CHAPTER

1

CHEMICAL REACTIONS & EQUATIONS

KICK

*"Chlroine is a deadly poison gas employed on Europen battlefields in World War I. Sodium is a corrosive metal which burns upn contact with water. Together they make a placid and unpoisonous material, table salt. Why each of these substances has the properties it does, is a subject called Chemistry"- **Carl Sagan***

OFF

Introduction

Chemistry is largely about chemical changes. Indeed, if there were no chemical changes, chemistry as such would not exist. Chemical changes are a fundamental part of chemistry. A chemical change result into formation of a chemical compound and there are different type of energies such as chemical energy, electrical energy, heat, etc. are either absorbed or released. During the chemical change the total mass of the compound remain same. For example, when calcium carbonate is heated, calcium oxide (lime) and carbon dioxide are formed.

Chemical Reactions

The process by which a compound undergo any chemical change to give a new compound is known as a chemical reaction. This chemical change is indicated by a chemical equation. The matter that is undergoing change in equation known as **reactant** and new chemical compound /substance formed is known as **product**.

Characteristics of a Chemical Reaction

- ❒ The product that is formed as new compound with new chemical formula.
- ❒ These reactions required splitting and forming of chemical bonds.
- ❒ Properties of products formed during a chemical reaction are different from those of the reactants.
- ❒ It is difficult to alter a chemical reaction.
- ❒ There are other types of energies that are electricity and light that is used in carrying out chemical changes.

In all chemical reactions, the conversion from reactants to products is accompanied by different characteristics, that are also used in carrying out chemical change.

Example

Q. What is a chemical reaction?

Ans. Changes in which new product are formed.

1. **Gas evolution:** Some chemical reactions are indicated by evolution of a gas

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

   In the above reaction H_2 gas is evolved

Example

Q. Dilute HCl is added to granulated zinc taken in a test tube. The following observations are recorded. The correct observation that were noticed is.

a. The reaction mixture turns into milky colour

b. The surface of metal becomes shining

c. Odour of a pungent smelling gas is seen

d. A colourless and odourless gas is evolved

Ans. **(d)** Zinc metal reacts with dil. HCl to form zinc chloride ($ZnCl_2$) and bubbles of colourless and odourless hydrogen gas is evolved.

$$Zn(s) + \underset{(dil.)}{2HCl(aq)} \xrightarrow{\Delta} ZnCl_2(aq) + H_2(g)$$

Mind it

Formation of gaseous product is usually accompanied by bubbling in the solution.

2. **Colour change:** Some of the chemical reactions are indicated with the colour change of reacting compound.

Example:

$$\underset{\substack{\text{Lead oxide}\\(\text{Red})}}{2Pb_3O_4(s)} \xrightarrow{\text{heat}} 6\ \underset{\substack{\text{Lead monoxide}\\(\text{Yellow})}}{PbO(s)} + O_2(g)$$

In the above reaction lead oxide that is red in colour gets converted into yellow coloured compound PbO.

Mind it

In manufacture of fine crystal glass, PbO is used. One part PbO_2+ two parts PbO is called mixed oxide Pb_3O_4 called red lead, used as sindoor by married ladies.

3. **Precipitate formation :** Certain chemical reactions are identified by the formation of precipitate that is an insoluble substance, when the solutions of the soluble chemical compounds are mixed together.

Example:

$$\underset{\substack{\text{Silver nitrate}\\(\text{Colourless})}}{AgNO_3(aq)} + \underset{\substack{\text{Sodium chloride}\\(\text{Colourless})}}{NaCl(aq)} \longrightarrow \underset{\substack{\text{Sodium nitrate}\\(\text{Colourless})}}{NaNO_3(aq)} + \underset{\substack{\text{Silver chloride}\\(\text{White precipitate})}}{AgCl(s)}$$

In this chemical reaction silver chloride is formed as precipitate.

4. **Energy changes :** Many of chemical reactions undergo either with the absorption or release of energy.

Mind it

Change in temperature during a reaction can be measured with the help of thermometer.

On the basis of energy changes, there are two types of reactions:

(a) Endothermic reaction : The chemical reaction along with the absorption of heat energy is known as an endothermic reaction.

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

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

(b) Exothermic reaction : The chemical reaction along with the release of heat energy is known as an exothermic reaction.

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

When magnesium wire is heated from its tip in a bunsen flame, it burns with a dazzling white flame along with release of heat and light energy.

Mind it

Magnesium metal has a shining surface but due to attack of moist air, it is coated with a white layer of magnesium oxide. Therefore in order to use it for any chemical reaction, it is first rubbed with a sand paper.

5. State change: Some of the chemical reactions are indicated by a change in state i.e. solid, liquid or gas

Example:

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

In this reaction H_2 and O_2 are in gaseous state and they combine to form water which is liquid in state.

Find it

Q. Which of the following among the given options will be required to identify the gas evolved when dilute HCl acid reacts with Zn metal?

a. Red litmus paper
b. pH paper
c. Lime water
d. A burning splinter

Chemical Equations

All chemical reactions are shown by chemical equations. A chemical equation is a shorthand representation of a chemical reaction using the symbols and formulae of substance involved in the chemical reaction.

The symbols and formulae of the elements or compounds are arranged to show the reactants and products of a chemical reaction.

Types of Chemical Equations

There are two types of chemical equation:

(i) Word equations : A word equation is that equation which links together the names of the reactants and products. For example, the word equation, when sodium metal react with water to give sodium hydroxide and hydrogen gas, it written as-

Sodium + Water ⟶ Sodium hydroxide + Hydrogen gas

In a word equation

There are certain rules for writing word equation

- ❒ On the left hand side the reactants are written with a positive sign (+) is put between them.
- ❒ On the right hand side the products are written with a plus sign (+) is put between them.
- ❒ The direction of the arrow shows the product formation direction.
- ❒ An arrow (→) is put between the reactants and products.

(ii) Symbol equation : Symbol equation is short representation of a chemical reaction in terms of formulae and symbols of the element/substance that are involved in reaction.

In a symbol equation, the symbols and formulae of the elements and compounds are written in place of their word names.

For example: Sodium metal react with Water to give sodium hydroxide and hydrogen gas

$$Na + H_2O \longrightarrow NaOH + H_2$$

Mind it

Symbol equations are always formulated from the word equations.

Unbalanced and Balanced Chemical Equations:

In an unbalanced equation, the number of atoms of different elements that are taking part in a chemical reaction on both side of the equation are not equal. For example, in the equation given below, the number of Cl atoms on both sides of the equation and the number of hydrogen atoms are not equal, It is known as an unbalanced equations.

$$Mg + HCl \longrightarrow MgCl_2 + H_2$$

An unbalanced equation is also known skeletal equation.

In a balanced equation, the number of different elements on both sides of the equation are always equal. The balanced equation when magnesium reacts with HCl is written as -

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

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

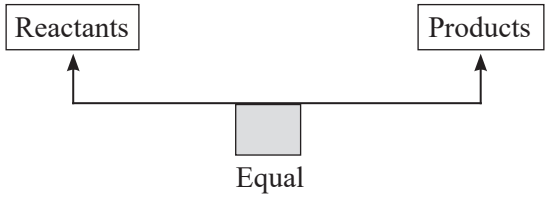


Fig. 1: Law of conservation of mass

Mind it

According to Dalton's atomic theory in every chemical reaction, the amount of each element is always conserved. Moreover in every chemical reaction the total amount of electrical charge is always conserved.

(ii) Balancing of chemical equations: Chemical equations is balanced by making the number of various types of elements, equal on both side of the equations.

Mind it

In a balanced chemical equation, an integer precedes the formula of each substance. This number is known as stoichiometric coefficient. If no number is there, stoichiometric coefficient is taken as 1.

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 no. of atoms of each element on both the side of the arrow are equal. This balancing is also known as **mass balancing** because the atoms of elements on both side are equal and their masses are also be equal.

Fig. 2: Total mass of reactants = Total mass of the products

Balanced chemical equation makes calculations easy.

The major steps that are involved in balancing a chemical equation are given:–

- ❒ The chemical equations are written in the form a word equations. Reactants are kept on the left hand side and the products are on the right side. The reactants and products are separated by an arrow.
- ❒ Word equation is then converted into the symbol equation with symbols and formulae used for all the reactants and product are written.
- ❒ Then the atoms of different elements on both side of the equation are made equal. This is how balancing of equation is done.
- ❒ The formulae of the substance while balancing the equation should not be changed.
- ❒ Try to 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 given below-

Zinc + Sulphuric acid $\rightarrow$ Zinc sulphate + Hydrogen

The symbol equation for the same reactions is given below-

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

Now we will count the number of atoms of all the elements that are present in the reactants and products on both sides for the given equations.

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

As in the above equation, the number of atoms of the elements that involved in the reactants and products are equal, so, the equation is already balanced there is no need of balancing for this equation.

