CHEMICAL REACTIONS & CHEMICAL EQUATIONS

1.1 INTRODUCTION:

Chemistry is defined as that branch of science which deals with the composition and properties of matter and the changes that matter undergone by various interactions. A chemical compound is formed as a result of a chemical change and in this process different type of energies such as heat, electrical energy, radiation etc. are either absorbed or evolved. The total mass of the substance remains the same throughout the chemical change.

1.2 CHEMICAL ACTION OR REACTION:

When a chemical change occurs, a chemical action is said to have taken place. A chemical change or chemical action is represented by a chemical equation. The matter undergoing change in known as reactant and new chemical component formed is known as product.

1.2 (a) Characteristics of a Chemical Reaction:

When we heat sugar crystals they melt and on further heating they give steamy vapour, leaving behind brownish black mass. On cooling no sugar crystals appears. Thus change which takes place on heating sugar is a chemical change and the process which brings about this chemical change is called chemical reaction.

- In this reaction the substance which take part in bringing about chemical change are called reactants.
- The substance which are produced as a result of chemical change are called products.
- These reactions involve braking and making of chemical bonds.
- Product(s) of the reaction is/are new substances with new name(s) and chemical formula.
- It is often difficult or impossible to reverse a chemical reaction.
- Properties of products formed during a chemical reaction are different from thos of the reactants.
- Apart from heat other forms of energies are light and electricity which are also used in carrying out chemical changes.

In all chemical reactions, the transformation from reactants to products is accompanied by various characteristics, which are-

(i) Evolution of gas : Some chemical reactions are characterized by evolution of a gas.

- When zinc metal is treated with dilute sulphuric acid, hydrogen gas is evolved. The hydrogen gas burns with a pop sound.
  $Zn\ (s) + H_2SO_4\ (dilute) \rightarrow ZnSO_4\ (aq) + H_2(g)$

- When washing soda is treated with hydrochloric acid, it gives off colorless gas with lots of effervescence.
  $Na_2CO_3(s) + 2HCl \rightarrow 2NaCl\ (aq) + H_2O(l) + CO2(g)$

- $2NaNCO_3\ (s) \xrightarrow{heat} Na_2SO_3\ (s) + H_2O\ (\ell) + CO_2\ (g)$
  Sodium hydrogen carbonate — Sodium carbonate — Water — Carbon dioxide

(ii) Change of colour: Certain chemical reactions are characterized by the change in colour of reacting substance.

- When red lead oxide is heated strongly it forms yellow coloured lead monoxide and gives off oxygen gas.
  $2Pb_3O_4\ (s) \xrightarrow{heat} 6PbO(s) + O_2(g)$
  Lead oxide (Red) — Lead monoxide (Yellow)

- When copper carbonate (green) is heated strongly it leaves behind a black residue.
  $CuCO_3\ (s) \xrightarrow{heat} CuO(s) + CO_2\ (g)$
  Copper carbonate (Green) — Copper oxide (Black) — Carbon dioxide

- $2Pb(NO_3)_2(s) \xrightarrow{heat} 2\ PbO(s) + 4NO_2\ (g) + O_2\ (g)$
  Lead (II) nitrate (White) — Lead (II) oxide (Yellow) — Nitrogen dioxide (Brown)

- $C_{12}H_{22}O_{11}\ (s) \xrightarrow{heat} 12C(s) + 11H_2O$
  White sugar — Carbon Black — Water

(iii) Formation of precipitate : Some chemical reactions are characterized by the formation of precipitate (an insoluble substance), when the solutions of the soluble chemical compounds are mixed together.

- When silver nitrate solution is mixed with a solution of sodium chloride.

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

- A dirty green precipitate of ferrous hydroxide is formed, when a solution of ferrous sulphate is mixed with sodium hydroxide solution.

$FeSO_4$ (aq)	+	2NaOH(aq)	⟶	Na_2SO_4 (aq)	+	$Fe(OH)_2$ (aq)
Ferrous sulphate (Light green)		sodium hydroxide (Colourless)		Sodium sulpahte (Colourless)		Ferrous hydroxide (Dirty green precipitate)

- $BaCl_2$ (aq) + dill H_2SO_4 ⟶ $BaSO_4$ (s) + 2HCl (aq)
  Barium chloride → Barium sulphate (White precipitate)

(iv) Energy changes : all chemical reactions proceed either with the absorption or release of energy. One the basis of energy changes, there are two types of reactions:

(A) Endothermic reaction : A chemical reaction which is accompanied by the absorption of heat energy is called an endothermic reaction.

- $C(s) + 2S(s) \xrightarrow{Heat} CS_2(\ell)$

- Light energy is essential for biochemical reaction, photosynthesis, by which green plants prepare their food from carbon dioxide & water.

(B) Exothermic reaction : A chemical reaction which is accompanied by the release of heat energy is called exothermic reaction.
When magnesium wire is heated from its tip in a bunsen flame, it catches fire and burns with a dazzling white flame with release of heat and light energy.

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

- When quick lie (calcium oxide) is placed in water, the water becomes very hot and sometimes starts boiling. It is because of release of heat energy during the reaction.

