$) on heating decomposes to give lead oxide (litharge) and brown fumes of nitrogen dioxide (No_2).

$$2Pb(NO_3)_2(s) \xrightarrow{\text{Heat}} 2PbO(s) + 4NO_2(g) + O_2(g)$$

Lead (II) nitrate, lead (II) oxide (Litharge), nitrogen dioxide, oxygen

{C} Displacement Reaction

"A reaction in which one part (an atom or a group of atoms) of a molecule is replaced by another is called displacement reaction".

► Displacement reactions are also called **substitution reactions**. For example, the following reaction

$$A + BC \rightarrow AC + B$$

In which A displaces B from BC, is a displacement (or substitution) reaction.

❑ **Displacement of copper (Cu) from copper sulphate solution ($CuSO_4$) by active metals like iron, zinc, lead and magnesium, is a typical displacement reaction.**

This displacement reaction can be demonstrated by performing the following simple experiment.

Take about 5 mL of copper sulphate solution in a test tube. Place an iron nail in the solution. Observe the change.

After some time, we will see

(a) Blue colour of the copper sulphate solution fades away

(b) Reddish deposit on the nail.

The reddish deposit on the nail is a displaced copper.

This experiment shows that **iron displaces copper from copper sulphate solution.**

$CuSO_4$ (aq) + Fe(s) → Cu(s) + $FeSO_4$ (aq)
Copper sulphate (Blue) | iron | copper metal | ferrous sulphate (Light green)

$CuSO_4$ (aq) + Zn(s) → Cu(s) + $ZnSO_4$ (aq)
Copper sulphate (Blue) | Zinc | copper metal | Zinc sulphate (Colourless)

$CuSO_4$ (aq) + Mg(s) → Cu(s) + $MgSO_4$ (aq)
Copper sulphate (Blue) | magnesium | Magnesium sulphate (Colourless)

❑ **Metals such as iron, zinc and magnesium are more reactive (more electropositive) than copper.**

❖ **Displacement** of less active halogen form the solution of corresponding halide by a more active halogen is also a displacement reaction. For example, chlorine displaces bromine and iodine from bromides and iodides,

2KBr (aq) + Cl_2 (aq) → 2KCl (aq) + Br_2 (aq)
Potassium bromide (colourless) | Chlorine | potassium chloride | bromine (deep yellow)

2KI (aq) + Cl_2 (aq) → 2KCl (aq) + I_2 (aq)
Potassium iodide (Colourless) | Chlorine | | Iodine (Deep brown)

❖ **Displacement** of hydrogen from acids by active metals is also a displacement reaction. For example, zinc metal displaces hydrogen from dilute hydrochloric and dilute sulphuric acids

Zn(s) + 2HCl (dil.) → $ZnCl_2$ (aq) + H_2 (g)
Zinc | hydrochloric acid | zinc chloride | hydrogen

Zn(s) + H_2SO_4 (dil.) → $ZnSO_4$ (aq) + H_2 (g)
Zinc | sulphuric acid | zinc sulphate | hydrogen

[C]Double displacement Reaction

A reaction in which the two reacting ionic compounds exchange their corresponding ions is called a double displacement reaction. For example:

(a) Reaction between silver nitrate and sodium chloride in solution.

$AgNO_3$ (aq) + NaCl (aq) → $NaNO_3$(aq) + AgCl (s)
Silver nitrate | Sodium chloride | Sodium nitrate | Silver chloride (White precipitate)

(b) Reaction between $BaCl_2$ and H_2SO_4 in solution.

$BaCl_2$ (aq) + H_2SO_4 (aq) → 2HCl (aq) + $BaSO_4$ (s)
Barium chloride | Sulphuric acid | Hydrochloric Acid | Barium sulphate (white precipitate)

{D} Precipitation Reaction:

The reaction in which one of the products formed is an insoluble substance and is thrown out of the solution as solid (called precipitate) is called precipitation reaction.

◙ The substance that separates out as precipitate is indicated by a downward arrow (↓).

❖ Reaction between silver nitrate and sodium chloride

$AgNO_3$ (aq) + NaCl (aq) → AgCl (s) ↓ + $NaNO_3$ (aq)
Silver nitrate | sodium chloride | sodium nitrate | silver chloride (White precipitate)

❖ Reaction between barium chloride and sulphuric acid

$BaCl_2$ (aq) + H_2SO_4 (aq) → $BaSO_4$ (s) ↓ + 2HCl (aq)
Barium chloride | Sulphuric acid | Barium sulphate (White precipitate) | Hydrochloric acid

❖ Reaction between lead nitrate and hydrogen sulphide

$Pb(NO_3)_2$(aq) + H_2S(aq) → PbS (s) ↓ + $2HNO_3$ (g)
Lead nitrate | Hydrogen sulphide | lead sulphide (Black precipitate) | nitric acid

[E] Exothermic Reaction:

The term exothermic means giving out heat, (exo – out, and thermic – heat). So,

"The **reactions in which heat is liberated (given out) are known as exothermic reactions".**

❑ **Burning of carbon.** Carbon (C) burns in oxygen (or in air) to form carbon dioxide (CO_2) gas, and liberating a large amount of heat.

C(s) + O_2(g) → CO_2(g) + Heat
Carbon | oxygen | carbon dioxide

❑ **Burning of methane.** Methane burns in air to form carbon dioxide, water and liberating a large amount of heat. Thus, burning of methane (CH_4) is an exothermic reaction.

CH_4(g) + $2O_2$(g) → CO_2(g) + $2H_2O$ + Heat
Methane | oxygen | carbon dioxide | water

●Exothermic reactions are,

❖ Dissolution of concentrated sulphuric acid in water.
❖ Dissolution of caustic soda (sodium hydroxide, NaOH) in water.
❖ Combustion of LPG, Kerosene, Furnace oil, etc.
❖ Reaction of lime (CaO) with water (H_2O).

[F] ENDOTHERMIC Reaction:

A reaction which proceeds with the absorption of heat is called endothermic reaction (endo – means in, and thermic means heat).

❑ **Reaction between nitrogen and oxygen**. Nitrogen reacts with oxygen at about 3000°C to form nitric oxide (NO).

N_2(g) + O_2(g) + Heat $\xrightarrow{3000^oC}$ 2NO(g)
Nitrogen | oxygen | nitric oxide

►This is one of the major reactions which takes place in the atmosphere when lightning strikes.

❑ **Preparation of water gas**. When steam (H2O(*v*)) is passed over red hot coke, water gas (CO + H_2) is formed. This reaction is also and endothermic reaction.

C(s) + H_2O(v) → Heat + CO(g) + H_2(g)
Red hot coke | steam | water gas

►Some other endothermic processes are,

❖ Dissolution of ammonium chloride (NH_4Cl) in water ❖ Conversion of water to steam

OXIDATION AND REDUCTION REACTIONS

► The two most common ways of describing oxidation and reduction are

(i) In terms of gain or loss of oxygen or hydrogen.
(ii) In terms of loss or gain of electrons.

►Oxidation and Reduction in terms of gain or loss of oxygen or hydrogen:

❑ Any process which involves

(i) Addition of oxygen

Or (ii) Removal of hydrogen .... Is termed as oxidation

◙ Examples of oxidation reactions.....

(i) **ADDITION OF OXYGEN**

❖ **Burning of carbon**: Carbon burns in the presence of oxygen to form carbon dioxide. This is an oxidation reaction because oxygen is added to carbon.

$$\underset{\text{Carbon}}{C(s)} + \underset{\text{oxygen}}{O_2(g)} \xrightarrow{\text{Burning}} CO_2$$

❖ **Burning of magnesium and phosphorus**: Magnesium and phosphorus also burn in the presence of oxygen forming their oxides. These are also oxidation reactions because oxygen is added to magnesium and phosphorus

$$\underset{\text{Magnesium}}{2Mg(s)} + \underset{\text{oxygen}}{O_2(g)} \xrightarrow{\text{Burn}} \underset{\text{magnesium oxide}}{2MgO(s)}$$

$$\underset{\text{Phosphorus}}{P4(s)} + \underset{\text{oxygen}}{5O_2(s)} \xrightarrow{\text{Burn}} \underset{\text{phosphorus pent oxide}}{2P_2O_5(s)}$$

(*ii*) Removal of Hydrogen

❖ **Oxidation of H_2S**: Hydrogen sulphide (H_2S) is oxidised by bromine (Br_2) to sulphur.

$$\underset{\text{Hydrogen sulphide}}{H_2S\,(aq)} + Br_2\,(aq) \rightarrow 2HBr\,(aq) + \underset{\text{sulphur}}{S}$$

Oxidation

(Hydrogen is removed from H_2S)

❖ **Oxidation of hydrochloric acid by manganese dioxide**: When hydrochloric acid is heated with manganese dioxide, it gets oxidised to chlorine.

$$\underset{\text{Hydrochloric acid}}{4HCl} + \underset{\text{manganese dioxide}}{MnO_2} \xrightarrow{\text{Heat}} MnCl_2 + 2H_2O + \underset{\text{chlorine}}{2Cl_2}$$

Oxidation

(Here, hydrogen is removed from HCl)

❑ A **process which involves**

(*i*) Addition of hydrogen

Or (*ii*) Removal of oxygen is termed reduction. ☻ Reduction is the reverse of oxidation.

Examples of reduction reactions.....

(*i*) Addition of Hydrogen

❖ **Reaction between hydrogen sulphide and chlorine**: Hydrogen sulphide (H_2S) when reacted with chlorine (Cl_2) gets oxidized to sulphur whereas chlorine (Cl_2) gets reduced to HCl.

$$\underset{\text{Hydrogen sulphide}}{H_2S\,(aq)} + \underset{\text{chlorine}}{Cl_2\,(g)} \rightarrow \underset{\text{hydrochloric acid}}{2HCl\,(aq)} + \underset{\text{sulphur}}{S}$$

Reduction

Hydrogen is added to chlorine

(*i*) Removal of Oxygen

❖ **Reaction between heated cupric oxide and hydrogen**: When hydrogen gas is passed over heated cupric oxide (CuO), CuO gets reduced to copper (Cu).

$$\underset{\text{Cupric oxide}}{CuO\,(s)} + \underset{\text{hydrogen}}{H_2\,(g)} \xrightarrow{\text{Heat}} \underset{\text{copper}}{Cu\,(s)} + \underset{\text{water}}{H_2O\,(g)}$$

Reduction

Hydrogen is added to chlorine

***Oxidising and Reducing agents*: ----------**

►**The substance which can bring about oxidation of other substance is called an oxidising agent.**

In other words,

A substance which causes addition of oxygen or removal of hydrogen from other substance is called an oxidising agent.