Example 2: Iron reacts with water (steam) to form iron (II, III) oxide and liberates hydrogen gas.

The word equation for the reactions is given below-

Iron + Water $\rightarrow$ iron (II, III) oxide + Hydrogen

The symbol equation for the same reaction is given below-

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

So, the balancing of the equations is done as follow:

1. First we will count the number of atoms of all the elements that are 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
O	1	4
H	2	2

   As in the equation, the number of H atoms are equal on both the sides, but the number of Fe and O atoms are not equal.
2. On noticing we have seen that, 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 oxygen atoms, we put coefficient 4 before H_2O on the reactant side. So, equation is written as

   $Fe + 4H_2O \rightarrow Fe_3O_4 + H_2$
3. Now we will equate H atoms, by putting coefficient 4 before H_2 on the product side. Thus, the H atoms on both sides on of the equation become 8 and are thus balanced. The equation now written as:

   $Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
4. At end we will balance the Fe atoms, by putting coefficient 3 before Fe on the reactant side. The equation is written as -

   $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
5. On final noticing at the end, the number of atoms of all the elements on both sides of the equation are equal. Thus, the equation is balanced.

Mind it

Mixture of ferrous oxide and ferric oxide is also known as magnetic oxide of iron.

Writing State Symbols

The physical states of the reactant and product species that are involved in the reaction are not written in symbol equation the equation is made more informative by mentioning the physical state with the use 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 that prepared in water.

A gas evolution is shown by the symbol (↑) in a reaction i.e., with an arrow point towards upwards. Similarly the precipitate formation is shown by the symbol (↓) in a reaction i.e., with an arrow point towards downwards.

The short form 'ppt' is used to indicate the precipitate formation.

(i) $ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2\uparrow$

(ii) $AgNO_3(aq) + KCl(aq) \rightarrow AgCl\downarrow + KNO_3(aq)$

Importance of State Symbols

The state symbols are most important part for those chemical reactions that are either accompanied by the release of heat (exothermic) or by the absorption of heat (endothermic). For example.

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

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

The above reactions are of exothermic as heat is released in these reactions. Thus, actual amounts of heat are different when water is in the liquid state i.e. $H_2O(l)$ and when it is in the gaseous state

Importance of Chemical Equation

1. The weight of reactant or products can be calculated by chemical equation.
   Total weight of reactants is equal to the total weight of products because matter is never destroyed.
2. It gives information about the substance that are taking part and formed in the reaction.
3. The information about the number of molecules of elements or compounds which are either taking part or formed in the chemical reaction.
4. In a chemical equation with the help of product we can get information about the valency as well.

Mind it

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

Find it

Q. On immersing an iron nail in $CuSO_4$ solution for few minutes, what will you observe?

Some of Limitations of Chemical Equations

(1) It does not give information about the physical state of reactants and products.
For example solid, liquid or gas.

(2) We does not get information about the reactants and products concentration.

(3) It does not give information about the speed of reaction and sense of timing.

(4) We does not get information about the favorable conditions of the reactions such as temperature, catalyst, pressure etc.

(5) The information whether heat is absorbed or released is not obtained during reaction.

(6) The information about the necessary precautions that has to be taken for the completion of reaction is not obtained.

(7) The information if the reaction is reversible or irreversible does not obtained.

NCERT Corner

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

Ans. Magnesium covers with a layer of MgO (magnesium oxide) when kept in air for a long period time. This layer MgO hinders the burning of magnesium. Thus, it is to be cleaned before burning.

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) $H_2 + Cl_2 \rightarrow 2HCl$

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

(iii) $2Na + 2H_2O \rightarrow 2NaOH + H_2\uparrow$

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

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

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

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

(ii) $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

Types of Chemical Reactions

1. Combination/Addition Reactions

It is a addition or combination of two or more than two substances/elements to form a new substance/compound. This can be done by the application of pressure, light electricity or heat.

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

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

Example, $CaO + CO_2 \rightarrow CaCO_3$

Addition reactions are also formed in the following conditions -

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

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

For eg. $N_2 + 3H_2 \rightarrow 2NH_3$ (Haber's Process)

Ammonia is synthesised from its components, nitrogen and hydrogen, so it is an example of synthesis reaction.

$2Mg + O_2 \rightarrow 2MgO$

Mind it

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

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

For eg.

$NH_3 + HCl \rightarrow NH_4Cl$

(iii) When an element and a compound combine to form a new compound.
For eg.

$2CO + O_2 \rightarrow 2CO_2$

2. Decomposition Reaction

It is breaking up of a substance into simpler compounds by the application of various forms of heat, light, electricity etc.

(i) A decomposition reaction that is carried out by the application of heat is known as **thermal decomposition**.
For eg.

$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

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

Find it

Q. How the colour changes when the gases after thermal decomposition of ferrous sulphate come in contact with an acidified solution of potassium dichromate?

(ii) Decomposition reactions that is carried out by the application of electricity is known as **electrolysis**.
For eg.

$2NaCl \xrightarrow{\text{Electricity}} 2Na + Cl_2$

$2Al_2O_3 \xrightarrow{\text{Electricity}} 4\,Al + 3O_2$

(iii) The decomposition reaction that is carried out by the application of light is known as **photo decomposition**.
For eg.

$2AgBr \xrightarrow{\text{Light}} 2Ag + Br_2$

$2AgCl \xrightarrow{\text{Light}} 2Ag + Cl_2$

Example

Q. Give an example each for thermal decomposition and photochemical decomposition reactions. Write relevant balanced chemical equations also.

Ans. Thermal decomposition reaction:

$$\underset{\substack{\text{Copper carbonate}\\(\text{Green})}}{CuCO_3(s)} \xrightarrow{\text{Heat}} \underset{\substack{\text{Copper oxide}\\(\text{Black})}}{CuO(s)} + CO_2(g)$$

Photochemical decomposition reaction:

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

Mind it

- ❒ Photolysis of AgBr/AgCl is used in black and white photography.
- ❒ Decomposition reaction is just opposite of the addition reaction.
- ❒ AgCl is stored in dark coloured bottles to avoid decomposition of AgCl in presence of light.

NCERT Corner

1. On heating blue coloured powder of copper (II) nitrate in boiling tube, copper oxide (black), oxygen gas and a brown gas 'A' is formed.

(a) Write a balanced chemical equation of the reaction.

(b) Identify the brown gas 'A' evolved.

(c) Identify the type of reaction.

(d) The pH range of aqueous solution of the gas 'A'?

Ans. (a) $\underset{\text{Copper (II) nitrate (Blue)}}{2Cu(NO_3)_2(s)} \xrightarrow{\text{heat}} \underset{\text{Copper oxide (Black)}}{2CuO(s)} + \underset{\text{'A' Nitrogen dioxide (Brown)}}{4NO_2(g)} + O_2(g)$

(b) The brown gas 'A,' is nitrogen dioxide (NO_2).

(c) The reaction is a thermal decomposition reaction.

(d) The gas 'A' is acidic in nature because it is a non-metallic oxide. Its aqueous solution has pH less than 7

2. 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 whose solution in water is used for white washing is calcium oxide (or quick lime). Its formula is CaO.

(ii) $\underset{\text{Calcium oxide (Quick lime)}}{CaO(s)} + H_2O(l) \longrightarrow \underset{\text{Calcium hydroxide (Slaked lime)}}{Ca(OH)_2(aq)}$

3. Why is the amount of gas collected in one of the test tubes in text book Activity 1.7 (NCERT Book) double of the amount collected in the other? Name this gas.

Ans. In Activity 1.7, water is electrolysed to give H_2 gas at one electrode and oxygen, gas at the other electrode.

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

Hence, the amount of hydrogen gas collected would be double than that of oxygen gas.

3. Displacement Reactions

This reaction involves displacement of one of the elements of a compound by another substance that is placed above in activity series.

For eg.

1. Zinc displaces hydrogen from sulphuric acid.
   $Zn\ (s) + \text{dil. } H_2SO_4\ (aq) \longrightarrow ZnSO_4\ (aq) + H_2\uparrow$
2. Iron displaces copper from a copper sulphate solution.
   $Fe\ (s) + CuSO_4(aq) \longrightarrow FeSO_4\ (aq) + Cu$

Mind it

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

Test Prep

The Reactivity Series of Metals

The reactivity series of metals is a chart listing metals in order of decreasing reactivity. In general, the more reactive a metal is:

- ❒ The more vigorously it reacts with other substances.
- ❒ The more easily it loses electrons to form positive ion.
- ❒ The metals at the top of the reactivity series are powerful reducing agents since they are easily oxidized.
- ❒ All metals that are found above hydrogen in the activity series liberate H_2 gas upon reacting with dilute HCl or dilute H_2SO_4.