CaO (s)	+ H_2O	⟶	$Ca(OH)_2$ (aq)	+ Heat energy
Calcium oxide	Water		Calcium hydroxide	

(v) Change of state: Some chemical reactions are characterised by a change in state i.e. solid, liquid or gas

- Two volumes of hydrogen gas react with one volume of oxygen gas to from water.
  $2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell)$
  or when electric current is passed through water it splits into its elements.

$2H_2O(\ell) \xrightarrow{\text{Electric current}} 2H_2(g) + O_2(g)$

$\bullet NH_3(g) + HCl(g) \longrightarrow NH_4Cl(s)$

Ammonia Hydrochloric acid Ammonium Chloride

1.3 CHEMICAL EQUATIONS :

All chemical changes are accompanied by chemical reactions. These reactions can be described in sentence form, but the description would be quite long. Chemical equations have been framed to describe the chemical reactions.

A chemical equation links together the substance which react (reactants) with the new substances that are formed (products).

Zinc + Hydrochloric acid $\longrightarrow$ Zinc chloride + Hydrogen
(Reactants) (Products)

A Chemical reaction can be summarised by chemical equation.

1.3 (a) Types of Chemical Equations :

(i) Word equations : A word equation links together the names of the reactants with those of the products. For example, the word equation, when magnesium ribbon burns in oxygen to form a white powder of magnesium oxide, may be written as follows-

Magnesium + Oxygen $\longrightarrow$ Magnesium oxide
(Reactants) (Product)

Similarly, the word equation for the chemical reaction between granulated zinc and hydrochloric acid may be written as -
Zinc + Sulphuric acid $\rightarrow$ Zinc sulphate + Hydrogen

In a word equation

- The reactants are written on the left hand side with a plus sign (+) between them.
- The products are written on the right hand side with a plus sign (+) between them.
- An arrow ($\rightarrow$) separates the reactants from the products.
- The direction of the arrow head points towards the product.

Although word equations are quite useful, yet they don't give the true picture of the chemical reactions.

(ii) Symbol equation : A brief representation of a chemical reaction in terms of symbols and formulae of the substance involved is known as a symbol equation.
In a symbol equation, the symbols and formulae of the elements and compounds are written instead of their word names.

For e.g. Burning of magnesium in oxygen to form magnesium oxide may be written as follows :

$Mg + O_2 \longrightarrow MgO$

Symbol equations are always written from the word equations.

1.3 (b) Unbalanced and Balanced Chemical Equations :

In an unbalanced equation, the number of atoms of different elements on both side of the equation are not equal. For example, in the equation given below, the number of Mg atoms on both sides of the equation is one (same), but the number of oxygen atoms are not equal, It is known as an unbalanced equations.

$$Mg + O_2 \longrightarrow MgO$$

An unbalanced equation is also called skeletal equation.

In a balanced equating, the number of different elements on both sides of the equation are always equal. The balanced equation for the burning of magnesium ribbon in oxygen is written as -

$$2\ Mg + O_2 \longrightarrow 2\ MgO$$

(i) Importance of balanced chemical equation: The balancing of a chemical equation is essential or necessary to fulfill the requirement of "Law of conservation of mass".

(ii) Balancing of chemical equations: Balancing of chemical equations may be defined as the process of making the number of different types of elements, on both side of the equations, equal.

The balancing of a chemical equation is done with the help of **Hit and Trial method. In this method,** the coefficients before the symbols or formulae of the reactants and products are adjusted in such a way that the total number of atoms of each element on both the side of the arrow head become equal. This balancing is also known as mass balancing because the atoms of elements on both side are equal and their masses will also be equal.

The major steps involved in balancing a chemical equation are as follow –

- Write the chemical equations in the form a word equations. Keep the reactants on the left side and the products on the right side. Separate them by an arrow whose head ($\rightarrow$) points from the reactants towards the product.

- Convert the word equation into the symbol equation by writing the symbols and formulae of all the reactants and product.

- Make the atoms of different elements on both side of the equation equal by suitable method. This is known as balancing of equation.

- Do not change the formulae of the substance while balancing the equation.

- Make the equations more informative if possible.

Example :

1. Zinc reacts with dilute sulphuric acid to give zinc sulphate and hydrogen.
Solution : The word equation for the reaction is -
Zinc + Sulphuric acid $\rightarrow$ Zinc sulphate + Hydrogen
The symbol equation for the same reactions is -
$Z n + H_2SO_4 \rightarrow ZnSO_4 + H_2$
Let us count the number of atoms of all the elements in the reactants and products on both sides for the equations.

Element	No. of atoms of reactants (L.H.S.)	No. of atoms of products (R.H.S.)
Zn	1	1
H	2	2
S	1	1
O	4	4

As the number of atoms of the elements involved in the reactants and products are equal, the equation is already balanced.

2. Iron reacts with water (steam) to form iron (II, III) oxide and liberates hydrogen gas.
Solution :- The word equation for the reactions is -
Iron + Water $\rightarrow$ iron (II, III) oxide + Hydrogen
The symbol equation for the same reaction is-
$Fe + H_2O \rightarrow Fe_3O_4 + H_2$
The balancing of the equations is done is the following steps:

I : Let us count the number of atoms of all the elements in the reactants and products on both sides of the equation.

Element	No. of atoms of reactants (L.H.S.)	No. of atoms of products (R.H.S.)
Fe	1	3
H	2	3
O	2	4

Thus, the number of H atoms are equal on both sides, At the same time, the number of Fe and O atoms are not equal.