Some common oxidising agents are, oxygen, chlorine, hydrogen peroxide, conc. sulphuric acid, potassium permanganate, potassium dichromate etc.

Examples: ----------

❖ In the reaction:

C	+	ZnO	→	CO	+	Zn
Carbon		zinc oxide		carbon monoxide		zinc

Carbon is able to remove oxygen from ZnO. So, **carbon (C) is the reducing agent in this reaction.**

❖ In this reaction,

H_2S	+	Cl_2	→	2HCl	+	S
Hydrogen sulphide		chlorine		hydrochloric acid		sulphur

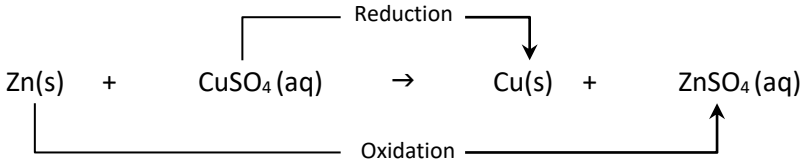
H_2S is able to add hydrogen to chlorine. So, **H_2S is the reducing agent in this reaction.**

► Oxidation – Reduction (or redox) reaction

An oxidation – reduction (or redox) reaction is defined as follows:

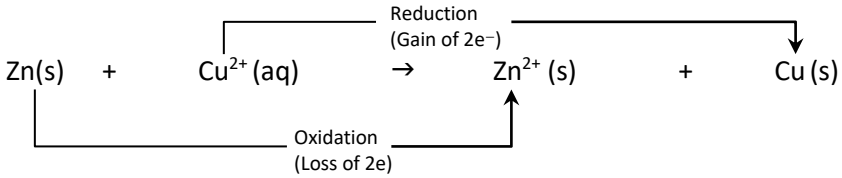
A reaction in which oxidation and reduction takes place simultaneously is called an oxidation – reduction (or redox) reaction.

Displacement of copper from copper sulphate solution by zinc is a redox reaction.



In this reaction, Zn metal gets oxidised to Zn^{2+} ions and Cu^{2+} ions in the solution get reduced to Cu metal.

This metal displacement redox reaction can be described by the ionic equation,



Some other redox or oxidation – reduction reactions are,

(*i*) Displacement of silver metal from silver nitrate solution by zinc scrap.

$2AgNO_3$ (aq)	+	Zn(s)	→	Zn $(NO_3)_2$(aq)	+	2Ag(s)
Silver nitrate		zinc metal		zinc nitrate		silver metal

(*ii*) **Thermite reaction**: reduction of iron oxide with aluminium powder.

Fe_2O_3	+	2Al(s)	→	Al_2O_3(s)	+	2Fe (*l*)
Iron (III) oxide		aluminium		aluminium oxide		iron

(*iii*) Reaction between iron and sulphur on heating.

			Heat →		
Fe(s)	+	S(s)	→	FeS(s)	
Iron		sulphur		iron (II) sulphide	

(*iv*) Reaction between H_2S and SO_2.

$2H_2S$	+	SO_2	→	$2H_2O$ (l)	+	3S(s)
Hydrogen sulphide		sulphur dioxide		water		sulphur

EFFECTS OF OXIDATION REACTIONS IN EVERYDAY LIFE

Many chemical reactions that occur around us are oxidation reaction. For example, burning of fuels, such as, Coal, LPG, Petrol etc., respiration, rusting of iron etc., are oxidation reactions. In this section, two typical processes due to oxidation are described.

CORROSION

In our daily life, we see many metals that react with the environment. For example,

► Silver gets tarnished, i.e., it loses its shine
► Iron gets coated with a brittle brown – coloured layer
► Copper and brass get a green – coloured deposit on their surfaces
► Surface of aluminium becomes dull and loses its shine and so on.

"Slow **destruction of metals due to their interaction with the environment is called corrosion".**

Corrosion takes place on the exposed surface. When the upper layer of the metal gets corrected, then the inner surface of the metal gets exposed, and the corrosion then continues up to certain depth.

► Corrosion needs oxygen (or air) and moisture to take place.
► Corrosion is accelerated by the presence of electrolytes in water.
► Corrosion causes damage to the structures made of iron, such as, bridges, car bodies, iron railings, ships etc.
►Corrosion is a very serious problem in industries. The chemical reactors and plants need replacement due to corrosion. This requires lot of money and time.

Prevention of corrosion:

Corrosion can be prevented

► By coating the surface with paint, oil, grease or varnish etc.

► By coating/depositing a thin layer of any other metal which does not corrode. For example, coating iron with zinc, brass with chromium etc.

RANCIDITY

Have you tasted or smelt the oil – containing food materials, such as, namkeen etc., left for a long time? The taste and smell of such foodstuff have gone bad. This is due to the degradation of oil/fat.

◙Rancidity is the natural oxidative chemical degradation of oils. Rancidity causes a change in the smell and taste of fat/ oils or any foodstuff containing oil.

◙Rancidity is due to a process which converts esters present in the oil into free fatty acids by reacting with air, moisture etc. Different oils become rancid after different time periods. The best way to prevent rancidity is to add an antioxidant in the foodstuff.

◙Keeping food in airtight containers helps to slow down oxidation, hence delays the rancidity.

Chips, namkeen manufacturers flush the package of chips/ namkeen with oxygen – free nitrogen gas. This also prevents the oxidation of oil/fat in the food material.

A E P: CONCEPTUALS.....

Q.1. Hydrogen and oxygen react to form water. Write the balanced chemical equation for this reaction.

Ans. The chemical equation for the reaction between hydrogen and oxygen to written as follows:

Step 1: The reactants and product are identified as follows:

Reactants: Hydrogen and oxygen

Step 2: Writing the formulae of reactants and product on either side of an arrow. The molecular formula of hydrogen is H_2 and that of oxygen is O_2. So, the skeleton equation is,

$H_2(g) + O_2(g) \rightarrow H_2O(l)$

Step 3: Counting of the atoms of each element on both the sides gives,

Element	**No. of atoms on the**	
	Reactant side (left – hand side)	Product side (right - hand side)
H	2	2
O	2	1

The number of atoms of oxygen (O) in not equal on both the sides, viz., there are two atoms on the reactant side (left – hand side), while there is only one O atom on the product side (right – hand side). Thus, the number of oxygen atoms on both the sides can be made equal by placing a coefficient of 2 before H_2O (on the product side). Thus,

$H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

But, by doing so, the number of hydrogen atoms on the right – hand side has become four. On the left - hand side, there are only two hydrogen atoms. So, hydrogen atoms can be equalized by placing a coefficient of 2 before H_2 (on the reactant side). Then, the chemical equation becomes,

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

Now, counting of the number of atoms of each element shows that there are four hydrogen atoms and two oxygen atoms on both the sides. Thus, the balanced chemical equation for the reaction between hydrogen and oxygen is,

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

Q.2. Rewrite the following information in the form of a balanced chemical equation. "Magnesium burns in carbon dioxide to form magnesium oxide and carbon."

Ans. The reaction can be written as follows:

Magnesium + Carbon dioxide → Magnesium oxide + Carbon

$Mg(s) + CO_2(g) \rightarrow MgO(s) + C(s)$

Inspection of this equation shows that it is not a balanced equation. The equation may be balanced by the hit – and – trial method, as follows.

(I) The balancing of the chemical equation may be started by balancing the oxygen atoms. This can be done by placing a coefficient 2 before MgO. So, the chemical equation may be rewritten as,

$Mg(s) + CO_2(g) \rightarrow 2MgO(s) + C(s)$

(II) Now, Mg can be balanced by placing a coefficient 2 before Mg. So, one gets,

$2Mg(s) + CO_2(g) \rightarrow 2MgO(s) + C(s)$

This is the balanced equation.

Q. 3. Rewrite the following equation in a balanced form showing in it that $Al(OH)_3$ is an insoluble product.

$$\mathbf{Al_2(SO_4)_3 + NaOH \rightarrow Al(OH)_3 + Na_2SO_4}$$

Ans. The chemical equation,

$Al_2(SO_4)_3$ + NaOH → $Al(OH)_3$ + Na_2SO_4

When balanced by the hit – and – trial method, as follows.

$Al_2(SO_4)_3$ + 6 NaOH → $2Al(OH)_3$ + $3Na_2SO_4(aq)$

The formation of insoluble product $Al(OH)_3$ is indicated by an arrow pointing downward(↓).

Q. 4. Acetylene (C_2H_2) burns in air (or oxygen) to give carbon dioxide (CO_2) and water (H_2O). Write the balanced chemical equation for this reaction.

Ans. The reactants and products in this reaction are,

Reactants: Acetylene (C_2H_2) and oxygen (O_2)

Products: Carbon dioxide (CO_2) and water (H_2O)

The reaction may be written as,

Acetylene + Oxygen (from air) → Carbon dioxide + Water

(I) The skeleton equation is,

$C_2H_2(g)$ + $O_2(g)$ → $CO_2(g)$ + $H_2O(l)$

(II) Inspection of the skeleton equation shows that the carbon and hydrogen, both occur twice. Hydrogen atoms are balanced. Therefore, first of all, carbon should be balanced. On the left, there are two carbon atoms and on the right, there is only one. Therefore, CO_2 (on RHS) should be multiplied by 2. The resulting equation is,

$C_2H_2(g)$ + $O_2(g)$ → $H_2O(l)$ + $2CO_2(g)$

(III) Now, we observe the number of oxygen atoms. There are 5 on RHS and only 2 on LHS. Therefore, multiply O_2 (LHS) by 5/2 . The resulting equation is,

$C_2H_2(g)$ + $5/2\ O_2(g)$ → $H_2O(l)$ + $2CO_2(g)$

(IV) Now, multiply throughout by 2 to convert the fractional coefficient to the whole number. This gives,

$2C_2H_2(g)$ + $5O_2(g)$ → $2H_2O(l)$ + $4CO_2(g)$

Q.5. Translate the following statements into chemical equations and then balance them,

(i) Chlorine gas burns in hydrogen gas to give hydrogen chloride.

(ii) Barium chloride reacts with zinc sulphate to give zinc chloride and a precipitate of barium sulphate.

(iii) Hydrogen sulphide gas burns in air to give water and sulphur dioxide.

(iv) Aluminium metal replaces iron from iron oxide Fe_2O_3, giving aluminium oxide and iron.

(v) Hydrogen gas combines with nitrogen to give ammonia.

(vi) Phosphorus burns in oxygen to give phosphorus pentoxide.

(vii) Sodium metal reacts with water to give sodium hydroxide and hydrogen gas.

(viii) Carbon disulphide burns in air to give carbon dioxide and sulphur dioxide.