Reactivity series of metals

K	Potassium	Most reactive
Na	Sodium	
Ca	Calcium	
Mg	Magnesium	
Al	Aluminium	
Zn	Zinc	Increasnigly reactive
Fe	Iron	
Sn	Tin	
Pb	Lead	
H	Hydrogen	
Cu	Copper	
Hg	Mercury	
Ag	Silver	
Au	Gold	Least reactive

4. Double Displacement

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

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

Mind it

Acid base neutralisation reactions are double displacement reactions.

Test Prep

Based on the velocity of chemical reactions, the reactions are classified into three types:

a. Very fast (or) instantaneous reactions

The chemical reactions that are completed within the fraction of seconds are known as very fast reactions.

Example:

1. Neutralization between strong acids and strong bases.
   $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

b. Moderate reactions

The chemical reactions that are completed within hours (or) minutes are known as moderate reactions.

Example:

1. Inversion of cane sugar
   $C_{12}H_{22}O_{11}(aq) + H_2O(l) \rightarrow \underset{\text{Glucose}}{C_6H_{12}O_6(aq)} + \underset{\text{fructose}}{C_6H_{12}O_6(aq)}$

c. Very slow reactions

The chemical reactions that complete in very long time are known very slow reactions.

Example:

1. Rusting of Iron in presence of air and moisture
   $4Fe + 3O_2 + xH_2O \rightarrow 2Fe_2O_3.xH_2O$

Reversible and irreversible chemical reaction

In a reversible chemical reaction, reactants combine to form products, and these products react within themselves to produce the reactants again.

As the products and reactants are constantly under reaction, reversible reactions never come to a state of completion.

In a reversible reaction, the forward reaction, the conversion of reactants into products, is often incomplete even after the reaction runs for a long time.

It is shown by $\rightleftharpoons$

Example

$$\underset{\text{Nitrogen}}{N_2} + \underset{\text{Hydrogen}}{3H_2} \rightleftharpoons \underset{\text{Ammonia}}{2NH_3}$$

$$\underset{\text{Nitrogen}}{N_2} + \underset{\text{Oxygen}}{O_2} \rightleftharpoons \underset{\text{Nitric oxide}}{2NO}$$

Irreversible chemical reaction

In an irreversible chemical reaction, reactants combine to form products, but these products cannot produce the reactants under similar conditions.

All the reactants react completely to form the product

Example

$$\underset{\text{Zinc}}{Zn} + \underset{\text{Sulphuric acid}}{H_2SO_4} \longrightarrow \underset{\text{Znic sulphate}}{ZnSO_4} + \underset{\text{Hydrogen}}{H_2}$$

$$\underset{\text{Magnesium}}{2Mg} + \underset{\text{Oxygen}}{O_2} \xrightarrow{\Delta} \underset{\text{Magnesium oxide}}{2MgO}$$

5. Oxidation and Reduction

Oxidation

It is a chemical reaction in which a substance gains oxygen or loses hydrogen. As O_2 is an electronegative element and H_2 is an electropositive element. Thus, oxidation is defined as a reaction in which a substance gains an electronegative ion or loses an electropositive ion.

(i) Example: Gain of oxygen atom in below equation

$$S + O_2 \longrightarrow SO_4$$

$$2SO_2 + O_2 \longrightarrow 2SO_3$$

(ii) Gain a electronegative ion

For eg. $Mg + Cl_2 \longrightarrow MgCl_2$

(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 element.

For e.g. $2KI + H_2O_2 \longrightarrow 2KOH + I_2$

Reduction

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

(i) Gain of hydrogen in the below equation.

For eg. $Cl_2 + H_2S \longrightarrow 2HCl + S$

$$O_2 + 2H_2 \longrightarrow 2H_2O$$

(ii) Gain of any electropositive element.

For eg. $CuCl_2 + Cu \longrightarrow Cu_2Cl_2$

(iii) Removal of oxygen atom.

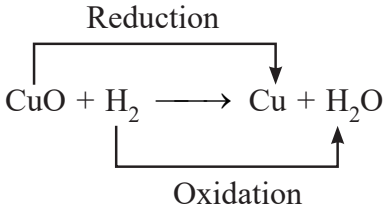
For eg. $ZnO + C \longrightarrow Zn + CO$

(iv) Loss of electronegative ion.

For eg. $Fe_2(SO_4)_3 + H_2 \longrightarrow 2FeSO_4 + H_2SO_4$

Redox Reactions

Reduction is loss of electronegative element or ions. The oxidation and reduction occur simultaneously, i.e. there can be no oxidation without and equivalent reduction. In a reaction when one substance is oxidised the other is reduced and vice-versa. Those reactions in which oxidation and reduction take place simultaneously are known as **redox reactions.**



When hydrogen gas is passed through hot cupric oxide, hydrogen is oxidised to water (H_2O) while cupric oxide is reduced to metallic copper by the loss of oxygen. H_2 helps in reduction of cupric oxide to metallic copper so it is act as reducing agent, where as cupric oxide helps in oxidation of hydrogen so it is acts as oxidizing agent. A substance, that brings about reduction, is known **reducing agent**. A substance, that brings about oxidation, is known an **oxidizing agent**.

Test Prep

Oxidation Number

It is defined as an imaginary or apparent charge developed over atom of an element when it goes from its elemental free state to combined state in molecules.

Rules to Determine Oxidation State

In uncombined state or free state, oxidation number of an element is zero (H_2, O_2, Cu, Zn, S).

In combined state, oxidation number of-

- F is always –1
- O is –2 in oxide, (–O–O–) in peroxide it is –1, in superoxide it is –1/2 . However in F_2O it is +2.
- H is +1, in ionic hydrides it is –1.
- Metal is always positive.
- Alkali metal (Li, Na, K) is always +1.
- Alkaline earth metal (Be, Mg, Ca, is always +2).
- Halogen in halide is –1, sulphur in sulphides is –2.
- The sum of oxidation number of all the elements is equal to zero.
- For ionic species sum is equal to total cationic or anion charge.

Note: Oxidation state of some of the compounds is to be determined by their structure.

Oxidation in terms of electrons transfer

The electronic concept explains the oxidation on the basis of electron transfer. According to octet rule, atom that 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 ios, the neutral sodium loses an electron and becomes positively charged sodium ion. Sodium is said to be oxidised.

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

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

Thus oxidation is a process that involves loss of electron.

Reduction in terms of electrons transfer

Reduction is a process that involve the gain of electrons and is the reverse of oxidation.

For example

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

$2Mg + O_2 \longrightarrow 2MgO$

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

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

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

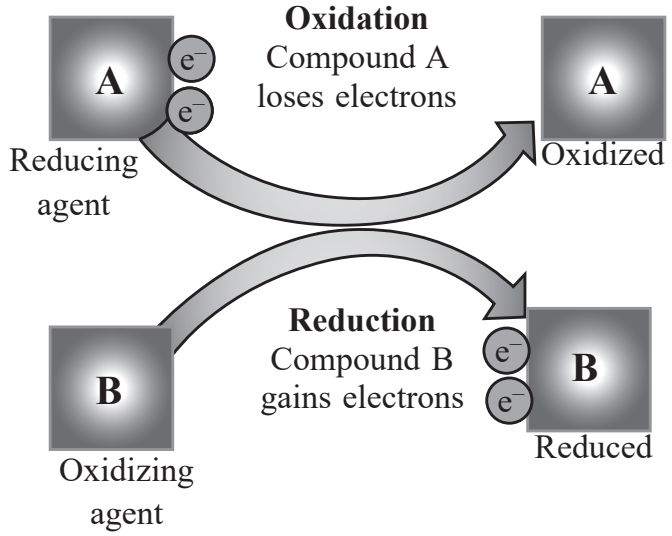


Fig. 3: Oxidation and reduction in terms of electronic concept.

Mind it

According to electronic concept, Oxidation is Loss of electrons.

Reduction is Gain of electrons

Test Prep

Spectator ions

Species that are present in the solution but do not take part in the reaction that occurs and they are omitted in writing the net ionic reaction.

$Zn + 2H^+ + 2Cl^- \rightarrow Zn^{2+} + 2Cl^- + H_2$

Cl^- ions are omitted. These omitted ions are called as spectator ions or bystander ions, in order to indicate that they do not take part in the reaction. The spectator ions appear on the reactant as well as on the product side.