II : On inspection, the number of O atoms in the reactant (H_2O) is 1 while in the product (Fe_3O_4), these are 4. To balance the atoms, put coefficient 4 before H_2O on the reactant side. The partially balance equation may be written as
$Fe + 4H_2O \rightarrow Fe_3O_4 + H_2$
III : In order to equate H atoms, put coefficient 4 before H_2 on the product side, As a result, the H atoms on both side on of the equation become 8 and are thus balanced. The partially balanced equation may now be written as
$Fe + 4H_2O \rightarrow Fe_3O_4 + H_2$

IV : In order to balance the Fe atoms, put coefficient 3 before Fe on the reactant side. The equation formed may be written as -

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

V : on final inspection, the number of atoms of all the elements on both sides of the equation are equal. Therefore, the equation is balanced.

1.3 (c) Writing State Symbols:

The chemical equations or symbol equations which we have enlisted don't mention the physical states of the reactant and product species involved in the reaction. In order to make the equation more informative, the physical state are also mentioned with the help of certain specific symbols known as state symbols. These symbols are

- (s) for solid state
- (ℓ) for liquid state
- (g) for gaseous state
- (aq) for aqueous solution i.e., solution prepared in water.

Sometimes a gas if evolved in a reaction is shown by the symbol ($\uparrow$) i.e., by an arrow pointing upwards. Similarly the precipitate, if formed during the reaction, is indicated by the symbol ($\downarrow$) i.e., by an arrow pointing downwards.
The abbreviation 'ppt' is also use to represent the precipitate, if formed.

(i) $2Na(s) + 2H_2O(\ell) \rightarrow 2NaOH\ (aq) + H_2(g)$ or $H_2(\uparrow)$

(ii) $Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(\downarrow) + H_2O(\ell)$

(iii) $AnNo_3(aq) + NaCl(aq) \rightarrow AgCl(\downarrow) + NaNO_3\ (aq)$

1.3 (d) Significance of State Symbols:

The state symbols are of most significance for those chemical reactions which are either accompanied by the evolution of heat (exothermic) or by the absorption of heat (endothermic). For example.

$2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell) + 572\ kJ$

$2H_2\ (g) + O_2(g) \rightarrow 2H_2O(g) + 44\ kJ$

Both these reactions are of exothermic nature because heat has been evolved in these. Howeve, actual amounts of heat are different when water is in the liquid state i.e. $H_2O(\ell)$ and when it is in the vapour state.

1.3 (e) Specialties of Chemical Equation :

(i) We get the information about the substance which are taking part and formed in the reaction.

(ii) We get the information about the number of molecules of elements or compounds which are either taking part or formed in the chemical reaction.

(iii) We also get the information of weight of reactant or products.

For example - $CaCO_3 \longrightarrow CaO + CO_2$
(100gm) (56 gm) (44 gm)

Total weight of reactants is equal to the total weight of products because matter is never destroyed. In the above example total weight of calcium carbonate (reactant) is 100 gram and of product is also 100 g (56 gram + 44 gram).

(iv) In a chemical equation if any reactant or product is in gaseous state, then its volume can also be determined. For example in the above reaction volume of carbon dioxide is 22.4 liters.

(vi) In a chemical equation with the help of product we can get information about the valency as well.

For example

$Mg + 2HCl \rightarrow MgCl_2 + H_2(\uparrow)$
In the above reaction one atom of Mg displaces two atoms of hydrogen, so valency of magnesium is two.

All chemical equations are written under N.T.P. Conditions (at 273 K and 1 atmosphere pressure) if conditions are not otherwise mentioned.

1.3 (f) Limitations of Chemical Equations :

(i) We do not get information about the physical state of reactants and products.
For example solid, liquid or gas.

(ii) No information about the concentration of reactants and products is obtained.

(iii) No information about the speed of reaction and sense of timing can be obtained.

(iv) Information regarding the favorable conditions of the reactions such as pressure, temperature, catalyst etc. can't be obtained during the reaction.

(v) We do not get information whether heat is absorbed or evolved during the reaction.

(vi) We do not get information whether the reaction of reversible or irreversible.

(vii) We do not get information about the necessary precautions to be taken for the completion of reaction.

The above limitations are rectified in the following manner –

- The physical sate of reactants and products are represented by writing them in bracket.
- The precipitate formed in the reaction is represented by (↓) symbol and gaseous substance by (↑) symbol.
- To express the concentration, dilute or conc. is written below the symbol.

$$Mg + \underset{\text{(dilute)}}{H_2SO_4} \longrightarrow MgSO_4 + H_2$$

- Favorable conditions required for the completion of reaction are written above and below the arrow.

$N_2 + 3H_2 \xrightarrow[200\ atm]{500^0.Fe\ /\ Mo} 2NH_3 + 22400$ Calorie heat.

- Reversible reaction is represented by ($\rightleftharpoons$) symbol and irreversible reaction by ($\rightarrow$) symbol.
- The heat absorbed in the chemical reaction is written on the right side by putting negative (-) sign and heat evolved in the chemical reaction is written on the right side by putting positive (+) sign.