Ans. **(i)** **Cl_2 (g) + H_2 (g) → HCl (g)** [skeleton equation]

Chlorine hydrogen hydrogen chloride

Cl_2 (g) + H_2 (g) → 2HCl (g) [balanced equation]

(ii) **Barium chloride + Zinc sulphate → Barium sulphate + Zinc chloride**

$BaCl_2$ (aq) + $ZnSO_4$ (aq) → $BaSO_4$(s) + $ZnCl_2$ (aq)

► The equation is balanced as such.

(iii) **Hydrogen sulphide + Air → Water + sulphur dioxide**

H_2S (g) + O_2 (g) (From air) → H_2O (l) + SO_2 (g) [skeleton equation]

$2H_2S$ (g) + $3O_2$ (g) → $2H_2O$ (l) + $2SO_2$ (g) [balanced equation]

(iv) **Aluminium metal + Ferric oxide → Aluminium oxide + Iron**

Al(s) + Fe_2O_3(s) → Al_2O_3(s) + Fe(s) [skeleton equation]

This skeleton equation can be balanced by the hit – and – trial method to get,

$2Al(s)$ + $Fe_2O_3(s)$ → $Al_2O_3(s)$ + $2Fe(s)$ [balanced equation]

(v) **Hydrogen gas + Nitrogen gas → Ammonia**

H_2 (g) + N_2 (g) → NH_3 (g) [skeleton equation]

The balanced equation is,

$3H_2$ (g) + N_2 (g) → $2NH_3$ (g) [balanced equation]

(vi) **Phosphorus + Oxygen → Phosphorus pentoxide**

P_4(s) + O_2 (g) → P_2O_5(s) [skeleton equation]

The balanced equation is,

$P_4(s)$ + $5O_2$ (g) → $2P_2O_5(s)$ [balanced equation]

(vii) **Sodium + Water → Sodium hydroxide + Hydrogen gas**

Na(s) + H_2O (l) → NaOH (aq) + H_2 (g) [skeleton equation]

The balanced equation is,

2Na(s) + $2H_2O$ (l) → 2 NaOH (aq) + H_2 (g) [balanced equation]

(viii) Carbon disulphide + Air → Carbon dioxide + Sulphur dioxide

$CS_2(l) + O_2 \rightarrow CO_2(g) + SO_2(g)$ [skeleton equation]

(From air)

$CS_2(l) + 3O_2 \rightarrow CO_2(g) + 2SO_2(g)$ [balanced equation]

Q.6. Why is decomposition reaction called opposite of combination reaction? Write equations for these reactions.

Ans. Decomposition reaction is called opposite of combination reaction. This can be supported by the following reactions:

Electric spark

$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ **Combination reaction**

Hydrogen oxygen water

Electrolysis

Decomposition reaction: $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

Acidulated water hydrogen oxygen

Q.8. What is the difference between combination and decomposition reactions? Write an equation for each type.

Ans. In combination reaction, two elements or compounds combine to form a new compound, whereas in decomposition reactions, a compound decomposes to give two or more elements or compounds.

Thus, combination and decomposition reactions are reverse of each other.

Combination reaction:

Burn

$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

Decomposition reaction:

Heat

$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

Q.9. What is difference between the displacement and double displacement reactions? Write equations for these reactions.

Ans. In a displacement reaction, only one atom or a group of atoms is displaced, whereas in double displacement, two different atoms or groups are displaced by other atoms or groups.

Displacement reaction:

$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

Double displacement reaction:

$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

Q.10. Classsify each of the following reactions as combination, decomposition, displacement or double displacement reactions.

(I) $2KNO_3(s) \rightarrow 2KNO_2(s) + O_2(g)$

(II) $Zn(s) + 2AgNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + 2Ag(s)$

(III) $Ni(NO_3)_2(aq) + 2NaOH(aq) \rightarrow Ni(OH)_2(\downarrow) + 2NaNO_3(aq)$

(IV) $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

(V) $2CuO(s) \rightarrow 2Cu(s) + O_2(g)$

(VI) $Cl_2(g) + 2NaBr(aq) \rightarrow Br_2 + 2NaCl(aq)$

(VII) $MgO(s) + C(s) \rightarrow CO(g) + Mg(s)$

(VIII) $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

Ans. The given reactions are of the following types:

(I) Decomposition reaction (II) Displacement reaction

(III) Double displacement reaction (IV) Displacement reaction

(V) Decomposition reaction (VI) Displacement reaction

(VII) Displacement reaction (VIII) Decomposition reaction

Q.11. Write balanced equations for the following reactions and identify the type of reaction:

(I) Zinc carbonate(s) → Zinc oxide (s) + Carbon dioxide (g)

(II)Magnesium(s) + Hydroxide acid (aq) → Magnesium chloride (aq) + Hydrogen (g)

(III) Potassium bromide (aq) + Barium iodide (aq) → Potassium iodide (aq) + Barium bromide (aq)

(IV) Hydrogen (g) + Chlorine (g) → Hydrogen chloride (g)

Ans. The balanced equations for the reactions and the type of reaction are given below:

	Balanced equation	Type of reaction
(I)	$ZnCO_3(g) \xrightarrow{\text{Heat}} ZnO(s) + CO_2(g)$	Decomposition reaction
(II)	$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$	Displacement reaction
(III)	$2KBr(aq) + BaI_2(aq) \rightarrow 2KI(aq) + BaBr_2(aq)$	Double – displacement reaction
(IV)	$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$	Combination (synthesis) reaction

Q.12. Two test tubes A and B contain solution of NaBr (or KBr) and NaI (or KI). How would you find which tube contains which salt?

Ans. To both the tubes add 0.5 mL of carbon tetrachloride (CCl_4), 5 mL of chlorine water and shake. Observe the colour in the CCl_4 layer. The solution which gives orange colour is that of NaBr (or KBr). The solution which gives purple colour contains NaI (or KI). Chlorine displaces bromine from bromides, and iodine from iodides in accordance with the chemical equations,

$2NaBr\ (aq) + Cl_2\ (aq) \rightarrow 2NaCl\ (aq) + Br_2$

Bromine dissolves in carbon tetrachloride to give orange coloured layer

$2NaI\ (aq) + Cl_2\ (aq) \rightarrow 2NaCl\ (aq) + I_2$

iodine dissolves in carbon tetrachloride to give purple (violet) coloured layer.

Q.13. In the refining of silver, the recovery of silver from silver nitrate solution involved displacement by copper metal. Write down the chemical equation of the reactions involved.

Ans.

$2AgNO_3\ (aq)$	+	$Cu(s)$	→	$2Ag(s)$	+	$Cu(NO_3)_2\ (aq)$
Silver nitrate		copper		silver metal		copper (II) nitrate

Q.14. Why will the colour of heated copper powder become black when air is passed over it?

Ans. When copper powder is heated in the presence of air, black copper oxide is formed.

$Cu(s)$	+	$O_2\ (g)$	→	$CuO(s)$
Copper powder (Heated)		in the air		copper oxide (Black)

Q.15. Why is respiration considered as an exothermic reaction? Explain.

Ans. During respiration, the digested food gets oxidised and the energy is released. That is why, it is considered as an exothermic reaction.

Q.16. A shiny brown coloured element X on heating in air becomes black in colour, Name the element X and the black coloured compound formed.

Ans. An element on heating in air forms its oxide. The brownish element which forms black oxide is copper. So,

Name of the element: Copper (Cu)

Name of black compound: Copper (II) oxide, (CuO)

Reaction:	$2Cu(s)$	+	$O_2\ (g)$	→	$2CuO(s)$
	Copper (Brown)		from air		copper (II) oxide (Black)

Q.17. Identify the substance oxidised and the substance reduced in the following reactions.

(i) $ZnO(s) + C(s) \rightarrow Zn + CO\ (g)$

(ii) $4Na(s) + O_2\ (g) \rightarrow 2Na_2O(s)$

(iii) $CuO(s) + H_2(s) \rightarrow Cu(s) + H_2O$

Ans.

Reaction	Substance	
(i) $ZnO + C \rightarrow Zn + CO$ (C: Oxidised; ZnO: reduced)	C	ZnO
(ii) $4Na(s) + O2(g) \rightarrow 2Na2O(s)$ (Na: oxidised; O_2: reduced)	Na	O_2
(iii) $CuO(s) + H2(g) \rightarrow Cu(s) + H2O(l)$ (CuO: reduced; H_2: oxidised)	H_2	CuO

Q.18. Giving two examples, explain the electronic concept of oxidation and reduction.

Ans. (i) Let us take the following reaction,

$2HgCl_2 + SnCl_2 \rightarrow Hg_2Cl_2 + SnCl_4$ ($SnCl_2$: Reduction; Hg_2Cl_2: Reduction)

This reaction may be written as follows:

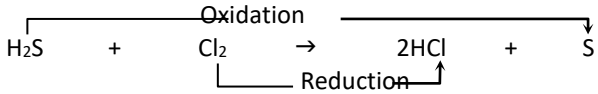
$Hg^{2+} + Sn^{2+} \rightarrow Hg_2^{2+} + Sn^{4+}$ (Sn^{2+}: Reduction; Sn^{4+}: Oxidation)

The two reactions can be written as,

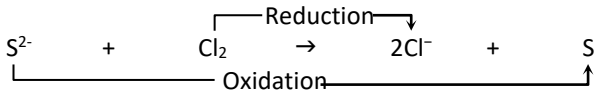
Oxidation:	Sn^{2+}	→	Sn^{4+}	+	2^{e-}	[loss of electrons]
Reduction:	$2Hg^{2+}$	+	2^{e-}	→	$Hg2^{2+}$	[gain of electrons]

Thus, oxidation is a process which involves loss of electrons, while reduction is a process which involves gain of electrons.

(ii) Another redox reaction is,



The ionic equation for this reaction is,



The two reactions may be separately written as follows.

Oxidation:	S^{2-}	→	S	+	2^{e-}	[loss of electrons]
Reduction:	Cl_2	+	2^{e-}	→	$2Cl^-$	[gain of electrons]

Q.19. In which part of the periodic table the elements which act (a) as reducing agents, and (b) as oxidising agents, are located?

Ans. Oxidising elements are located in the upper right-hand portion of the periodic table, (except noble gases). O, F and Cl are strong oxidising agents. This is because these elements accept electrons easily.

Reducing elements are located in the lower left part of the periodic table. Alkali metals such as potassium, rubidium and caesium are strong reducing agents. This is because these elements lose their valence electrons easily.

Q.20. Identify the substance oxidised and the substance reduced in the following reactions. Write the ionic equations for the substance oxidised and reduced.