Example

Q. Give one example of a redox reaction that is also a combination reaction.

Ans. $2Mg + O_2 \rightarrow 2MgO$

Test Prep

Types of Redox Reactions

1. **Chemical combination reactions**

   $A + B \rightarrow AB$

   Examples:

   $\overset{0}{C}(s) + \overset{0}{O_2}(g) \rightarrow \overset{+4}{C}O_2^{-2}(g)$

2. **Decomposition reactions**

   $AB \rightarrow A + B$

   Eg: $2\overset{+1}{K}\overset{+5}{Cl}O_3^{-2} \rightarrow 2\overset{+1}{K}\overset{-1}{Cl} + 3O_2^0$

3. **Displacement reactions**

   $A + BC \rightarrow AC + B$

   $\overset{0}{Zn}(s) + \overset{+2}{Cu}SO_4^{-2}(aq) \rightarrow \overset{+2}{Zn}SO_4^{-2}(aq) + \overset{0}{Cu}(s)$

4. **Disproportionation Reaction**

   One of the reactants in a disproportionation reaction always contains **an element that can exist in at least three oxidation states**. The element in the form of reacting substance is in the intermediate oxidation state and both higher and lower oxidation states of that element are formed in the reaction. For example:

   $2H_2\overset{-1}{O_2}(aq) \rightarrow 2H_2\overset{-2}{O}(l) + \overset{0}{O_2}(g)$

List of some important disproportionation reactions

- $P_4 + OH^- \rightarrow PH_3 + H_2PO_2^-$
- $S_8 + OH^- \rightarrow S^{2-} + S_2O_3^{2-}$
- $MnO_4^{2-} \rightarrow MnO_4^- + MnO_2$
- $2Cu^+ \rightarrow Cu^{2+} + Cu^0$

To balance a redox reaction two methods are used.

These are

(I) Oxidation number method

1. First of all the oxidation number of every atom is to be identified.
2. The change in oxidation number for each atom that changes is to be determined.
3. Then the total increase in oxidation number is to be made equal to the total decrease in oxidation number
4. Then place these numbers as the coefficients in front of the formulas containing those atoms
5. Then all remaining atoms other than H and O are to be balanced.
6. Then O and H are balanced.

Example, balance the equation

$$HNO_3 + H_3AsO_3(aq) \rightarrow NO(g) + H_3AsO_4(aq) + H_2O(l)$$

Steps:

1. On Left hand side the elements with their oxidation no. is: H = +1; N = +5; O = –2; As = +3
   O.N of element on Right hand side: N = +2; O = -2; H = +1; As = +5
2. N: +5 → +2; Change in oxidation state of N = –3
   As: +3 → +5; Change in oxidation state of As = +2
3. We require 2 atoms of N for every 3 atoms of As. This will gives us total changes of –6 and +6
4. Coefficient in front of formula contains those atoms are placed $2HNO_3 + 3H_3AsO_3(aq) \rightarrow 2NO(g) + 3H_3AsO_4(aq) + H_2O(l)$
5. Then H and O are balanced at the end.

(II) Balancing Redox Reaction by Ion electron Method (Half reaction method)

Steps:

1. The complete reaction are split into two half-reactions, one will represent oxidation and the other represent reduction.
2. Firstly all the atoms other than 'O' and 'H' atoms are balanced.
3. In acidic or neutral medium balance oxygen atoms are balanced by adding H_2O molecule and H-atoms are balanced by adding H^+ ions.
4. In an alkaline medium, the O atom is balanced by adding H_2O molecule and an equal number of OH^- ions are added on the opposite side, H^+ atoms are still unbalanced so add OH^-
5. Balance the charges by the addition of electrons.
6. Multiplication is done with a help of suitable integer such that the number of electrons will gets cancelled.
7. At last both the half-reactions are added, similar terms are subtracted and the final balanced equation is written.

NCERT Corner

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

OR

An iron nail is dipped in the solution of copper sulphate for about 30 minutes. State the change in colour observed. Give reason for the change.

Ans. When an iron nail is dipped in $CuSO_4$ solution, the displacement reaction takes place. The colour of copper sulphate solution fades due to the formation of pale green solution of iron sulphate ($FeSO_4$).

$$\underset{\text{(Blue solution)}}{Fe(s) + CuSO_4(aq)} \longrightarrow \underset{\text{(Greenish solution)}}{FeSO_4(aq) + Cu(s)}$$

2. Give an example of a double displacement reaction other than the one given in Activity 1.10 (NCERT Text Book).

Ans. Sodium hydroxide and hydrochloric acid react to form sodium chloride and water.

$$\underset{\text{Sodium hydroxide}}{NaOH(aq)} + \underset{\text{Hydrochloric acid}}{HCl(aq)} \longrightarrow \underset{\text{Sodium chloride}}{NaCl(aq)} + \underset{\text{Water}}{H_2O(l)}$$

3. Identify the substances that are oxidised and the substances which are 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) Substances that oxidised is Na as it gains oxygen and oxygen is reduced.

(ii) Substances that reduced is CuO as hydrogen is oxidised as it gains oxygen.

Effect of Oxidation Reactions in Everyday Life

Oxygen is most essential element that is important for sustaining life. O_2 is involved in a variety of process that have wide range of effects on our day to day life. Some of these effects are-

1. Combustion Reactions

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

$$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$$

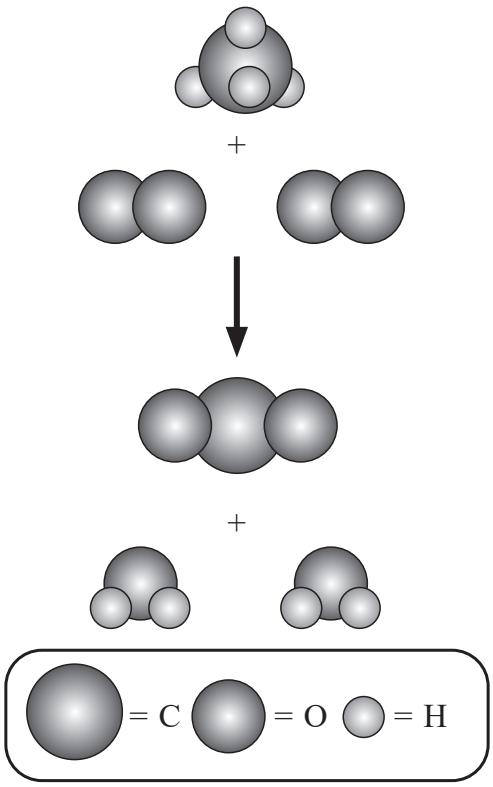


Fig. 4: The reaction between methane and oxygen.

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

$$\underset{\text{Butane}}{C_4H_{10}}\ (g) + 13/2O_2(g) \longrightarrow 4CO_2(g) + 5H_2O$$

All combustion reactions are example of exothermic reaction and are accompanied by release of heat energy. The carbohydrates such as glucose, fructose, starch etc. are the major source of energy to the human body. They undergo combustion with the help of O_2 that we inhale to form carbon dioxide and water. For example.

$$C_6H_{12}O_6(s) + 6O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(l) + \text{energy}$$

Generally all combustion reactions are not accompanied by flame. Combustion is usually oxidation along with release of energy.

Mind it

The decomposition of vegetable matter into compost is also an example of an exothermic reaction.

2. Respiration

- ❒ Respiration is the most important biochemical process that releases energy in the cells.
- ❒ When we inhale, oxygen enters our lungs and passes into thousands of smalls air sacs known as alveoli. These air sacs occupys a large area of membranes and O_2 diffuses from the membranes into blood. It attach itself to haemoglobin present in red blood cells (RBC) and is carried out to various cells in the body.
- ❒ Respiration process occurs in these cells along with the combustion of glucose producing carbon dioxide and water.

  $C_6H_{12}O_6(aq) + 6O_2(aq) \rightarrow 6CO_2(aq) + 6H_2O(l) + \text{energy}$

  (Glucose) (Carbon dioxide)
- ❒ As the reaction is exothermic reaction, the energy released during respiration process carry out many cell reactions and also keeps our heart and muscles working.
- ❒ Both carbon dioxide and water are pass back into the blood and we finally breathe them out.
- ❒ Respiration takes place in the cells of all living beings.

Mind it

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

3. Corrosion

Corrosion is defined the process of deterioration of the surfaces of metals when kept in open for a long period of time and metal get converted into oxide, sulphide etc.

Few examples of corrosion are: black coating on the surface of silver and green layer on the surface of copper. In case of iron, corrosion is known rusting. Rust is a chemical substance that brown in colour and is produced by the chemical action of moist air (containing O_2 and H_2O) on iron. It is usually 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.

$$4Fe + 3O_2 + 2xH_2O \rightarrow 2Fe_2O_3.xH_2O$$

Both corrosion and rusting are very harmful and damage the building, Railway tracks, cars and other objects/ materials where metals are used are damaged due to rusting. We have heard that an old building has collapsed on its own causing loss of both lives and property.

Mind it

Unreactive metals such as gold, platinum, palladium, titanium etc. corrode negligibly and thus are called native metals.

Find it

Q. Silver articles become black when exposed to air. It is due to the formation of which compound

4. Rancidity

When the fats and oils present in butter and margarine are oxidised, they become rancid on prolonged exposure in air. As a result, their smell and taste change. They become quite unpleasant. This process is known as rancidity. Rancidity can be prevented by below measures.

Prevention of Rancidity

- ❒ Manufacturer sometimes add certain food additives to the food materials. These are known as antioxidant and check their oxidation.
- ❒ Food should be kept in air tight containers to prevent its oxidation.
- ❒ Refrigeration of food also retards rancidity as the temperature inside refrigerator is very low and direct contact with air or oxygen is avoided.
- ❒ Chips manufacturers usually fills their bags with nitrogen gas (as it is unreactive gas) before packing so that they may not be oxidised.