  $N_2 + 3H_2 \rightleftharpoons 2NH_3 + 22400$ Calorie (Exothermic Reaction)

  $N_2 + O_2 \rightleftharpoons 2NO - 43200$ Calorie (Endothermic Reaction)

DAILY PRACTIVE PROBLMES # 1

OBJECTIVE DPP-1.1

1. In the balanced equation -
$aFe_2O_3 + bH_2 \longrightarrow cFe + dH_2O$
The value of a,b,c,d are respectively -
(A) 1,1,2,3 (B) 1,1,1,1 (C) 1,3,2,3 (D) 1,2,2,3

2. Which of the following reactions is not balnced \
(A) $2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$ (B) $2C_4H_{10} + 120_2 \longrightarrow 8CO_2 + 10H_2O$
(C) $2Al + 6H_2O \longrightarrow 2Al(OH)_3 + 3H_2$ (D) $4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$

3. The equation - $Cu + xHNO_3 \rightarrow Cu(NO_3)_2 + yNO_2 + 2H_2O$
The values of x and y are-
(A) 3 and 5 (B) 8 and 6 (C) 4 and 2 (D) 7 and 1

4. Neutralization reaction is an example of -
(A) exothermic reaction (B) endothermic reaction
(C) oxidation (D) none of these

5. Which of the following statements is/are true \
(A) The total mass of the substance remains same in a chemical change.
(B) A chemical change is permanent and irreversible.
(C) A physical change is temporary and reversible.
(D) All the these.

6. Which of the following statements is correct
(A) A chemical equation tells us about the substances involved in a reaction.
(B) A chemical equation informs us about the symbols and formulae of the substances involved in a reactin.
(C) A chemical equation tells us about the atoms or molecules of the reactants and products involved in a reaction.
(D) All are correct.

7. $Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$ is an example of-
(A) precipitation reaction (B) endothermic reaction
(C) evolution of gas (D) change in colour

8. When dilute hydrochloric acid is added to iron fillings -
(A) hydrogen gas and ferric chloride are produced.
(B) chlorine gas and ferric hydroxide are produced.
(C) no reaction takes place.
(D) iron salt and water are produced.

9. In the reaction $xPb(NO_3)32 \xrightarrow{Heat} yPbo + zNO_2 + O_2$ x,y and z are -
(a) 1,1,2 (B) 2,2,4 (C) 1,2,4 (D) 4,2,2

10. In the reaction $FeSo_4 + x \longrightarrow Na_2SO_4 + Fe(OH)_2$, x is -
(A) Na_2SO_4 (B) H_2SO_4 (C) NaOH (D) None of these

SUBJECTIVE DPP-1.2

1. Balance the following equations -
(i) $HgO \longrightarrow Hg + O_2$
(ii) $C_4H_{10}(g) + O_2(g) \longrightarrow CO_2(g) + H_2O(\ell)$

2. What are chemical equations? Give significance and limitations of chemical equations ?

3. What information do we get from a chemical equation ? Explain with the help of examples.

4. Write the balanced chemical equations for the following chemical reactions -
(i) Aqueous solution of sulphuric acid and sodium hydroxide reacts to from aqueous sodium sulphate an water.
(ii) Phosphorus burns in chlorine gas to from phosphorus pentachloride.

5. Write the balance chemical equations for the following reactions -
(i) Zinc carbonate (s) $\longrightarrow$ Zinc oxide (s) + Carbon dioxide (g)
(ii) Potassium bromide (aq) + Barium iodide (aq) $\longrightarrow$ Potassium iodide (aq) + Barium bromide (aq)

6. What happens when electric current is passed through slightly acidic water ?

7. What happens when silver nitrate is mixed with a solution of sodium chloride ?

8. What do you mean by exothermic reactions ? Explain with an example.

9. What do you mean by endothermic reactions ? Explain with an example .

CHEMICAL REACTIONS & CHEMICAL EQUATIONS

2.1 TYPES OF CHEMICAL REACTIONS:

2.1 (a) Addition Reactions :

It is a union of two or more than two substances to from a new substance. It may be brought about by the application of heat, light electricity or pressure.

For eg. $H_2 + Cl_2 \rightarrow 2HCl$

In the above example H_2 and Cl_2 two elements combine to from hydrogen chloride.

Addition reactions may be formed in the following conditions -

(i) When two or more elements combine to form a new compound.

Synthesis reaction : It is a type of addition reaction in which a new substance is formed by the union of its component elements.

For eg. $N_2 + 3H_3 \rightarrow 2NH_3$ (Haber's Process)

Ammonia is synthesised from its components, nitrogen and hydrogen, so it is a synthetic reaction.

All synthesis reaction are addition reactions but all addition reactions are not synthesis reactions.

Other Example of synthesis reactions are -

- $2H_2 + O_2 \longrightarrow 2H_2O$
- $2Mg + O_2 \longrightarrow 2MgO$
- $2Na + Cl_2 \longrightarrow 2NaCl$

(ii) When two or more compounds combine to from a new compound.

For eg.

- $NH_3 + HCl \longrightarrow NH_4Cl$
- $CaO + CO_2 \longrightarrow CaCO_3$
- $CH_2 = CH_2 + Br_2 \longrightarrow \begin{matrix} CH_2 - Br \\ | \\ CH_2 - Br \end{matrix}$

(iii) When and element and a compound combine to from a new compound.

For eg.

- $2CO + O_2 \longrightarrow 2CO_2$
- $2CO_2 + O_2 \longrightarrow 2CO_3$

Only single substance is formed as a product in the addition reactions.