(I)	$H_2(g)$	+	$Cl_2(g)$	→	2HCl (g)			
(II)	$H_2(g)$	+	CuO (s)	→	Cu(s)	+	H_2O (l)	
(III)	H_2S (g)	+	SO_2 (g)	→	3S(s)	+	$2H_2O$ (l)	
(IV)	Zn(s)	+	$2AgNO_3$ (aq)	→	$Zn(NO_3)_2$ (aq)	+	2Ag(s)	
(V)	2Al (s)	+	3HCl (aq)	→	$2AlCl_3$(aq)	+	$3H_2$(g)	

Ans. The required information is given below:

	Substance		Ionic equation	
	Oxidised	Reduced	For oxidation	For reduction
(I)	$H_2(g)$	$Cl_2(g)$	$H_2(g) \rightarrow 2H^+ + 2e^-$	$Cl_2 + 2e^- \rightarrow 2Cl^-$
(II)	$H_2(g)$	Cu^{2+} (in CuO (s))	$H_2(g) \rightarrow 2H^+ + 2e^-$	$Cu^{2+} + 2e^- \rightarrow Cu(s)$
(III)	H_2S (g)	S^{4+}(in SO_2 (g))	$2S^{2-} \rightarrow 2S + 4e^-$	$S^{4+} + 4e^- \rightarrow S$
(IV)	Zn(s)	$AgNO_3$ (aq)	$Zn(s) \rightarrow Zn2+(aq) + 2e^-$	$2Ag +(aq) + 2e^- \rightarrow 2Ag(s)$
(V)	2Al (s)	HCl (aq)	$2Al(s) \rightarrow 2Al^{3+}(aq) + 6^{e-}$	$6H^+ + 6e^- \rightarrow 3H^2(g)$

Q.21. Name the substance oxidised, reduced, oxidising agent and reducing agent in the following reactions:

(i) Ca	+	Cl_2	→	$CaCl_2$		
(ii) $3MnO_2$	+	4Al	→	3Mn	+	$2Al_2O_3$
(iii) Fe_2O_3	+	3CO	→	2Fe	+	$3CO_2$
(iv) Fe	+	S	→	FeS		

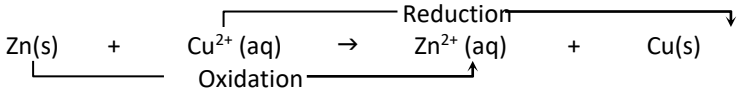
Ans. The substance oxidised, reduced, oxidising agent and reducing agent for the given reactions are as follows.

	Substance		Oxidising	Reducing
	Oxidised	Reduced	agent	agent
(i)	Ca	Cl_2	Cl_2	Ca
(ii)	Al	MnO_2	MnO_2	Al
(iii)	CO	Fe_2O_3	Fe_2O_3	CO
(iv)	Fe	S	S	Fe

Q.22. What is the relationship between oxidation and oxidising agent in a redox reaction? Write an example of a redox reaction showing the relationship between oxidation and oxidising agent.

Ans. The substance that oxidises another substance is called an oxidising agent. Thus, an oxidising agent can remove electrons from the other substance and itself get reduced.

Example: Consider the reaction,



Here Cu^{2+} (aq) oxidises Zn atom to Zn^{2+} and itself gets reduced to Cu. So in this reaction, Cu2+ (aq) is the oxidising agent and Zn gets oxidised to Zn^{2+}.

Q.23. Why should magnesium ribbon be cleaned before burning in air?

Ans. Magnesium when kept in air for long, gets covered with a layer of magnesium oxide. So it is removed before burning the magnesium ribbon.

Q.24. Why does colour of copper sulphate solution change when an iron nail is dipped into it?

Ans. Iron displaces copper from copper sulphate solution. This is because iron is more reactive than copper.

$CuSO_4$ (aq)	+	Fe(s)	→	$FeSO_4$ (aq)	+	Cu(s)
Copper sulphate solution (Blue coloured) (Light green)		iron (from iron nail)		Iron (II) sulphate (Light green)		copper metal (displaced)

Q.25. Oil and fat – containing food items are flushed with nitrogen gas. Why?

Ans. Oil and fat containing (or fried) foodstuffs, such as, chips, namkeen etc., are flushed with nitrogen gas before packaging to prevent the oxidation of the fat / oil present in the foodstuff.

Q.26. Why dog we protect iron articles by applying paint on them?

Ans. Iron articles are painted to prevent its rusting. The paint coating does not permit air and moisture to come in contact with iron surface and hence protects it from corrosion.

Q.27. Why do gold and silver not corrode in moist air?

Ans. Gold and silver are amongst the least reactive metals. These metals do not react with oxygen (in the air) and water (present as moisture in the air). Therefore, silver and gold do not corrode in moist air.

NCERT QUESTIONS

Q.1. Why should a magnesium ribbon be cleaned before burning in air?

Ans. The magnesium ribbon which we use usually has a coasting of a white layer of magnesium oxide on its surface. It is formed by the slow action of moist air on it. This hinders the burning of magnesium, so, this layer is removed by rubbing with sandpaper before burning.

Q.2. Write the balanced equation for the following chemical reactions:

(i) Hydrogen + Chlorine → Hydrogen chloride

(ii) Barium chloride + Aluminium sulphate → Barium sulphate + Aluminium chloride

(iii) Sodium + Water → Sodium hydroxide + Hydrogen

Ans. (i) H_2 (g) + Cl_2 (g) → 2HCl (g)

(ii) $3BaCl_2$ (aq) + $Al_2(SO_4)_3$ (aq) → $3BaSO_4$ (s) + $2AlCl_3$ (aq)

(iii) 2Na(s) + $2H_2O$ (l) → 2NaOH (aq) + H_2 (g)

Q.3. Write a balanced chemical equation with state symbols for the following reactions.

(i) Solution of barium chloride and sodium sulphate in water react to give insoluble barium sulphate and the solution chloride.

(ii) Sodium hydroxide solution (in water) reacts with hydrochloric acid solution (in water) to produce sodium chloride solution and water.

Ans. (i) Barium chloride + Sodium sulphate → Barium sulphate + Sodium chloride

$BaCl_2$ (aq) + Na_2SO_4 (aq) → $BaSO_4$ (s) + 2 NaCl (aq)

(ii) Sodium hydroxide + Hydrochloric acid → Sodium chloride + Water

NaOH (aq) + HCl (aq) → NaCl (aq) + H_2O (l)

Q.4. A solution of a substance 'X' is used for white washing,

(i) Name the substance 'X' and write its formula.(ii) Write the reaction of the substance 'X' named in (i) above with water.

Ans. (i) The substance 'X' used for white washing is quick lime (calcium oxide). The formula is CaO.

(ii) When quick lime is mixed with water, the following reaction takes place:

CaO(s)	+	H_2O (l)	→	$Ca(OH)_2$ (aq)	+	Heat
Quick lime (Calcium oxide)		water		Calcium hydroxide (Slaked lime)		

Q.5. Why is the amount of gas collected in one of the test tubes double of the amount collected in the other in electrolysis of water experiment? Name this gas.

Ans. The gas which is collected in double the amount in the electrolysis of water experiment is hydrogen. This is because water (H_2O) contains two parts of hydrogen element as compared to only one part of oxygen element.

Q. 6. Why does the colour of copper sulphate solution change when an iron nail is dipped in it?

Ans. Iron is more reactive than copper. It displaces copper from copper sulphate solution according to the following reaction:

Fe(s)	+	$CuSO_4$ (aq)	→	$FeSO_4$ (aq)	+	Cu(s)
Iron		Copper sulphate		Iron (II) sulphate		Copper

Thus, as copper sulphate reacts to form iron (II) sulphate, the blue of copper sulphate solution fades.

Q.7. Give an example of a double displacement reaction other than the one between barium chloride and sodium sulphate solutions.

Ans.

$AgNO_3$ (aq)	+	NaCl (aq)	→	AgCl (s)	+	$NaNO_3$ (aq)
Silver nitrate		Sodium chloride		silver chloride		Sodium nitrate

Q.8. Identify the substance oxidised and the substance reduced in the following reactions:

(i) $4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$

(ii) $CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(l)$

Ans. (i) In this reaction, sodium (Na) is changed into sodium oxide (Na_2O). This is the addition of oxygen to sodium. Since addition of oxygen is called oxidation, therefore, the substance oxidised is sodium (Na).

Oxygen (O_2) is changed into Na_2O. Here, the addition of metal to oxygen takes place. So the substance reduced is oxygen.

(ii) Here, copper oxide is reduced to copper metal whereas hydrogen is oxidised to water.

Q.9. **When you mix the solutions of lead (II) nitrate and potassium iodide.**

(i) What is the colour of the precipitate formed? Name the compound precipitated.

(ii) Write the balanced chemical equation for this reaction.

(iii) Is this also a double displacement reaction?

Ans. (i) Colour of the precipitate formed is yellow. The compound precipitated is lead iodide PbI_2.

(ii) $Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$

Lead (II) nitrate — Potassium iodide — Lead iodide — Potassium nitrate.

(iii) Yes, it is a double displacement reaction.

NCERT EXERCISES

Q.1. Which of the statements about the reaction below are incorrect?

$2PbO(s) + C(s) \rightarrow 2Pb(s) + CO_2(g)$

(a) Lead is getting reduced. **(b) Carbon dioxide is getting oxidised.**

(c) Carbon is setting oxidised **(d) Lead oxide is getting reduced.**

(i) a and b **(ii) a and c** **(iii) a, b and c** **(iv) all**

Ans. The incorrect statements are:

(a) Lead is getting reduced (b) carbon dioxide is getting oxidised. Hence, (i) is the correct answer.

Q.2. **$Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe$**

The above reaction is an example of

(a) Combination reaction. **(b) Double displacement reaction.**

(c) Decomposition reaction **(d) Displacement reaction**

Ans. The given equation is a displacement reaction in which Fe of Fe2O3 has been displaced by Al. Hence, (d) is the correct answer.

Q.3. What happens when dilute hydrochloric acid is added to iron filings? Choose the correct answer.

(a) Hydrogen gas and iron chloride are produced.

(b) Chlorine gas and iron hydroxide are produced.

(c) No reaction takes place.

(d) Iron salt and water are produced.

Ans. The following reaction takes place:

$Fe + 2HCl \rightarrow FeCl_2 + H_2$

Iron — Hydroxide acid — Iron chloride — Hydrogen

Thus, hydrogen gas and iron chloride are produced. Therefore, (a) is the correct answer.

Q.4. What is a balanced chemical equation? Why should the chemical equations be balanced?

Ans. A balance chemical equation is one which contains an equal number of atoms of each element on both sides of the equation. For example,

$2H_2 + O_2 \rightarrow 2H_2O$

According to the law of conservation of mass, matter can neither be created nor destroyed in a chemical reaction. During a chemical reaction, the total mass of reactants and products remain the same. Hence, in a chemical reaction, the number of atoms of the various elements on both sides should be equal. Therefore, a chemical equation is to be balanced with the law of conservation of mass.