Mind it

Common antioxidations are:

(a) BHA (Butylated Hydroxy Anisole)

(b) BHT (Butylated Hydroxy Toluene)

Vitamin-E and vitamin-C (ascorbic acid) are the two naturally occuring antioxidants.

Find it

Q. Potato chips manufacturers fill the packet of chips with nitrogen gas. Why?

Test Prep

Application of Redox Reaction

Redox Reaction in Combustion

Combustion is a type of oxidation-reduction reaction and hence it is a redox reaction. An explosion is a fast form of combustion and hence explosion can be treated as a redox reaction. Even the space shuttle uses redox reactions. The combination of ammonium perchlorate and powdered aluminium inside the rocket boosters gives rise to an oxidation-reduction reaction.

Applications in Photosynthesis

Green plants convert water and carbon dioxide into carbohydrates and this process is defined as photosynthesis. The reaction is given as

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

In the above reaction, we can see that carbon dioxide is reduced to carbohydrates while the water gets oxidized to oxygen and hence it is a redox reaction. The energy is provided by the sunlight for this reaction. This reaction is a source of food for animals and plants.

Summary

Chemical Reaction

When a chemical change occurs, a chemical compound is formed and it is known as chemical reaction. A chemical change or chemical action is shown by chemical equation.

Characteristics of a Chemical Reaction

(i) Evolution of gas

(ii) Change of colour

(iii) Formation of precipitate

(iv) Energy changes

(v) Change of state

Representation of chemical reaction using symbols and formulae of the substances is called **Chemical Equation**.

Example: $A + B \rightarrow C + D$

Types of Chemical Equations

(i) Word equations: A word equation links together the names of the reactants with those of the products. For example, Magnesium + Oxygen $\longrightarrow$ Magnesium oxide

(ii) Symbol equation: A short representation of a chemical reaction in terms of symbols and formulae of the substance involved is known as a symbol equation Eg $Mg + O_2 \longrightarrow 2MgO$

Unbalanced and Balanced Chemical Equations

In an **unbalanced equation**, the number of atoms of different elements that are on both side of the equation are not equal. It is also known as **skeletal reaction**.

In a **balanced** equation, the number of different elements on both sides of the equation are always equal.

Importance of balanced chemical equation: The balancing of a chemical equation is essential to satisfy the requirement of "Law of conservation of mass".

The balancing of a chemical equation is done with the **Hit and Trial method.** In this method, the coefficients before the symbols or formulae of the reactants and products are placed in such a way that the total number of atoms of each element on both the side of the equation had become equal.

For e.g., $Fe + H_2O \longrightarrow Fe_2O_3 + H_2$ can be written as

$$3\ Fe(s) + 4H_2O(g) \longrightarrow Fe_2O_3(s) + 4H_2(g)$$

Types of Chemical Reaction

1. **Combination Reactions:** It is a addition or combination of two or more than two substances to from a new substance.

   $CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2\ (aq)$

2. **Decomposition Reaction:** It is breaking up of a substance into simpler compounds and it is done by the application of heat, light, electricity etc.

   $2AgBr + \text{sunlight} \longrightarrow 2Ag(s) + Br_2(g)$

3. **Displacement Reactions:** It involves displacement of one of the elements of a compound by another substance that is placed above in activity series.

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

4. **Double Displacement:** It is mutual exchange of the ions of two compounds that takes part in the reaction and results in the formation of two new compounds

   $Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4(s) + 2NaCl$

   Precipitation reaction: It is a type of double displacement reaction in which precipitate formation takes place.

5. **Oxidation and Reduction:** 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,

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

   A substance, which brings about reduction, is called **reducing agent**. Examples: Li,Zn

   A substance, which brings about oxidation, is called an **oxidizing agent**. Examples: F_2, O_2

   Redox Reaction: The reaction in which one reactant gets oxidised while other gets reduced

   $ZnO + C \longrightarrow Zn + CO$

   $MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$

Effects of Oxidation Reactions in Our Daily Life

Corrosion: When a metal is attacked by substances around it such as moisture, acids etc. eg. Reddish brown coating on iron.

Prevention: Use a coating or barrier product such as grease, oil, paint or carbon fibre coating.

Rancidity: When fats and oils are oxidised they become rancid and their smell and taste change.

Prevention: Antioxidants are added to foods containing fats and oil.

Quick Recall

Fill in the blanks

1. Reaction in which an element displaces another element from its compound is called _____
2. Two antioxidants which are usually added to fat and oil containing foods to prevent rancidity, are _____ , _____ .
3. $SO_2 + 2H_2S \rightarrow 2H_2O + 3S$; SO_2 is acting as _____ agent.
4. $Na_2SO_4 + BaCl_2 \rightarrow$ _____ + 2NaCl
5. Precipitation reactions produce insoluble _____
6. A balanced chemical equation has equal masses of various elements in _____ and _____
7. _____ is the process in which metals are eaten up gradually by the action of air, moisture or a chemical on their surface.
8. The colour of $FeSO_4$ crystal before heating is _____ and after heating is _____ .
9. Reactions in which energy is given out are known as _____ .
10. $2KClO_3 \xrightarrow[MnO_2]{\Delta} 2KCl + 3O_2$
    is an example of _____ reaction.

True and False Statements

1. Rusting is a double decomposition reaction.
2. The reaction between nitrogen and hydrogen to give ammonia is an example of a combination reaction.
3. A magnesium ribbon burns with a dazzling flame in air (oxygen) and changes into a white substance, magnesium oxide.
4. Curdling of milk is a physical change.
5. A chemical reaction cannot be reversed.
6. The formation of Cu and H_2O the reaction of copper oxide is an example of a redox reaction.
7. The number of atoms of each element is conserved in any chemical reaction.
8. The reaction of nitrogen and hydrogen gives ammonia. This is an example of a decomposition reaction.
9. Reduction is the gain of electrons by a substance.
10. A complete chemical equation represents the reactants, products and their physical states symbolically.
11. Oxidation is the loss of electrons from a substance.

Match The Followings

In this section, each question has two matching lists. Choices for the correct combination from Column-I and Column-II are given as options (a), (b), (c) and (d) out of which one is correct.

1. For the given reaction, match column I with column II and mark the correct option from the codes given below.

   $Fe_2O_3 + aCO \rightarrow bFe + aCO_2$

	Column I		Column II
(P)	Oxidising agent	(1)	2
(Q)	Reducing agent	(2)	3
(R)	a	(3)	Fe_2O_3
(S)	b	(4)	CO

   a. P–(3); Q–(2); R–(1); S–(4)
   b. P–(4); Q–(3); R–(1); S–(2)
   c. P–(2); Q–(1); R–(3); S–(4)
   d. P–(3); Q–(4); R–(2); S–(1)

2.

	Column I	Column II
(P)	$C + O_2 \longrightarrow CO_2$	(1) Displacement
(Q)	$2AgCl \xrightarrow{light} 2Ag + Cl_2$	(2) Combination
(R)	$Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$	(3) Decomposition
(S)	$CH_3CH_2OH \xrightarrow{Cu} CH_3CHO + H_2$	(4) Oxidation

   a. P–(3); Q–(2); R–(4); S–(1)
   b. P–(2); Q–(3); R–(1); S–(4)
   c. P–(4); Q–(1); R–(3); S–(2)
   d. P–(1); Q–(3); R–(4); S–(1)

3.

Column-I	Column-II
(P) $\rightarrow$	(1) Aqueous
(Q) (g)	(2) Gives
(R) Δ	(3) Heat
(S) (aq)	(4) Evolution of gas

a. P–(3); Q–(1); R–(4); S–(2)

b. P–(2); Q–(3); R–(1); S–(4)

c. P–(2); Q–(4); R–(3); S–(1)

d. P–(4); Q–(3); R–(1); S–(2)

4.

Column I	Column II
(P) Combination reaction	(1) Synthesis reaction
(Q) Oxidation of iron	(2) Splitting-up of reactants
(R) Displacement reaction	(3) Combustion reaction
(S) Decomposition	(4) Substitution reaction

a. P–(3); Q–(1); R–(2); S–(4)

b. P–(4); Q–(2); R–(3); S–(1)

c. P–(1); Q–(3); R–(4); S–(2)

d. P–(2); Q–(1); R–(3); S–(4)

5.