2.1 (b) Decomposition Reaction :

It is breaking up of a substance into simpler compounds and it may be brought about by the application of heat, light, electricity etc.

(i) A decomposition reaction brought by heat is known as thermal decomposition.
For eg.

- $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$
- $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

(ii) Decomposition performed by electricity is known as electrolysis.
For eg.

- $2H_2O \xrightarrow{Electricity} 2H_2 + O_2$
- $2NaCl \xrightarrow{Electricity} 2Na + Cl_2$
- $2Al_2O_3 \xrightarrow{Electricity} 4\,Al + 3O_2$

(iii) A decomposition reaction brought by light is known as photo decomposition.
For eg.

- $2AgBr \xrightarrow{Light} 2Ag + Br_2$
- $2AgCl \xrightarrow{Light} 2Ag + Cl_2$

(iv) Decomposition reaction in which a compound decomposes into its elements is known as analysis reaction.
For eg.

- $2HgO \xrightarrow{\Delta} 2Hg + O_2$
- $2HI \xrightarrow{\Delta} H_2\uparrow + \downarrow$

All analysis reactions are decomposition reactions, but all decomposition reactions are not analysis reactions.

Decomposition reaction is just opposite of the addition reaction.

2.1 (c) Displacement Reactions :

It involves displacement of one of the constituents of a compound by another substance and may be regarded as a displacement reaction.

For eg.

(i) Zinc displaces hydrogen from sulphuric acid.

$Zn\,(s) + dill.\ H_2SO_4\,(aq) \longrightarrow ZnSO_4\,(aq) + H_2\uparrow$

(ii) Iron displaces copper from a copper sulphate solution.

$Fe\,(s) + CuSO_4(aq) \longrightarrow FeSO_4\,(aq) + Cu$

In general a more reactive element displaces a less reactive element from the soluble solution of its salt.

2.1 (d) Double Displacement :

It is mutual exchange of the radicals of two compounds taking part in the reaction and results in the formation of two new compounds.

- $NaCl\ (aq) + AgNO_3\ (aq) \longrightarrow AgCl \downarrow + NaNO_3\ (aq)$
- $BaCl_2\ (aq) + Na_2SO_4\ (aq) \longrightarrow BaSO_4 \downarrow + 2NaCl\ (aq)$

Acid base neutralisation reactions are double displacement reactions.

DAILY PRACTICE PROBLEMS # 2

OBJECTIVE DPP-2.1

1. Chemical reaction $2Na + Cl_2 \longrightarrow 2\,NaCl$ is an example of -
(A) Combination reaction (B) decomposition reaction
(C) displacement reaction (D) double displacement reaction

2. Which of the following equations is representing combination of two elements?
(A) $CaO + CO_2 \longrightarrow CaCO_3$ (B) $4\,Na + O_2 \longrightarrow 2Na_2O$
(C) $SO_2 + 1/2\,O_2 \longrightarrow SO_3$ (D) $2Na + 2H_2O \longrightarrow 2NaOH + H_2$

3. Which of the following equations is not an example of single displacement reaction?
(A) $2Al + Fe_2O_3 \longrightarrow Al_2O_3 + 23Fe$ (B) $Ca + CO_2 \longrightarrow CaCl_2$
(C) $2KI + Cl_2 \longrightarrow 2KCl + I_2$ (D) $2Na + 2H_2O \longrightarrow 2NaOH + H_2$

4. Which of the following is/are a decomposition reaction(s)?
(A) $2HgO \xrightarrow{Heat} 2Hg + O_2$ (B) $CaCO_3 \xrightarrow{Heat} CaO + CO_2$
(C) $2H_2O \xrightarrow{Electrolysis} H_2 + O_2$ (D) All of these

5. Match the following -

Column A **Types of chemical reaction**	**Column B** **Chemical equations**
(a) Combination reaction	(i) $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$
(b) Decomposition reaction	(ii) $2H_2O \xrightarrow{Electricity} 2H_2 + O_2$
(c) Displacement reaction	(iii) $CaO + CO_2 \longrightarrow CaCO_3$
(d) Analysis reaction	(iv) $Fe + CuSO_4\,(aq.) \longrightarrow FeSo_4(aq) + Cu$

(A) a(ii), B(i), C9iv), d(iii) (B) a(i), b(ii), c(iii), d(iv)
(C) a(iii), b(i), c(iv), d(ii) (D) a(iii), b(i), c(iii), d(iv)

6. Which of the following reactions is/are a double displacement reactions (s) ?
(i) $AgNO_3 + NaBr \longrightarrow NaNO_3 + AgBr$
(ii) $BaCl_2 + H_2SO_4 \longrightarrow BaSO_4 + 2HCl$
(iii) $As_4O_4 + 3H_2S \longrightarrow As_2S_3 + 3H_2O$
(iv) $NaOH + HCl \longrightarrow NaCl + H_2O$
(A) (i) & (ii) (B) only (iii) (C) only (iv) (D) (i) to (iv) all

7. $AgNo_3\,(a) + NACl\,(Aq) \longrightarrow AgCl\,(s) + NaNO_3\,(Aq)$
Above reaction is a -
(A) precipitation reaction (B) dboule displacement reaction