Q.5. Translate the following statements into chemical equations and then balance them.

(a) Hydrogen gas combines with nitrogen to form ammonia.

(b) Hydrogen sulphide gas burns in air to give water and sulphur dioxide.

(c) Barium chloride reacts with aluminium sulphate to give aluminium chloride and a precipitate of barium sulphate.

(d) Potassium metal reacts with water to give potassium hydroxide and hydrogen gas.

Ans. (a) $3H_2(g) + N_2(g) \rightarrow 2NH_3(g)$

(b) $2H_2S(g) + 3O_2(g) \rightarrow 2H_2O(l) + 2SO_2(g)$

(c) $3BaCl_2 + Al_2(SO_4)_3 \rightarrow 2AlCl_3 + 3BaSO_4$

(d) $2K + 2H_2O \rightarrow 2KOH + H_2$

Q.6. 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) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$
(d) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + HCl$

Ans. (a) $2HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + 2H_2O$
(b) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$
(c) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$
(d) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

Q.7. Write the balanced chemical equations for the following reactions.

(a) Calcium hydroxide + Carbon dioxide → Calcium carbonate + Water
(b) Zinc + Silver nitrate → Zinc nitrate + Silver.
(c) Aluminium + Copper chloride → Aluminium chloride + Copper.
(d) Barium chloride + Potassium sulphate → Barium Sulphate + Potassium chloride.

Ans. (a) $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$
(b) $Zn + 2AgNO_3 \rightarrow Zn(NO_3)_2 + 2\,Ag$
(c) $2Al + 3\,CuCl_2 \rightarrow 2AlCl_3 + 3Cu$
(d) $BaCl_2 + K_2SO_4 \rightarrow BaSO_4 + 2KCl$

Q.8. Write the balanced chemical equation for the following and identify the type of reaction in each case.

(a) Potassium bromide (aq) + Barium iodide (aq) → Potassium iodide (aq) + Barium bromide (s)
(b) Zinc carbonate(s) → Zinc oxide (s) + Carbon dioxide (g)
(c)Hydrogen (g) + Chlorine (g) → Hydrogen chloride (g)
(d) Magnesium (s) + Hydrochloric acid (aq) → Magnesium chloride (aq) + Hydrogen (g)

Ans. (a) $2KBr\,(aq) + BaI_2\,(aq) \rightarrow 2KI\,(aq) + BaBr_2\,(s)$; Double displacement reaction
(b) $ZnCO_3\,(s) \rightarrow ZnO(s) + CO_2\,(g)$ Decomposition reaction
(c) $H_2\,(g) + Cl_2\,(g) \rightarrow 2HCl\,(g)$ Combination reaction
(d) $Mg(s) + 2HCl\,(aq) \rightarrow MgCl_2\,(aq) + H_2\,(g)$; Displacement reaction.

Q.9. What does one mean by exothermic and endothermic reactions? Give examples.

Ans. **Exothermic reaction**: In exothermic reaction heat is evolved during the reaction, which is indicated by '+ heat' sign on the right-hand side of the equation, for example:

CaO + 2H2O → Ca (OH)2 + H2 + Heat.

Endothermic reaction: In this reaction heat is absorbed which is indicated by putting '+ heat' sign on the left hand side of the equation.

$N_2\,(g) + 3H_2\,(g) + Heat \rightarrow 2NH_3\,(g)$

Q.10. Why is respiration considered as an exothermic reaction? Explain.

Ans. Rice, potatoes and bread contain carbohydrates. During digestion, these carbohydrates are broken down into simpler substance called glucose. This glucose combines with oxygen in the cells of our body and provides energy. The special name of this reaction is respiration. Thus respiration is an exothermic process because energy is produced during this process.

$C_6H_{12}O_6\,(aq) + 6O_2\,(g) \rightarrow 6CO_2\,(g) + 6H_2O\,(l) + Energy$
Glucose

Q.11. Why are decomposition reactions called the opposite of combination reactions? Write equations for these reactions.

Ans. In a combination reaction, two or more substance combine to form a single product. Also, a large amount of heat is evolved. The decomposition reactions require energy either in the form of heat, light or electricity for breaking down the reactants.

$N_2 + 3H_2 \rightarrow 2NH_3 + Heat$ Combination
$2NH_3 + Heat \rightarrow N_2 + 3H_2$ Decomposition

Q.12. Write one equation each for decomposition reactions where energy is supplied in the form of heat, light or electricity.

Ans. Decomposition reaction involving absorption of heat

$CaCO_3\,(s) \rightarrow CaO\,(s) + CO_2\,(g)$
Calcium carbonate → Calcium oxide + Carbon dioxide

Decomposition reaction involving absorption of light

$2AgCl\,(s) \rightarrow 2Ag\,(s) + Cl_2\,(g)$
Silver chloride → Silver + chlorine

Decomposition reaction involving absorption of electrical energy

2H2O (l) → 2H2 (g) + O2 (g)
Water → Current Hydrogen + Oxygen

Q.13. What is the difference between displacement and double displacement reactions? Write equations for these reactions.

Ans. Displacement reaction

1. In a displacement reaction, a more reactive element displaces or removes another element from a compound.

2. $Zn(s) + CuSO4\ (aq) \rightarrow ZnSO4(aq) + Cu(s)$

Double displacement reaction

The reactions in which two compounds react by an exchange of ions to form two new compounds are called double displacement reactions.

$AgNO_3\ (ag) + NaCl\ (aq) \rightarrow AgCl(s) + NaNO_3(aq)$

Q.14. In the refining of silver, the recovery of silver from silver nitrate solution involved displacement by copper metal. Write down the reaction involved.

Ans. $Cu\ (s) + 2AgNO_3\ (aq) \rightarrow Cu(NO_3)_2\ (aq) + 2Ag\ (s)$

Copper — Silver nitrate — Copper (II) nitrate — Silver

Q.15. What do you mean by precipitation reactions? Explain giving examples.

Ans. On mixing the clear solutions of two ionic compounds, a substance which is insoluble in water, is formed. This insoluble substance formed is known as precipitate. Any reaction that produces a precipitate can be called a precipitation reaction. When sodium sulphate solution is mixed with barium chloride solution, a white substance $BaSO_4$ is formed.

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

The white precipitate of $BaSO_4$ is formed by the reaction of SO^{2-}_4 and Ba^{2+}. The other product formed is sodium chloride which remains in the solution.

Q.16. Explain the following in terms of gain or loss of oxygen with two examples each:

(a) Oxidation **(b) Reduction**

Ans. (a) Oxidation: It is defined as a process which involves gain of oxygen. For example,

(i) $2Mg\ (s) + O_2\ (g) \rightarrow 2MgO\ (s)$

Magnesium — Oxygen — Magnesium oxide

Here, Mg has gained oxygen to form MgO. Hence, Mg is oxidised to MgO.

(ii) $2Cu\ (s) + O_2\ (g) \xrightarrow{Heat} 2CuO\ (s)$

Copper — Oxygen — Copper oxide

In this reaction, Cu has gained oxygen to form CuO. Thus, Cu is oxidised to copper oxide (CuO).

(b) Reduction: It is defined as the process which involves loss of oxygen. For example,

(i) $CuO + H_2 \xrightarrow{Heat} Cu + H_2O$

Copper Oxide — Hydrogen — Copper — Water

In this reaction, copper oxide is losing oxygen. So it is being reduced to copper.

(ii) $ZnO + C \xrightarrow{Heat} Zn + CO$

Zinc oxide — Carbon — Zinc — Carbon monoxide

In this reaction, zinc oxide is losing oxygen. So, it is being reduced to zinc.

Q.17. A shiny brown coloured element 'X' on heating in air becomes black in colour. Name the element 'X' and the black coloured compound formed.

Ans. Element X is copper. The black coloured compound formed is copper oxide.

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

Copper (Brown) — Oxygen — Copper oxide (Black)

Q.18. Why do we apply paint on iron articles?

Ans. Paint covers the surface of the iron articles. Hence, moist air cannot attack iron and prevents rusting.

Q.19. Oil and fat containing food items are flushed with nitrogen. Why?

Ans. In the presence of oxygen of the air, the fats present in the fatty food are oxidised to compounds which have a bad smell, i.e., the food becomes rancid. Flushing with nitrogen cuts off oxygen and protects the food from rancidity.

Keeping in refrigerator lowers the temperature. As a result, oxidation of the food is slowed down. Hence, the food can be preserved for longer time.

Q.20. Explain the following terms with one example each.
(a) Corrosion (b) Rancidity

Ans. (a) Corrosion: The process of slowly eating up of the metals due to attack of atmospheric gases such as oxygen, carbon dioxide, hydrogen sulphide, water vapour, etc. on the surface of the metals so as to convert the metal into oxide, carbonate, sulphide, etc. is known as ***corrosion***.

$2Ag(s) + H_2S(g) \rightarrow Ag_2S(s) + H_2(g)$
Silver — Hydrogen sulphide (From air) — Silver sulphide (Black)

(b) Rancidity: We have often noticed that a food containing oil or fat, if left for a long time, develops a bad taste and bad smell. This is because the oils and fats present in such foods get oxidised with the passage of time. The products (compounds) formed as a result of this oxidation is volatile and have bad smell. Due to this reason, the taste of the food also changes. The oxidation of oils or fats in a food resulting into a bad smell and bad taste is called ***rancidity***.

SOME IMPORTANT QUESTIONS

■ **Very Short Answer Questions [1 mark]**

Q.1. What is a chemical reaction?
Ans. Chemical reactions are processes in which new substance with new properties are formed.

Q.2. What is wrong with the following equation?
$Mg + O \rightarrow MgO$
Correct and balance it.
Ans. In this equation oxygen should be in molecular form (O_2).
$2Mg + O \rightarrow 2MgO$

Q.3. Why is photosynthesis considered an endothermic reaction?
Ans. Photosynthesis is an endothermic reaction. This is because sunlight energy is absorbed during the process of photosynthesis by green plants.

Q.4. Write balanced chemical equation with state symbols for the following reaction:
Sodium hydroxide solution reacts with hydrochloric acid solution to produce sodium chloride solution and water.
Ans. $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

Q.5. Convey the following information in the form of a balanced chemical equation:
"An aqueous solution of ferrous sulphate reacts with an aqueous solution of sodium hydroxide to form a precipitate of ferrous hydroxide and sodium sulphate remains in solution."
Ans. $FeSO_4(aq) + 2\,NaOH(aq) \rightarrow Fe(OH)_2(s) + Na_2SO_4(aq)$

Q.6. Potassium chlorate ($KClO_3$) on heating forms potassium chloride and oxygen. Write a balanced equation for this reaction.
Ans. $2\,KClO_3(s) \rightarrow 2\,KCl(s) + 3\,O_2(g)$

Q.7. What type of reaction is represented by the digestion of food in our body?
Ans. Decomposition reaction

Q.8. In the reaction represented by the following equation:
$CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(l)$
(a) Name the substance oxidised.
(b) Name the substance reduced.
Ans. (a) Hydrogen H_2
(b) Copper oxide, CuO.