Column I	Column II
(P) $2Ca + O_2 \longrightarrow$	(1) 2HCl
(Q) $4Fe + 3O_2 \xrightarrow{\text{moisture}}$	(2) 2CaO
(R) $H_2 + Cl_2 \xrightarrow{hv}$	(3) $2Fe_2O_3$
(S) $2Fe + 3Cl_2 \longrightarrow$	(4) $2FeCl_3$

a. P-(3); Q-(1); R-(2); S-(4)

b. P-(4); Q-(3); R-(1); S-(2)

c. P-(2); Q-(1); R-(3); S-(4)

d. P-(2); Q-(3); R-(1); S-(4)

Answers

Fill in the Blanks

1. displacement reaction **2.** BHA, BHT

3. oxidising **4.** $BaSO_4$

5. Salts **6.** reactants, products

7. Corrosion **8.** green, reddish brown

9. exothermic reactions **10.** decomposition

True & False

1. False **2.** True **3.** True

4. False **5.** True **6.** True

7. True **8.** False **9.** True

10. True **11.** True

Match the Following

1. (d) **2.** (b) **3.** (c) **4.** (c) **5.** (d)

NCERT Exercise

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

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

(i) Lead is getting reduced.

(ii) Carbon dioxide is getting oxidised.

(iii) Carbon is getting oxidised.

(iv) Lead oxide is getting reduced.

a. (i) and (ii) **b. (i) and (iii)**

c. (i), (ii) and (iii) **d. All**

Exp. (a) PbO reduces to Pb and C oxidises into CO_2.

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

The above reaction is an example of a

a. Combination reaction

b. Double displacement reaction

c. Decomposition reaction

d. Displacement reaction

Exp. (d) Aluminium (Al) being more reactive than iron (Fe) displaces iron from Fe_2O_3 and results in the formation of aluminium oxide and iron.

3. What happens when dilute hydrochloric acid is added to iron filings ? Tick 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.

Exp. (a) $Fe + dil.2HCl \rightarrow FeCl_2 + H_2\uparrow$

Hydrogen gas and iron chloride are produced.

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

Exp. A balanced chemical equation contains an equal number of atoms of different elements in the reactants and products side of a chemical equation..

The chemical equations should be balanced in order to satisfy the law of conservation of mass

That say total mass of element in product = Total mass of element in reactants.

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.

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

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

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

(d) $2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2\ (g)$

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) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + HCl$

Exp. (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) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

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

Exp. (a) $Ca\ (OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

(b) $Zn + 2AgNO_3 \rightarrow Zn(NO_3)_2 + 2\ Ag$

(c) $2Al + 3CuCl_2 \rightarrow 2AlCl_3 + 3\ Cu$

(d) $BaCl_2 + K_2SO_4 \rightarrow BaSO_4 + 2KCl$

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

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

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

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

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

Type of reaction: Double displacement reaction

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

Type of reaction: Decomposition reaction

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

Type of reaction: Combination reaction

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

Type of reaction: Displacement reaction

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

Exp. Reactions in which heat is released are known as exothermic reactions. This reaction is represented by writing "+ Heat"on the products side of an equation.

Example:

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

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

Reactions in which heat is absorbed are known as endothermic reactions. This reaction is represented by writing "-Heat" on the product side of a chemical equation.

Examples :

(i) $C(s) + 2S(s) \rightarrow CS_2(l) - Heat$

(ii) $N_2(g) + O_2(g) \rightarrow 2NO(g) - Heat$

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

Exp. Respiration is considered an exothermic process because in respiration process glucose combines with oxygen in the cells of our body to form carbon dioxide and water along with the release of energy.

$$\underset{\text{Glucose}}{C_6H_{12}O_6(aq)} + 6O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(l)$$

+ Energy

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

Exp. In a decomposition reaction, a compound breaks down to give two or more simpler product.

For example:

$$\underset{\text{Water}}{2H_2O(l)} \xrightarrow[\text{(decomposition)}]{\text{Electricity}} 2H_2(g) + O_2(g)$$

Whereas in a combination reaction, two or more substances combine to give a new product.

For example:

$$2H_2(g) + O_2(g) \xrightarrow{\text{Combination}} \underset{\text{Water}}{2H_2O(l)}$$

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

Exp. $$\underset{\text{Calcium carbonate}}{CaCO_3(s)} \xrightarrow{\text{Heat}} CaO(s) + CO_2(g)$$

$$\underset{\text{Silver bromide}}{2AgBr(s)} \xrightarrow{\text{Light}} 2Ag(s) + Br_2(g)$$

$$\underset{\text{Water}}{2H_2O(l)} \xrightarrow{\text{Electricity}} 2H_2(g) + O_2(g)$$

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

Exp. In displacement reactions, a more reactive metal displaces a less reactive metal from its solution. For example,

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

This is a displacement reaction where Fe displaces Cu from its $CuSO_4$ solution.

In double displacement reactions, two reactants in solution mutual exchange their ions. For example,

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

This is a double displacement reaction where silver nitrate $AgNO_3$ and sodium chloride (NaCl) exchange Cl^- and NO_3^- ions mutually between them.

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

Exp. Displacement reaction.

$$\underset{\text{Silver nitrate}}{2AgNO_3(aq)} + \underset{\text{Copper}}{Cu(s)} \longrightarrow \underset{\text{Copper nitrate}}{Cu(NO_3)_2} + \underset{\text{Silver}}{2Ag(s)}$$

15. What do you mean by a precipitation reaction? Explain by giving examples.

Exp. In precipitation reaction, an insoluble solid mass called precipitate is formed that separates out from the solution.

Example: When a solution of iron (III) chloride and ammonium hydroxide reacts with each other, a brown precipitate of iron (III) hydroxide is formed.

$$\underset{\text{Iron (III) chloride}}{FeCl_3(aq)} + \underset{\text{Ammonium hydroxide}}{3NH_4OH(aq)} \longrightarrow \underset{\text{Iron (III) hydroxide}}{Fe(OH)_3(s)\downarrow} + \underset{\text{Ammonium chloride}}{3NH_4Cl(aq)}$$

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

(a) Oxidation and

(b) Reduction.

Exp. (a) Oxidation: The addition of oxygen to a substance is called oxidation.

Example:

(i) $S(s) + O_2(g) \rightarrow SO_2(g)$

(Addition of oxygen to sulphur)

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

(Addition of oxygen to magnesium)

(b) Reduction: The removal of oxygen from a substance is called reduction.

Example:

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

Oxygen gets removed from copper oxide and reduce to Cu.

(ii) $ZnO + C \rightarrow Zn + CO$

Uxygen gets removed from zinc oxide and reduce to zinc.

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.

Exp. The element 'X' is copper (Cu).

The black coloured compound is copper oxide (CuO). The reaction:

$$\underset{\text{Copper (Brown)}}{2Cu} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Copper oxide}}{2CuO}$$

18. Why do we apply paint on iron articles ?

Exp. We apply paint as it does not allow iron articles to come in contact with air, water or moisture and saves them from damage caused due to rusting.

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

Exp. Food items are flushed with nitrogen so to keep food items fresh and prevent from getting oxidised.

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

Exp. (a) Corrosion is a process in which metals are deteriorated slowly slowly by the action of air, moisture or a chemicals (such as an acid) on their surface.

Example: When iron is exposed to moist air for a long span of time, its surface develop a coating of a brown, flaky substance known as rust.

$$4Fe + 3O_2 + 2xH_2O \longrightarrow \underset{\substack{\text{Hydrated iron (III) oxide}\\(\text{Rust})}}{2Fe_2O_3 \cdot xH_2O}$$

(b) Rancidity is a process that is produced by aerial oxidation of fats and oils in foods noticed by an unpleasant smell and taste.

Rancidity spoils the food materials and makes them unfit for eating.

Subjective Questions

Very Short Answer Type Questions

1. What is the colour of the precipitate formed when H_2S is bubbled through copper sulphate solution.
2. Chemical equation balancing is done on what basis.
3. In electrolysis of water, why is the volume of gas collected over one electrode double that of gas collected over the other electrode?
4. Give an example of the following chemical changes.

   An exothemic reaction involving carbon as one of the reactants.
5. H_2 is a highly inflammable gas and O_2 being a supporter of combustion, yet water which is a compound made up of hydrogen and oxygen is used to extinguish fire. Give reason for same.
6. Write the conditions necessary for a chemical change or reaction.
7. What happens chemically when quicklime is added to water filled in a bucket?
8. Define photochemical reaction.
9. Write a balanced chemical equation for the reaction between sodium chloride and silver nitrate indicating the physical state of the reactants and the products.
10. Balance the following chemical equations.

    $Pb(NO_3)_2 \longrightarrow PbO + NO_2 + O_2$
11. What is meant by a chemical reaction?
12. When H_2S reacts with oxidizing agents, what substance is always a product of the reaction.
13. Give the one basic difference between a physical change and a chemical change.
14. Write the chemical reaction where the following changes are observed.
    (a) Gas is evolved
    (b) Colour change is noticed
15. What change in colour is observed when white silver chloride is left exposed to sunlight? State the type of chemical reaction in this change.