(C) combination reaction (D) (A) and (B) both

8. $H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$
Above equation is a
(i) neutralization reaction (ii) double displacement reaction)
(iii) decomposition reaction (iv) addition reaction
(A) (i) to (iv) all (B) (i) and (ii)
(C) (i) and (iii) (D) (ii) and (iv)

9. $Zn + H_2SO_4$ (dil) $\longrightarrow ZnSO_4 + H_2\uparrow$
Above equation is a=
(A) Decomposition (B) Single displacement reaction
(C) Combination reaction (D) Synthesis reaction

10. The reaction in which two compounds exchange their ions to form two new compounds is-
(A) a displacement reaction (B) a decomposition reaction
(C) an addition reaction (D) a double displacement reaction

SUBJECTIVE DPP-2.2

1. Classify the following reactions -
(i) $N_2 + O_2 \longrightarrow 2NO$ - Heat (ii) $2HgO \longrightarrow 2Hg + O_2$
(iii) $Na_2SO_4 + BaCl_2 \longrightarrow 2NaCl + BaSO_4$ (iv) $CuSO_4$ (aq.) + Zn $\longrightarrow ZnSO_4$ (aq.) + Cu
(v) $NH_3 + HCl \longrightarrow NH_4Cl$

2. Differentiate between combination and synthesis reaction with example.

3. What is an analysis reaction? Give an example.

4. When a white compound 'X' is placed under sunlight, it turns grey, Give the name of reaction and write the balanced chemical equation.

5. What is the difference between displacement and double displacement reaction ? Write equations for these reactions.

6. What happens when copper metal is dipped in silver nitrate solution ? Give the balanced chemical equation for the change.

7. What happens when ferrous sulphate is heated ? Write the name and balanced chemical equation for the change.

8. What happens when the iron nail is kept into copper sulphate solution ?

CHEMICAL REACTIONS & CHEMICAL EQUATIONS

3.1  OXIDATION AND REDUCTION :

3.1 (a) Oxidation :

Oxidation is a chemical reaction in which a substance gains oxygen or loses hydrogen. Since oxygen is an electronegative element and hydrogen is an electropositive element, so, oxidation is defined as a reaction in which a substance gains and electronegative radical or loses and electropositive radical.

(i) A reaction in which a substance gains oxygen is known as oxidation.
For eg.

- $S + O_2 \longrightarrow SO_4$
- $2SO_2 + O_2 \longrightarrow 2SO_3$
- $2Ca + O_2 \longrightarrow 2CaO$
- $Pbs + 2O_2 \longrightarrow PbSO_4$

(ii) Gain or addition of a electronegative radical
For eg.

- $2FeCl_2 + Cl_2 \longrightarrow 2FeCl_3$
- $Mg + Cl_2 \longrightarrow MgCl_2$
- $2FeSO_4 + H_2SO_4 + [O] \longrightarrow Fe_2(SO_4)_3 + H_2O$
- $SnCl_2 + Cl_2 \longrightarrow SnCl_4$

(iii) Removal of a hydrogen atom.
For eg.

- $2HCl \longrightarrow Cl_2 + H_2$
- $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

(iv) Removal or loss of electropositive radical or element.
For e.g.

- $2KI + H_2O_2 \longrightarrow 2KOH + I_2$

3.1 (b) Reduction :

It is a chemical reaction in which there is a gain of hydrogen or any electropositive radical or a loss of oxygen or electronegative radical.

(i) Gain of hydrogen.
For eg.

- $Cl_2 + H_2S \longrightarrow 2HCl + S$
- $O_2 + 2H_2 \longrightarrow 2H_2O$
- $C_2H_4 + H_2 \longrightarrow C_2H_6$

(ii) Gain of any electropositive radical or element.
For eg.

- $SnCl_2 + 2HgCl_2 \longrightarrow Hg_2Cl_2 + SnCl_4$
- $CuCl_2 + Cu \longrightarrow Cu_2Cl_2$

(iii) Loss of oxygen atom.
For eg.

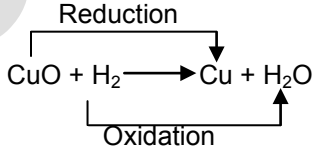
- $CuO + H_2 \longrightarrow Cu + H_2O$
- $ZnO + C \longrightarrow Zn + CO$

(iv) Loss of electronegative radical.
For eg.

- $Fe_2(SO_4)_3 + H_2 \longrightarrow 2FeSO_4 + H_2SO_4$
- $SnCl_4 + Hg_2Cl_2 \longrightarrow 2HgCl_2 + SnCl_2$

3.2 REDOX REACTIONS :

Reduction is loss of electronegative element or radical. From all above example it is clear that oxidation and reduction occur side by side, i.e. there can be no oxidation without and equivalent reduction. In a reaction whenever one substance is oxidised the other is definitely reduced. The reverse is also true whenever one substance is reduced the other is oxidized. Such reactions in which oxidation and reduction take place simultaneously are known as **redox reactions.**



When hydrogen gas is passed through not cupric oxide, hydrogen is oxidised to water (H_2O) while cupric oxide is reduced to metallic copper by loss of oxygen. Hydrogen gas helps in reduction of cupric oxide to metallic copper so it is known as reducing agent, where as cupric oxide helps in oxidation of hydrogen so it is known as oxidizing agent. A substance, which brings about reduction, is called reducing agent. A substance, which brings about oxidation, is called an oxidizing agent.