Q.9. In the following reaction between lead sulphide and hydrogen peroxide:
$Pbs(s) + 4H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$
(a) Which substance is oxidised?
(b) Which substance is reduced?
Ans. (a) PbS (b) H_2O_2

Q.10. Identify the substance oxidised in the following reaction:
$H_2S + Cl_2 \rightarrow S + 2HCl$
Ans. H_2S

Q.11. Which term is used to indicate the development of unpleasant smell and taste in fat and oil containing foods due to oxidation?
Ans. Rancidity.

Q.12. What is the general name of the chemicals which are added t fat and oil containing foods to prevent the development of rancidity?
Ans. Anti – oxidant.

Q.13. Give two examples from everyday life solutions where redox reactions are taking place.
Ans. (i) Burning of a fuel in oxygen is a redox reaction.
(ii) Rusting of iron is a redox reaction.

Q.14. In which type of reactions of reactants give simpler products?
Ans. In decomposition reactions, the reactant breaks down to give simpler products.
Q.15. When does decomposition reaction take place?
Ans. The decomposition reaction takes place when the energy is supplied in the form of heat, light or electricity.
Q.16. Ionic compounds usually undergo double displacement reaction.
Ans. Ionic compounds usually undergo double displacement reaction.
Q.17. Can a double displacement reaction take place when the products are highly soluble or highly ionised?
Ans. No, double displacement reaction takes place when there is a formation of a slightly soluble salt.
Q.18. Why will the colour of heated copper powder become black when air is passed over it?
Ans. When copper powder is heated in the presence of air, black copper oxide is formed.

Cu(s)	+	O_2 (g)	→	CuO (s)
Copper powder (heated)		in the air		Copper oxide (black)

Q.19. What is the difference between the following two types of reactions?

$$\mathbf{AgNO_3 + HCl \rightarrow AgCl + HNO_3}$$
$$\mathbf{Mg + 2HCl \rightarrow MgCl_2 + H_2}$$

Ans. The first reaction is a double displacement reaction whereas second reaction is a single displacement reaction.
Q.20. Name the oxidising and reducing agent in the following reaction:

$$\mathbf{2H_2S + SO_2 \rightarrow 2H_2O + 3S\downarrow}$$

Ans. H_2S is reducing agent while SO_2 is the oxidising agent.

Q.21. Give one example of a reaction which is double displacement reaction as well as precipitation reaction?

Ans.	$AgNO_3$ (aq) Silver nitrate	+	NaCl (aq) Sodium chloride (ppt.)	→	AgCl (s)↓ Silver chloride	+ $NaNO_3$ (aq) Sodium nitrate

Q.22. Why is hydrogen peroxide kept in coloured bottles?
Ans. This is done to cut off light because hydrogen peroxide decomposes into water and oxygen in the presence of light.

Q.23. Why is hydrogen peroxide kept in coloured bottles?
(a) $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$
(b) $Cu + FeSO_4 \rightarrow CuSO_4 + Fe$
Which out of these two reactions will take place and why?
Ans. Reaction (a) will take place. This is because Fe (iron) is more reactive than Cu (copper) and so can displace it from its compound ($CuSO_4$).
Copper cannot displace iron, so reaction (b) will not take place.

Q.24. Name the substance that has been oxidised in the following reaction:

$$Cl_2 + H_2S \rightarrow 2HCl + S$$

Ans. H_2S has been oxidised to S.
Q.25. What are the two necessary conditions for rusting of an iron article?
Ans. (i) Presence of air (or oxygen).
(ii) Presence of moisture (water vapour).

■ Short Answer Questions [2, 3 marks]

Q.1. Give some example of chemical reactions keep on occurring in our daily life.
Ans. (i) Souring of milk (ii) Formation of curd from milk.
(iii) Process of respiration. (iv) Cooking of food.
(v) Digestion of food in our body. (vi) Fermentation of grapes.
(vii) Ripening of fruits (viii) Burning of candle wax and (ix) Rusting of iron
Q.2. How do we come to know that a chemical reaction has taken place?
Ans. Any one of the following characteristics can tell us whether a chemical reaction has taken place or not.
(a) New substance(s) formed (b) Change of states
(c) Change in colour (d) Change in temperature
(e) Precipitates formed (f) Evolution of a gas
For example, if on mixing two substances a gas is evolved, then we can say that a chemical reaction has taken place.
Q.3. State one example of a chemical reaction characterised by the evolution of a gas.
Ans. When zinc granules react with dilute sulphuric acid, then bubbles of hydrogen gas are produced. Thus, the chemical reaction between zinc and dilute sulphuric acid is characterised by the evolution of hydrogen gas.
This chemical equation shows two characteristics: Evolution of a gas (hydrogen gas) and change in temperature (rise in temperature).

Q.4. Give an example of a chemical reaction characterised the change in temperature.

Ans. The chemical reaction between quicklime and water to form slaked lime is characterised by a change in temperature (rise in temperature).

Q.5. What is a chemical equation? Explain with the help of an example.

Ans. A chemical equation is method of representing a chemical reaction with the help of symbols and formulae of the substances involved in a chemical reaction.

When magnesium ribbon is burnt in oxygen, magnesium oxide is obtained. This discription of a chemical reaction in a sentence form is quite ling. It can be written in a shorter form as a chemical equation in words or in symbols (chemical formula).

Magnesium + oxygen → Magnesium oxide
(Reactants) (Products)

$2Mg + O_2 \rightarrow 2MgO$ (balanced)

Q.6. What are the various ways in which a chemical equation can be made more informative? Give example to illustrate your answer.

Ans. The chemical equation can be made more informative in the following three ways:

(i) By indicating the physical states of the reactants and products.

$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$

(ii) By indicating the heat changes in an equation:

Exothermic reaction:

$C(s) + O_2(g) \rightarrow CO_2(g) + Heat$

Endothermic reaction:

$CaCO_3(s) + Heat \rightarrow CaO(s) + CO_2(g)$

(iii) By indicating the conditions under which the reaction takes place.

$CO(g) + 2H_2(g) \xrightarrow{340\ atm} CH_3OH(l)$

$6CO(aq) + 6H_2O(l) \xrightarrow[Chlorophyll]{Sunlight} C_6H_{12}O_6(aq) + 6O_2(g)$

Q.7. Which of the following are exothermic reactions and which are endothermic?

(a) Burning of natural gas **(b) Photosynthesis**
(c) Respiration **(d) Electrolysis of water**
(e) Decomposition of calcium carbonate

Ans. Exothermic reactions: (a) and (c)
Endothermic reactions: (b), (d) and (e)

Q.8. Translate the following statements into chemical equation and then balance the equations:

(a) Phosphorous burns in oxygen to give phosphorus pentoxide.
(b) Aluminium metal replaces ion from ferric oxide, Fe_2O_3, giving aluminium oxide and iron.
(c) Carbon disulphide burns in air to give carbon dioxide and sulphur dioxide.
(d) Barium chloride reacts with zinc sulphate to give zinc chloride and barium sulphate.

Ans. (a) $P_4 + 5O_2 \rightarrow 2P_2O_5$ (b) $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$
(c) $CS_2 + 3O_2 \rightarrow CO_2 + 2SO_2$ (d) $BaCl_2 + ZnSO_4 \rightarrow ZnCl_2 + BaSO_4$

Q.9. When hydrogen burns in oxygen, water is formed and when water is electrolysed, then hydrogen and oxygen are produced. What type of reaction takes place in both the cases.

Ans. (i) In the first case – Combination reaction
(ii) In the second case – Decomposition reaction

Q.10. What type of chemical reactions take place when?

(a) Limestone is heated? **(b) A magnesium wire is burnt is air?**
(c) Electricity is passed through water?
(d) Ammonia and hydrogen chloride are mixed?
(e) Silver bromide is exposed to sunlight?

Ans. (a) Decomposition (b) Combination (c) Decomposition (d) Combination (e) Decomposition

Q.11. What happens when silver chloride is exposed to sunlight? Write a chemical equation for this reaction. Also give one use of such a reaction.

Ans. When silver chloride is exposed to light, it decomposes to form silver metal and chlorine gas.

$2AgCl(s) \rightarrow 2Ag(s) + Cl_2(g)$

This reaction is used in black and white photography.

Q.12. What type of chemical reactions are represented by the following equations?

(a) A + B → C

(b) A + BC → AC + B

(c) A → B + C

(d) PQ + RS → PS + RQ

Ans. (a) Combination reaction

(b) Displacement reaction

(c) Decomposition reaction

(d) Double displacement reaction

Q.13. What happens when a piece of iron metal is placed in copper sulphate solution? Name the type of reaction involved.

Ans. When a piece of iron metal is placed in copper sulphate solution, then iron sulphate solution and copper metal are formed.

$CuSO_4$ (aq) + Fe(s) → $FeSO_4$ (aq) + Cu (s)

This is displacement reaction.

Q.14. What happens when silver nitrate solution is added to sodium chloride solution?

(a) Write the equation for the reaction which takes place.

(b) Name the type of reaction involved.

Ans. When silver nitrate solution is added to sodium chloride solution, a white precipitate of silver chloride is formed along with sodium nitrate solution. $AgNO_3$ (aq) + NaCl (aq) → AgCl (s) + $NaNO_3$ (aq)

(White ppt.) This is double displacement reaction.

Q.15. When copper powder is heated strongly in air, it forms copper oxide. Write a balanced chemical equation for this reaction. Name, (a) Substance reduced (b) Substance oxidised.

Ans.

$$2Cu + O_2 \xrightarrow{\text{Heat}} 2CuO$$

(a) Substance reduced → oxygen

(b) Substance oxidised → copper

Q.16. Show decomposition reaction of lead nitrate with the help of an activity.

Ans. When lead nitrate is heated strongly, it breaks down to form simpler substance like lead oxide, nitrogen dioxide and oxygen.

$2Pb(NO_3)_2$ (s) → 2PbO (s) + $4NO_2$ (g) + O_2 (g)

Activity:

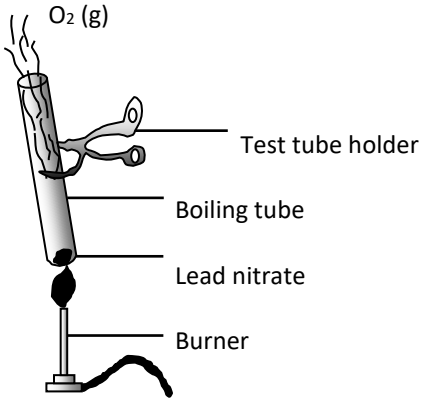
(i) Take about 2 g of lead nitrate powder in a boiling tube. Lead nitrate is a colourless compound.