Short Answer Type Questions

1. Write balanced chemical equations for the following reactions.
   (i) Silver bromide on exposure to sunlight decomposes into silver and bromine,
   (ii) Sodium metal reacts with water to form sodium hydroxide and hydrogen gas.
2. Complete and balance the following equations:
   (a) $NaOH + \_\_\_\_\_ \longrightarrow Na_2SO_4 + H_2O$
   (b) $Ca(OH)_2 + \_\_\_\_\_ \longrightarrow CaCO_3 + H_2O$
3. (i) Write a balanced chemical equation for process of photosynthesis.
   (ii) When do desert plants take up carbon dioxide and perform photosynthesis?
4. What changes are noticed when a solution of potassium iodide solution is added to a solution of lead nitrate? State the type of reaction. Write a balanced chemical equation to represent the above chemical reaction.
5. A zinc plate was put into a solution of copper sulphate kept in a glass container. It was found that blue colour of the solution gets fader and fader with the passage of time. After few days, when zinc plate was taken out of the solution, a number of holes were observed on it.
   (i) What is the reason for changes observed on the zinc plate.
   (ii) Write the chemical equation for the reaction involved.
6. Convert the following statement into chemical equation and then balance it Barium chloride reacts with aluminium sulphate to give aluminium chloride and a precipitate of barium sulphate. State the two types in which this reaction can be classified.
7. What is meant by redox reaction? Identify the substance oxidised and the substance reduced in the following reactions.
   (i) $2PbO + C \longrightarrow 2Pb + CO_2$
   (ii) $MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$
8. What is the colour of ferrous sulphate crystals? How does this colour change after heating?

9. Using a appropriate chemical equation, justify that some chemical reactions are determined by:

(i) change in colour, (ii) change in temperature.

10. (a) The colour of the precipitate formed when barium chloride solution is mixed with sodium sulphate solution is.

(b) Why does the colour of copper sulphate solution change when an iron nail is dipped in it?

11. Name the reducing agent in the following reaction:

$3MnO_2 + 4Al \longrightarrow 3Mn + 2Al_2O_3$

State which is more reactive, Mn or A1 and why?

Long Answer Type Questions

1. Write a balanced chemical equation for each of the following reactions and also classify them.

(1) Lead acetate solution is treated with dilute hydrochloric acid to form lead chloride and acetic acid solution.

(2) Hydrogen sulphide gas reacts with oxygen gas to form solid sulphur and liquid water.

(3) Iron (III) oxide on heating with carbon monoxide reacts to form solid iron and liberates carbon dioxide gas.

(4) A piece of sodium metal is added to absolute ethanol to form sodium ethoxide and hydrogen gas.

2. (a) Explain the two methods by which food industries prevent rancidity.

(b) Discuss the importance of decomposition reaction in metal industry with three points.

3. Identify the oxidising agent (oxidant) in the following reactions :

(1) $Pb_3O_4 + 8HCl \longrightarrow 3PbCl_2 + Cl_2 + 4H_2O$

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

(3) $CuSO_4 + Zn \longrightarrow Cu + ZnSO_4$

(4) $V_2O_5 + 5Ca \longrightarrow 2V + 5CaO$

(5) $3Fe + 4H_2O \longrightarrow Fe_3O_4 + 4H_2$

4. (a) Define a balanced chemical equation. Why should an equation be balanced?

(b) Write the balanced chemical equation for the following reaction:

(i) Phosphorus burns in presence of chlorine to form phosphorus penta chloride.

(ii) Burning of natural gas.

(iii) The process of respiration.

5. A substance A, that is an oxide of a group 2 element, is used intensively in the cement industry. This element is present in bones also. On treatment with water, it forms a solution which turns red litmus blue. Identify A and also write the chemical reactions involved.

6. (a) Write one example for each of decomposion reaction that is carried out with help of

(i) Electricity (ii) Heat (iii) Light

(b) Why copper can displace silver from silver nitrate solution?

Integer Type Questions

1. What is the oxidation state of oxygen in hydrogen peroxide.

2. What is the oxidation number of Fe in $K_4Fe(CN)_6$.

3. The element fluorine has same oxidation number in all the compounds. What is its oxidation number?

4. What is the oxidation number of chlorine in hypochlorite ion (ClO^-)?

5. What is the oxidation number of carbon in CH_2O.

Multiple Choice Questions

Level-I

1. Silver jewellery becomes black on prolonged exposure to air, it is due to the formation of

a. Ag_2S and Ag_3N b. Ag_2S

c. Ag_3N d. $Ag_2O + Ag_2S$

2. Which of the following solution can be stored in aluminium container?

a. $MgSO_4(aq)$ b. $FeSO_4(aq)$

c. $Cu(NO_3)_2(aq)$ d. $ZnSO_4(aq)$

3. An element X that is on exposing to moist air turns reddish brown and new substance 'Y' is formed. The substance 'X' and 'Y' are

a. X = Fe; Y = Fe_2O_3

b. X = Ag_2S; Y = Ag

c. X = Zn; Y = ZnO

d. X = Mn; Y = Mn_2O_3

4. The blue coloured $CuSO_4$ solution fades away when Mg wire is kept in this solution due to the formation of

a. $CuSO_4$ b. $MgSO_4$

c. $ZnSO_4$ d. No reaction

5. We store silver chloride in dark bottles because it is

a. To avoid action of sunlight

b. A white solid is formed

c. Undergoes displacement reaction

d. None of the above

6. Fatty foods become rancid due to

a. Oxidation b. Corrosion

c. Hydrogenation d. Reduction

7. Copper reacts with nitric acid to give _____

a. Nitrogen dioxide b. Nitrogen pentoxide

c. Nitric oxide d. All of the above

8. Identify the type of reaction taking place in $Fe + CuSO_4 \longrightarrow Cu + FeSO_4$

a. Redox reaction b. Displacement reaction

c. Acid-base reaction d. Both (a) and (b)

9. On addition of which element the blue coloured copper sulphate solution turns into colourless solution

a. Ag b. Au

c. Zn d. Hg

10. Which of the following compound is known as freon?

a. CCl_2F_2 b. $CHCl_3$

c. CF_4 d. CH_2F_2

11. When crystals of lead nitrate are heated strongly in a dry test tube then which of the following change is observed?

a. Crystals immediately melt

b. White fumes will appear in the test tube

c. A brown residue is left

d. A yellow residue is left

12. $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

Identify the substance that is oxidized in the given equation.

a. H_2O b. MnO_2

c. $MnCl_2$ d. HCl

13. State the type of chemical reactions take place when electricity is passed through water?

a. Double displacement b. Synthesis

c. Decomposition d. Displacement

14. Name the products formed when iron filings are heated with dilute hydrochloric acid

a. Fe (III) chloride and water

b. Fe (II) chloride and water

c. Fe (II) chloride and hydrogen gas

d. Fe (III) chloride and hydrogen gas

15. The brown gas evolved on heating of copper nitrate is

a. N_2 b. NO_2

c. O_2 d. N_2O_5

16. Zinc reacts with silver nitrate to form which compounds?

a. $ZnNO_3 + Ag$ b. $AgNO_3 + Zn(NO_3)_2$

c. $Zn(NO_3)_2 + Ag$ d. No reaction

17. $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$. Identify the oxidising agent:

a. MnO_2 b. HCl

c. $MnCl_2$ d. $Ag + Zn(NO_3)_3$

18. $2AgI(s) \xrightarrow{\text{Sunlight}} 2Ag(s) + I_2(g)$

What is the colour of iodine?

a. Green b. Purple

c. Colourless d. Blue

19. A substance 'X' is used in white-washing and is obtained by heating limestone in the absence of air. Identify 'X'.

a. $Ca(OH)_2$ b. $CaOCl_2$

c. CaO d. $CaCO_3$

20. Consider the reaction

$Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$

The above reaction is an example of

a. Combination reaction

b. Double displacement reaction

c. Redox reaction

d. Simple displacement reaction

21. Mg dissolves in hot water to form

a. MgOH b. MgO

c. $Mg(OH)_2$ d. No reaction

22. What happens when copper rod is dipped in iron sulphate solution?

a. Reaction is endothermic

b. Blue colour of copper sulphate solution is obtained

c. No reaction takes place

d. Reaction is exothermic

23. $AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$

Above reaction is

a. Precipitation reaction

b. Double displacement reaction

c. Displacement reaction

d. (a) and (b) Both

24. $CuO + H_2 \longrightarrow H_2O + Cu$ reaction is an example of-

a. Redox reaction b. Synthesis reaction

c. Neutralisation d. Analysis reaction

25. Chemically the 'water gas' is

a. H_2O (gaseous) b. $CO_2 + H_2 + N_2$

c. CH_4 d. $CO + H_2$

26. Which chemical is mixed in butter for preservation?

a. Sodium benzoate b. Vitamin-C

c. BHA d. Sodium stearate

27. A neutralization reaction is a

a. Displacement reaction

b. Double displacement reaction

c. Addition reaction

d. Decomposition reaction

28. The process of respiration is:

a. Displacement reaction that is endothermic

b. Combination reaction that is exothermic

c. Reduction reaction that is endothermic

d. Oxidation reaction that is exothermic

29. When a magnesium ribbon is burnt in air, the ash formed is

a. Yellow b. White

c. Black d. Grey

30. What happens when ferrous sulphate crystals are heated?

a. A gas having the smell of burning sulphur is evolved

b. No reaction

c. Colourless and odourless gas is evolved

d. Brown coloured gas is evolved

Level-II

1. At reaction temperature, which of the given chemical equations, represent the correct states of the reactants and products involved.