3.2 (a) Electronic Interpretation of Oxidation:

The electronic theory attempts to interpret oxidation on the basis of electron transfer. According to octet rule, atom will try to complete its octet by losing gaining or sharing electrons. Sodium chloride is an electrovalent compound and consists of an ion pair (Na^+) (Cl^-) even in the solid state. In its formation, the neutral sodium loses and electron and becomes positively charged sodium ion. Sodium is said to be oxidised and loss of electrons is termed as oxidation.

$2Na \rightarrow 2Na^+ + 2e^-$

$2Na^+ + 2Cl^- \rightarrow 2NaCl$

3.2 (b) Electronic Interpretation of Reduction :

Reduction which is also referred to as electronation is a process involving the gain of electrons and is the reverse of oxidation.

For example

Mg combines with oxygen and is oxidized to MgO. According to electronic theory magnesium atom loses two electrons from its outermost shell (M) and is oxidised to mG which oxygen atom gains these two electrons and gets reduced to oxide anion, hence oxidation involves loss of electrons and it is also referred as de- electronation. Reduction involves gain of electrons so it is referred to as electronation.

$2Mg + O_2 \rightarrow 2MgO$

$Mg \rightarrow Mg^{+2} + 2e^-$

$O + 2e^- \rightarrow O^{2-}$

$Mg^{+2} + O^{2-} \rightarrow MgO$

3.3 EFFECT OF OXIDATION REACTIONS IN EVERYDAY LIFE :

We are all aware of the fact that oxygen is most essential for sustaining life. One can live without food or even water for a number of days but not without oxygen. It is involved in a variety of actions which have wide range of effects on our daily life. Most of them are quite useful while a few may be harmful in nature. Some of these effects are briefly discussed. Some examples are-

3.3 (a) Combustion Reactions:

A chemical reaction in which a substance burns or gets oxidised in the presence of air or oxygen in called combustion reaction. For example, kerosene, coal, charcoal, wood etc. burn in air and thus, undergo combustion. Methane (CH_4) a major constituent of natural gas undergoes combustion in excess of oxygen upon heating.

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$

Methane

Similarly, butane (C_4H_{10}) the main constituent of L.P.G. also undergoes combustion.

$C_4H_{10}(g) + 13/2O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g)$

Butane

All combustion reactions are of exothermic nature and are accompanied by release of heat energy. The human body may be regarded as a furnace or machine in which various food stuffs that we eat undergo combustion or oxidation. The heat energy evolved keeps our body working. Carbohydrates such as

glucose, fructose, starch etc. Are the major source of energy to the human body. They undergo combustion with the help of oxygen that we inhale to form carbon dioxide and water. For example.

$C_5H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O\ (\ell) + \text{energy}$

All combustion reactions are not accompanied by flame. Combustion is basically oxidation accompanied by release of energy.

3.3 (b) Respiration :

Respiration is the most important biochemical reaction which releases energy in the cells. When we breathe in air, oxygen enters our lungs and passes into thousands of smalls air sacs (alveoli). These air sacs occupy a large area of membranes and oxygen diffuses from the membranes into blood. It binds itself to hemoglobin present in red blood cells and is carried to millions of cells in the body. Respiration occurs in these cells and is accompanied by the combustion of glucose producing carbon dioxide and water. Since the reaction is of exothermic nature, the energy released during respiration carry out many cell reactions and also keeps our hart and muscles working. It also provides the desired warmth to the body. Both carbon dioxide and water pas back into the blood and we ultimately breathe them out. Respiration takes place in the cells of all living beings.

Fish takes up oxygen dissolved in water through their gills while plants take up air through small pores (stomata) present in their leaves.

3.3 (c) Harmful Effects of Combustion :

We have discussed the utility of combustion in releasing energy which our body needs to keep warm and working; however, combustion has harmful effects also. The environmental pollution is basically due to combustion. Poisonous gases like carbon monoxide (CO), sulphur dioxide (SO_2) sulphur trioxide (SO_3) and oxide of nitrogen (NO_X) etc. are being released into the atmosphere as a result of variety of combustion reaction which are taking place. They pollute the atmosphere and make our lives miserable. In addition to these, other harmful effects of combustion are corrosion and rancidity. These are briefly discussed.

(i) Corrosion : Corrosion may be defined as the process of slow eating up of the surfaces of certain metals when kept in open for a long time.

Quite often, when we open the bonnet of a car after a long time, we find a deposit around the terminals of the battery. This is an example of corrosion. Black coating on the surface of silver and green layer on the surface of copper are the examples of corrosion. In case of iron, corrosion is called rusting. Rust is a chemical substance brown in colour and is formed by the chemical action of moist air (containing O_2 and

H_2O) on iron. It is basically an oxidation reaction and the formula of rust is Fe_2O_3, xH_2O. It is very slow in nature and once started keeps on.

Both corrosion and rusting are very harmful and case damage to the building, Railway tracks, cars and other objects/ materials where metals are used. We quite often hear that an old building has collapsed on its own causing loss of both lives and property. This is on account of the rusting of iron which is used in making the structure particularly the roof.

(ii) Rancidity : Oxidation has damaging effects on food and eatables. When the fats and oils present in butter and margarine are oxidised, they become rancid. As a result, their smell and taste change. They become quite unpleasant. This is known a rancidity. It can be checked in a number of away.