(ii) Hold the boiling tube in a test – tube holder and heat it over a burner as shown in figure.

(iii) Brown fumes of nitrogen dioxide (NO_2) are evolved.

(iv) If a glowing splinter is held over the mouth of the boiling tube, it catches fire and starts burning again. This shows that oxygen is also evolved during this reaction.

(v) A yellow solid is left behind in the boiling tube. This is lead oxide.



Q.17. Write the balanced chemical equation for the following chemical reactions.

(i) Aqueous solutions of sulphuric acid and sodium – hydroxide react to form aqueous sodium sulphate and water.

(ii) Phosphorous burns in chlorine gas to form phosphorous pentachloride.

Ans. (i) H_2SO_4 (aq) + 2NaOH (aq) → Na_2SO_4 (aq) + $2H_2O$ (l)

(ii) P_4 (s) + 10 Cl_2 (g) → $4PCl_5$ (s)

Q.18. A student placed a china dish containing 2g of silver chloride in sunlight for some time.

(i) What is the colour change that she would notice?

(ii) Give a reason for this colour change. (iii) Write an equation for the reaction.

Ans. (i) White silver chloride turns grey in sunlight.

(ii) This is due to the decomposition of silver chloride into silver and chlorine by light.

(iii) 2AgCl (s) → 2Ag(s) + Cl_2 (g)

Q.19. Balance the following equations.

(i) H_2S (g) + SO_2 (g) → S(s) + H_2O (l)

(ii) $BaCl_2$ (aq) + $Al_2(SO_4)_3$ (aq) → $AlCl_3$ (aq) + $BaSO_4$ (↓)

(iii) $Pb(NO_3)_2$ (aq) + $Fe_2(SO_4)_3$ (aq) → $Fe(NO_3)_3$ (aq) + $PbSO_4$ (↓)

Ans. (i) $2H_2S$ (g) + SO_2 (g) → 3S(s) + $2H_2O$ (l)

(ii) $3BaCl_2\,(aq) + Al_2(SO_4)_3\,(aq) \rightarrow 2AlCl_3\,(aq) + 3BaSO_4\,(\downarrow)$

(iii) $3Pb(NO_3)_2\,(aq) + Fe_2(SO_4)_3\,(aq) \rightarrow 2Fe(NO_3)_3\,(aq) + 3PbSO_4\,(\downarrow)$

Q.20. A shiny brown coloured element X on heating in air becomes black in colour. Name the element X and the black coloured compound formed.

Ans. An element on heat in air forms its oxide. The brownish element which forms black oxide is copper. So,

Name of the element: Copper (Cu)

Name of black compound: Copper (II) oxide, (CuO)

Reaction: $2Cu(s)$ (Copper) (Brown) + $O_2\,(g)$ from air $\rightarrow$ $2CuO(s)$ Copper (II) oxide (Black)

Q.21. Look at the given equation:

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

How can this equation be made more informative?

Ans. To make a chemical equation more informative, the physical states of the reactants and products are mentioned along with their chemical formulae.

The given equation can be written as follows:

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

Where 'g' represents gaseous state and's' represents solid state of the substances.

Q.22. Classify each of the following reactions as combination, decomposition, displacement of double displacement reactions.

(i) $2KNO_3\,(s) \rightarrow 2KNO_2\,(s) + O_2\,(s)$

(ii) $Zn\,(s) + 2AgNO_3\,(aq) \rightarrow Zn(NO_3)_2\,(aq) + 2Ag\,(s)$

(iii) $Ni(NO_3)_2\,(aq) + 2NaOH\,(aq) \rightarrow Ni(OH)_2\,(\downarrow) + 2NaNO_3\,(aq)$

(iv) $Zn\,(s) + 2HCl\,(aq) \rightarrow ZnCl_2\,(aq) + H_2\,(g)$

(v) $2CuO\,(s) \rightarrow 2Cu\,(s) + O_2\,(g)$

(vi) $MgO\,(s) + C\,(s) \rightarrow CO\,(g) + Mg\,(s)$

(vii) $2KClO_3\,(s) \rightarrow 2KCl\,(s) + 3O_2\,(g)$

Ans.

(i) $2KNO_3\,(s) \rightarrow 2KNO_2\,(s) + O_2\,(s)$ [Decomposition reaction]

(ii) $Zn\,(s) + 2AgNO_3\,(aq) \rightarrow Zn(NO_3)_2\,(aq) + 2Ag\,(s)$ [Displacement reaction]

(iii) $Ni(NO_3)_2\,(aq) + 2NaOH\,(aq) \rightarrow Ni(OH)_2\,(\downarrow) + 2NaNO_3\,(aq)$ [Double displacement reaction]

(iv) $Zn\,(s) + 2HCl\,(aq) \rightarrow ZnCl_2\,(aq) + H_2\,(g)$ [Displacement reaction]

(v) $2CuO\,(s) \rightarrow 2Cu\,(s) + O_2\,(g)$ [Decomposition reaction]

(vi) $MgO\,(s) + C\,(s) \rightarrow CO\,(g) + Mg\,(s)$ [Displacement reaction]

(vii) $2KClO_3\,(s) \rightarrow 2KCl\,(s) + 3O_2\,(g)$ [Decomposition reaction]

Q.23. Consider the chemical equation given below and answer the questions that follow:

$CuO + H_2 \xrightarrow{\text{Heat}} Cu + H_2O$

(i) Name the substance which is getting oxidised.

(ii) Name the substance which is getting reduced.

(iii) Name the oxidised agent.

(iv) Name the reduction agent.

(v) Since oxidation and reduction is taking place simultaneously, this reaction is an example of redox reaction.

Ans. (i) The substance getting oxidised is H_2.

(ii) The substance getting reduced is CuO.

(iii) CuO is the oxidising agent.

(iv) H_2 is the reducing agent.

(v) Since oxidation and reduction is taking place simultaneously, this reaction is an example of redox reaction.

Q.24. What is the difference between combination and decomposition reactions? Write an equation for each type.

Ans.

Combination reactions	**Decomposition reactions**
1. In a combination reaction, two or more substance (elements or compounds) simply combine to form a new substance.	In a decomposition reaction, a single compound breaks down to produce two or more simple substance.
2. Hydrogen burns in oxygen to form water. $2H_2$ (Hydrogen) + O_2 (Oxygen) $\xrightarrow{\text{Combination}}$ $2H_2O$ (Water)	When electric current passed through acidified water, it decomposes to give hydrogen gas and oxygen gas. $2H_2O$ (Water) $\xrightarrow{\text{Electricity}}$ $2H_2$ (Hydrogen) + O_2 (Oxygen)

Q.25. Name the substance oxidised and reduced in the following reactions.

(i) **$3MnO_2 + 4Al \rightarrow 3Mn + 2Al_2O_3$**

(ii) **$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$**

(iii) **$2Na + O2 \rightarrow 2Na2O$**

(iv) **$CuO + H_2 \rightarrow Cu + H_2O$**

(v) **$MnO_2 + 4HCl \rightarrow Mncl_2 + Cl_2$**

Ans. (i) $3MnO_2 + 4Al \rightarrow 3Mn + 2Al_2O_3$

Al is oxidised and MnO2 is reduced.

(ii) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

CO is oxidised and Fe_2O_3 is reduced.

(iii) Na is oxidised and O_2 is reduced

(iv) H_2 is oxidised and CuO is reduced.

(v) HCl is oxidised (to Cl_2) and MnO_2 is reduced (to $MnCl_2$).

Q.26. What are the different types of combination reactions?

Ans. There are three different types of combination reactions:

(i) Combination of one element with another element to form a compound.

$2H_2$ (g) + O_2 (g) → $2H_2O$ (l)

(ii) Combination of two or more compounds to form a new compound.

MgO (s) + CO_2 (g) → $MgCO_3$ (s)

(iii) The combination of one element and one compound.

2CO (g) + O_2 (g) → $2CO_2$ (g)

Q.27. Why does blue colour of copper sulphate solution start fading when a zinc rod is dipped in it?

Ans. Zinc is more reactive than copper. It displaces copper from copper sulphate solution to form zinc sulphate which is colourless. Hence the blue colour of copper sulphate solution starts fading.

Zn(s)	+	$CuSO_4$ (aq)	→	$ZnSO_4$ (aq)	+	Cu
Zinc		Copper sulphate (Blue)		Zinc sulphate (Colourless)		Copper

Q.28. When iron rod is kept dipped in copper sulphate solution for some time, a brown coating is formed on the iron rod. Explain why? What change will you observe in the colour of the solution?

Ans. Iron is more reactive than copper. It displaces copper from copper sulphate solution according to the reaction

Fe(s)	+	$CuSO_4$ (aq)	→	$FeSO_4$ (aq)	+	Cu
Iron		Copper sulphate (Blue)		Iron (II) sulphate (Green)		Copper (Reddish brown)

The reddish-brown copper thus displaced is deposited on the surface of iron. Hence, there is a brown coating on iron. Further ferrous sulphate formed has green colour, Hence, the blue colour of copper sulphate solution fades and changes to light green.

Q.29. A copper coin was kept dipped in silver nitrate solution for a few hours/days. What will happen to the copper coin? What will happen to the colour of the solution?

Ans. Copper is more reactive than silver. Hence, it displaces silver from silver nitrate solution according to the reaction.

Cu(s)	+	$2AgNO_3$ (aq)	→	$Cu(NO_3)_2$ (aq)	+	2Ag(s)
Copper		Silver nitrate		Copper (II) nitrate		Silver

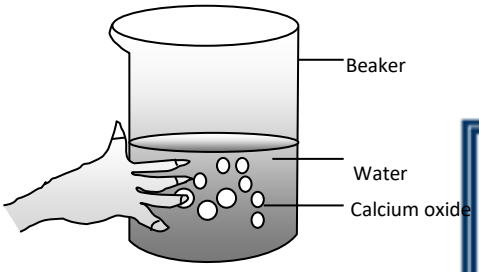
The silver thus formed is deposited on the surface of copper thereby giving it a white shining appearance. The solution becomes blue due to the formation of copper nitrate.

■ Long Answer Questions [4 marks]

Q.1. (a) Perform an activity to show that reaction between calcium oxide and water is a combination reaction.
(b) A solution of calcium hydroxide formed is used for white washing the walls. Explain.

Ans. (a) Activity:

(i) Take a small amount of calcium oxide in a beaker.
(ii) Add some water to this slowly.
(iii) Touch the beaker as shown in figure.
(iv) Do you feel any change in temperature?
(v) You will feel warm.