(A) Manufacturer sometimes add certain food additives to the food materials. These are known as antioxidant and check their oxidation.

(B) Keeping food in air tight containers prevents its oxidation.

(C) Refrigeration of food also slows down rancidity because the temperature inside refrigerator is very low and direct contact with air or oxygen is avoided.

(D) Chips manufacturers generally flush their bags with nitrogen before packing so that they may not be oxidised.

DAILY PRACTICE PROBLESM # 3

OBJECTIVE DPP-3.2

1. In the reaction $Mg + Cl_2 \rightarrow MgCl_2$

   Chlorine may be regarded as -

   (A) an oxidising agent (B) a reducing agent

   (C) a catalyst (D) providing an inert medium

2. When the gases sulphur dioxide and hydrogen sulphide react, the reaction is

   $SO_2 + 2H_2S \rightarrow 2H_2O + 3S$

   Here hydrogen sulphide is acting as -

   (A) an oxidising agent (B) a reducing agent

   (C) a dehydrating agent (D) a catalyst

3. Which of the following statements is/are false for oxidation reaction?

   (A) Gain or addition of electronegative radical

   (B) Removal of hydrogen atom.

   (C) Removal or loss of electropositive radical or element

   (D) None of these

4. $CiO + H_2 \rightarrow H_2O + Cu$, reaction is an example of -

   (A) redox reaction (B) synthesis reaction

   (B) neutralisation (D) analysis reaction

5. Which of the following is an example of oxidation reaction ?

   (A) $Sn^{+2} - 2e^- \rightarrow Sn^{+4}$ (B) $Fe^{+3} + e^- \rightarrow Fe^{+2}$

   (C) $Cl_2 + 2e^- \rightarrow 2Cl$ (D) None of these

6. In the process of burring of magnesium in air, magnesium undergoes -

   (A) reduction (B) sublimation (C) oxidation (D) all of these

7. A substance which oxidises itself and reduces other is known as-

   (A) an oxidising agent (B) a reducing agent (C) Both of these (D) None of these

8. Oxidation is a process which involves -

   (A) addition of oxygen (B) removal of hydrogen

   (C) loss of electrons (D) All are correct

9. In the reaction PbO + C $\rightarrow$ Pb + CO.
(A) PbO is oxidised
(B) C acts as oxidising agent.
(C) C acts as a reducing agent.
(D) This reaction does not represent a redox reaction.

10. A redox reaction is one in which -
(A) both the substances are reduced.
(B) both the substances are oxidised.
(C) and acid is neutralised by the base.
(D) one substance is oxidised, which the other is reduced.

SUBJECTIVE DPP-3.2

1. Oxidation reaction have some harmful effects. Comment on the sentence.

2. Can oxidation occur without reduction ? Explain

3. Explain the terms oxidation and reduction with examples.

4. What is rancidity? Example with example.

5. What do you mean by corrosion ?

6. Identify the substances that are oxidized and the substances that are reduced in the following reactions -
(a) $ZnO + C \longrightarrow Zn + CO$
(b) $MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$
(c) $2FeCl_3 + H_2S \longrightarrow 2FeCl_2 + S + 2HCl$
(d) $3Mg + N_2 \longrightarrow Mg_3N_2$

ANSWERS

OBJECTIVE DPP 1.1

Quse.	1	2	3	4	5	6	7	8	9	10
Ans.	C	B	C	A	D	D	C	A	B	C

SUBJECTIVE DPP 1.1

1. (i) $2HgO \longrightarrow 2Hg + O_2$

   (ii) $C_4H_{10} + \frac{13}{2}O_2 \longrightarrow 4CO_2 + 5H_2O$

4. (i) $H_2SO_4\,(aq) + 2NaOH\,(aq \longrightarrow Na_2SO_4\,(aq) + 2H_2O\,(\ell)$

   (ii) $P_4\,(d) + 10\,Cl_2\,(g) \longrightarrow 4\,PCl_5\,(g)$

5. (i) $ZnCO_3\,(s) \longrightarrow ZnO\,(s) + Co_2\,(g)$

   (ii) $2KBr\,(aq) + BaI_2\,(aq) \longrightarrow 2KI\,(q) + BaBr_2\,(aq)$

OBJECTIVE DPP 2.1

Quse.	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	B	D	C	D	D	B	B	D

OBJECTIVE DPP 2.1

1. (i) Endothermic Reaction
   (ii) Analysis reactions
   (iii) Double displacement reaction
   (iv) Single displacement reaction
   (v) Combination reaction

4. Decomposition reaction

   $2AgCl\,(s) \longrightarrow 2Ag\downarrow + Cl_2\,(g)$

   (X) grey

6. $Cu\,(s) + 2AgNO_3\,(aq) \longrightarrow Cu\,(NO_3)_2\,(aq) + 2Ag\,(s)$

OBJECTIVE DPP 3.1

Quse.	1	2	3	4	5	6	7	8	9	10
Ans.	A	B	D	A	A	C	B	D	C	D

SUBJECTIVE DPP 3.1

6. (a) ZnO is reduced and C is oxidised.
   (b) MnO_2 is reduced and HCl is oxidised.
   (c) $FeCl_3$ is reduced and H_2S is oxidised.
   (d) Mg is oxidised and N_2 is reduced.