Calcium oxide reacts with water to form calcium hydroxide (slaked lime), liberating a large amount of heat. This makes the reaction mixture warm.

$$\underset{\text{Calcium oxide}}{CaO\ (s)} + H_2O\ (l) \rightarrow \underset{\text{Calcium hydroxide}}{Ca(OH)_2\ (aq)}$$

A single product, calcium hydroxide is formed by the combination of calcium oxide and water. Thus, a reaction in which two or more reactants combine to form a single product is known as a combination reaction.

(b) A solution of calcium hydroxide is used for white washing the walls. It reacts with carbon dioxide slowly in the air to form a thin layer of calcium carbonate on the walls. After two or three days of white washing calcium carbonate $CaCO_3$ is formed which gives a shiny finish to the walls.

$$\underset{\text{Calcium hydroxide}}{Ca(OH)_2\ (aq)} + CO_2\ (g) \rightarrow \underset{\text{Calcium carbonate}}{CaCO_3\ (s)} + H_2O\ (l)$$

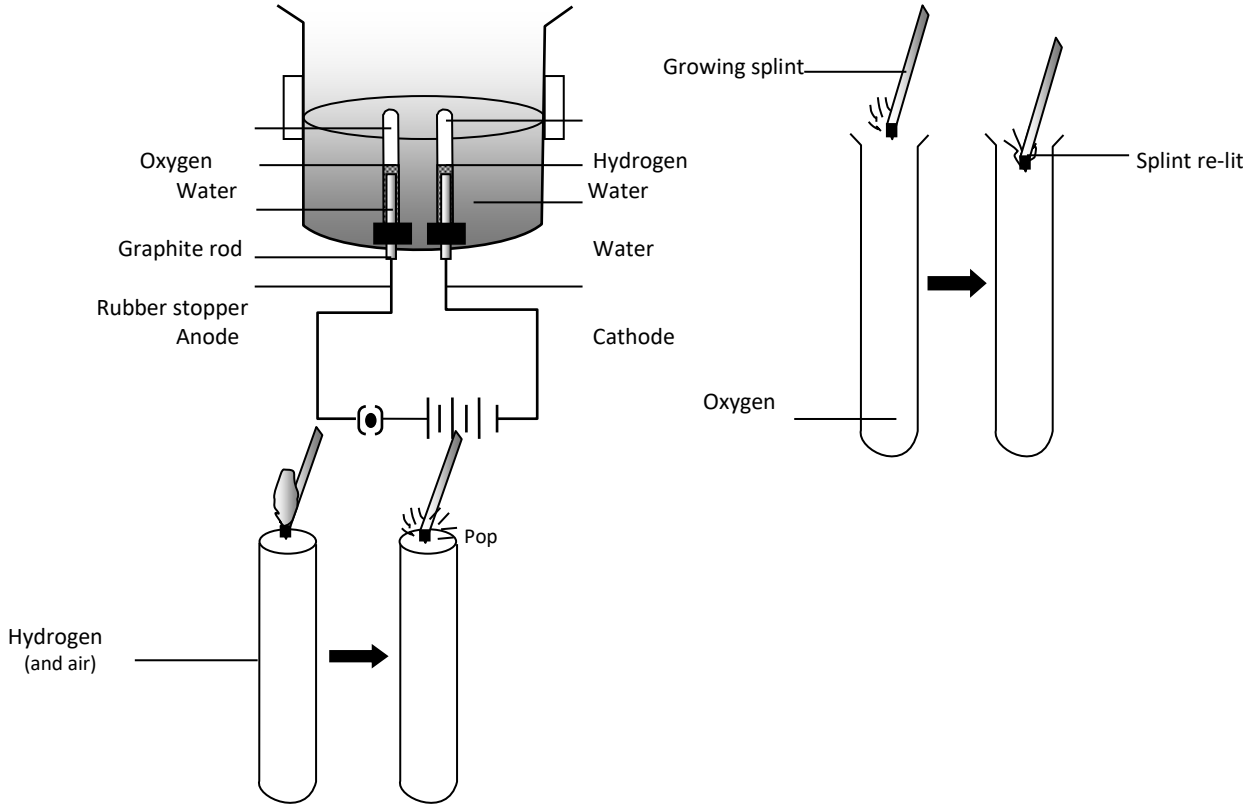
Q.2. (a) Perform an activity to show that the decomposition reaction takes place by the action of electricity.
(b) Test the gases evolved.
(c) Write the decomposition reaction in our body.

Ans. (a) Activity:

(I) Take a plastic vessel. Drill two holes at its bottom and set rubber stoppers in these holes.
(II) Insert carbon electrodes in these rubber stoppers and connect these electrodes to a 6 volt battery and a switch.
(III) Fill the vessel with water such that the electrodes are immersed. Add a few drops of dilute sulphuric acid to the water in the vessel.
(IV) Take two graduated test tubes filled with water and inverts them over the two carbon electrodes.
(V) Switch on the current and leave the apparatus for some time.
(VI) After sometime you will observe the formation of bubbles at both the electrodes. These bubbles displace water in the graduated tubes.
(VII) Once the test tubes are filled with the respective gases remove them carefully.
(VIII) Test these gases one by one by bringing a burning splinter of wood close to the mouth of test tubes.
(IX) What happens in each case? (X) Which gas is present in each test tube?

(b) When a glowing splinter of wood is bought close to the mouth of one test tube, it relights. Oxygen is the only common gas that can do this. This is, therefore, used as the chemical test for oxygen. Oxygen is not combustible but is a supporter of combustion. When a burning splinter of wood is brought close to the mouth of second test tube, the gas burns with a pop. We say that **hydrogen burns with a pop**.
We also observe that the volume of gases collected in the two test – tubes is not the same. The volume of gas collected on the negative electron is double the volume of gas collected on the positive electrode.

(b) The digestion of food in the body is an example of decomposition reaction. When we eat foods like wheat, rice or potatoes, then the starch present in them decomposes to give simple sugars like glucose in the body and the proteins decomposes to form amino acids



Q.3. **(a) Perform an activity to show that the photo decomposition is an endothermic reaction.**
(b) Write one more equation of photo decomposition. Give one use of this decomposition.

Ans. **(a) Activity: Photo decomposition**

(i) Take about 2 silver chloride on a China dish. It is white in colour.
(ii) Place this China dish under sunlight for some time.
(iii) Observe the colour of the silver chloride after sometime.

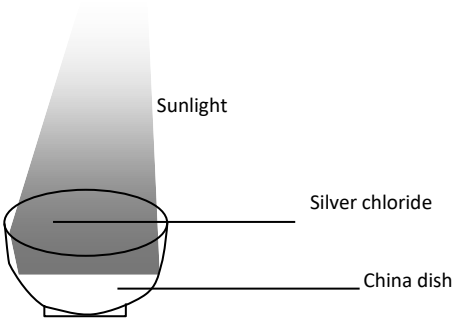
You will observe that white silver chloride turns grey in sunlight. This is because the light causes silver chloride to decompose into metallic silver and chlorine gas.

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

(b) Silver bromide also decomposes in the same way.

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

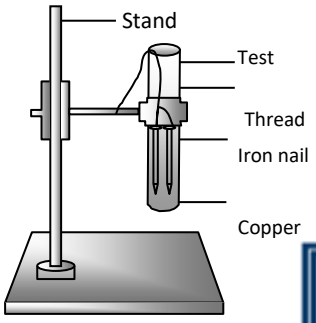
The above reactions are used in black and white photography. Thus, we have seen that this decomposition reaction require energy in the form of light for breaking down the reactants. Reactions in which energy is absorbed are known as **endothermic reactions**.



Q.4. **(a) What is displacement reaction? Perform an activity to show that react in between copper sulphate solution and iron nail is a displacement reaction.**
(b) Give one more example of displacement reaction.

Ans. (a) A displacement reaction is one in which one atom or a group of atoms (called radical) of a compound is replaced by another atom or group of atoms. It is indicated by the following general reaction:

A + BC → B + AC

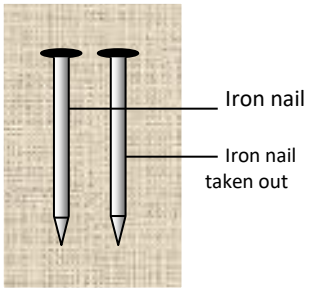


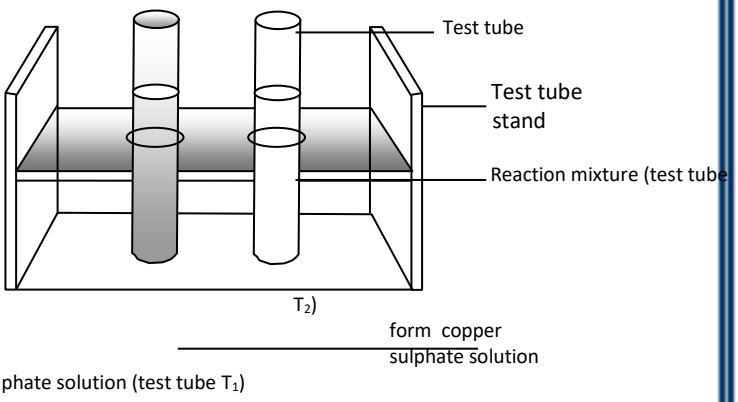
Activity: When a piece of iron is placed in copper sulphate solution,
tube
the more reactive iron displaces the less reactive copper from copper sulphate.
(i) Take three iron nails and clean them by rubbing with sandpaper.

(ii) Take two test tubes marked as (T_1) and (T_2).
Sulphate

Take about 10 mL copper sulphate solution in each test tube.
Solution

(iii) Tie two iron nails with a thread and immerse them carefully
in copper sulphate solution in test tube T_2. Keep one iron nail a side for comparison.
(iv)After 20 minutes, take out the iron nails from the copper sulphate solutions
(v) Compare the intensity of the blue colour of copper sulphate solutions in test tubes (T_1) and (T_2).
(vi) Compare the colour of iron nails dipped in copper sulphate solution with the one kept aside.





We observe that iron nail becomes brownish in colour and blue colour of copper sulphate solution fades away.

$CuSO_4$ (aq) + Fe(s) → $FeSO_4$ (aq) + Cu (s)
Copper sulphate — Iron — Ferrous sulphate — Copper

(b) When a strip of Zn is placed in aqueous, blue $CuSO_4$, it does not take long for the displacement reaction to form metallic copper and colourless $ZnSO_4$ solution.

$CuSO_4$ (aq) + Zn(s) → $ZnSO_4$ (aq) + Cu (s)
Copper sulphate — Zinc — Zinc sulphate — Copper