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

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

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

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

2. Two test tubes 'A' and 'B' contain aqueous solution of potassium iodide and lead nitrate separately. When these two test-tubes 'A' and 'B' are mixed to each other, results into 'X' and 'Y'. The 'X' and 'Y' are:

a. Yellow ppt, yellow solution

b. Yellow ppt, colourless solution

c. White ppt, black solution

d. Black ppt, colourless solution

3. A substance X reacts with another substance Y to produce the product Z and a gas D. If a mixture of the gas D and ammonia is passed through an aqueous solution of Z, baking soda is formed. The Substance X and Y are

a. HCl and NaOH
b. Na and NH_4Cl
c. HCl and Na_2CO_3
d. Na_2CO_3 and $NaHCO_3$

4. A student added dilute hydrochloric acid to a test tube containing Zn granules and notice the following observation

(i) The zinc surface became dull and black.
(ii) A gas evolved which burnt with a pop sound.
(iii) The solution remained colourless.

Correct observations regarding the above experiment are-

a. (ii) and (iii)
b. (i) and (iii)
c. (i) and (ii)
d. All three

5. Which of these statements(s) is/are correct?

(i) Rusting is a process in which double decomposition reaction take place.
(ii) Silver salt are usually sensitive to light.

a. (i) only
b. (ii) only
c. Both (i) and (ii)
d. Neither (i) nor (ii)

6. A is a yellow coloured non-metal, when A is burnt it produces a pungent smelling gas B. Gas B gets mixed with rain water to cause acid rain, which is harmful for building and crops both. Identify A and B.

a. Na, NaOH
b. C, CO_2
c. N_2, NH_3
d. S, SO_2

7. The element 'A' reacting with chlorine forms a compound that is water soluble and having high melting point. Element 'A' is

a. Mg
b. Ne
c. CO_2
d. He

8. Which of the following reaction represent endothermic process?

a. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
b. $CaCO_3 \rightarrow CaO + CO_2$
c. $C + O_2 \rightarrow CO_2$
d. $CaO + H_2O \rightarrow Ca(OH)_2$

9. The following reactions are given below:

(A) $Cu + I_2 \rightarrow CuI_2$ (B) $Fe + S \rightarrow FeS$

Which of the given reactions is/are redox reactions?

a. Only (A)
b. Neither (A) nor (B)
c. Both (A) and (B)
d. Only (B)

10. Which one of the following statements is correct regarding the below reaction?

$2FeCl_2 + Cl_2 \rightleftharpoons 2FeCl_3$

a. $FeCl_2$ is an oxidizing agent
b. Cl_2 is a reducing agent
c. Cl_2 is an oxidizing agent
d. $FeCl_3$ is an oxidizing agent

11. Which among the following statement(s) is(are) true? Silver chloride on exposing to sunlight for a long period of time turns grey due to

(i) The formation of silver by decomposition of AgCl
(ii) Sublimation of AgCl
(iii) Decomposition of chlorine gas from AgCl
(iv) Oxidation of AgCl

a. (i) only
b. (i) and (iii)
c. (iv) only
d. (ii) and (iii)

12. $O_2(g) + H_2(g) \longrightarrow H_2O(g)$.

The given reaction is an example of

1. Oxidation of H_2
2. Reduction of O_2
3. Reduction of H_2
4. Redox reaction

a. 1, 2 and 3
b. 1, 2 and 4
c. 1, 3 and 4
d. 2, 3 and 4

13. What is the product (Z) in the following reaction series

$$CH_3CN \xrightarrow{Na/C_2H_5OH} (X) \xrightarrow{HNO_2} (Y) \xrightarrow{[O]} (Z)$$

a. CH_3COOH
b. CH_3CONH_2
c. CH_3CHO
d. CH_3CH_2NHOH

14. When hydrogen sulphide gas is passed through a blue solution of copper sulphate, a black ppt. of copper sulphide is obtained and the sulphuric acid that is formed remains in the solution. The reaction is an example of

a. An addition reaction
b. A redox reaction
c. A decomposition reaction
d. A double decomposition reaction

15. A dilute solution of sodium carbonate which was added to two test-tubes-one containing dil HCl(I) and the other containing dilute NaOH(II). The correct observation regarding the reaction was:

a. A colourless gas liberated in test-tube I
b. A colourless gas liberated in test-tube II
c. A brown coloured gas liberated in test-tube I
d. A brown coloured gas liberated in test-tube II

16. Consider the following statements:

(i) Oxidation is process in which loss of electrons from a substance take place

(ii) Reduction is process in which electron is gained by the substance.

(iii) The formation of Na^+Cl^- by the action of sodium and chlorine is an example of a redox reaction.

Which of these statements(s) is/are correct?

a. (i) and (ii) b. (i) and (iii)

c. (ii) only (iii) d. All are correct

17. On passing CO_2 in excess in aqueous solution of sodium carbonate the compound that is formed is:

a. NaCl b. $NaHCO_3$

c. Na_2CO_3 d. $Na_2CO_3.H_2O$

18. The equation

$Mg(s) + CuO(s) \rightarrow MgO(s) + Cu(s)$ represents which type of reaction

(i) Decomposition reaction

(ii) Displacement reaction

(iii) Addition reaction

(iv) Neutralization reaction

(v) Redox reaction

a. (ii) and (v) b. (iii) and (iv)

c. (i) and (ii) d. (iv) and (v)

19. For the balanced equation given below:

$aP_4 + bCl_2 \rightarrow cPCl_5$, the value of a, b, c are

a. 1, 2, 2 b. 1, 10, 4

c. 2, 3, 4 d. 1, 3, 4

Assertion & Reason Type Questions

Direction: In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice.

a. Both A and R are individually true and R is the correct explanation of A:

b. Both A and R are individually true but R is not the correct explanation of A.

c. A is true but R is false

d. A is false but R is true

1. Assertion: Stannous chloride give grey precipitate with mercuric chloride, but stannic chloride does not do so.

Reason: Stannous chloride is a powerful oxidising agent which oxidises mercuric chloride to mercury.

2. Assertion: Corrosion of iron is called as rusting.

Reason: Corrosion of iron occurs in presence of air and water.

3. Assertion: In the given reaction,

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

Zn acts as a reductant but itself gets oxidised.

Reason: In a redox reaction, oxidant gets reduced by accepting electrons and reductant gets oxidized by losing electrons.

4. Assertion: Quicklime reacts vigorously with H_2O and release a large amount of heat.

Reason: The above chemical reaction is an example of an exothermic reaction.

5. Assertion: Photosynthesis is considered as an example of an endothermic reaction.

Reason: In the process of photosynthesis, energy gets released.

6. Assertion: When CO_2 gas is passed through lime water, a white precipitate is formed initially.

Reason: White preciptate formed is of $CaCO_3$ which is formed during the reaction.

Case-Based Type Questions

Case-Based-I: In redox reaction, oxidation and reduction always occur simultaneously. So, every redox reaction contain two half reactions. One half reaction shows oxidation and other half reaction shows the reduction. Oxidation and reduction of an atom, molecule or ion is defined in terms of electrons transfer between two species. The substance that gains electrons, is reduced to a lower oxidation state and will act as an oxidising agent. Similarly, the substance which loses electrons is oxidisied to a higher oxidation state, and is also known as a reducing agent.

1. In which of the following reactions hydrogen peroxide will act as a reducing agent?

a. $2FeCl_2 + 2HCl + H_2O_2 \rightarrow 2FeCl_3 + 2H_2O$

b. $Cl_2 + H_2O_2 \rightarrow 2HCl + O_2$

c. $H_2SO_3 + H_2O_2 \rightarrow H_2SO_4 + H_2O$

d. $2HI + H_2O_2 \rightarrow 2H_2O + I_2$

2. The following reaction: $H_2S + H_2O_2 \rightarrow S + 2H_2O$ will represent which type of nature of H_2O_2.

a. Oxidising nature of H_2O_2

b. Reducing nature of H_2O_2

c. Alkaline nature of H_2O_2

d. Acidic nature of H_2O_2

3. In presence of acidic medium Mn^{7+} changes to Mn^{2+}, it is

a. Oxidation by 3 electrons

b. Reduction by 5 electrons

c. Oxidation by 4 electrons

d. Reduction by 7 electrons.

Case-Based-II: Combination reactions has greater number of application in the manufacturing of some industrial based important compounds such as

- Ammonia (NH_3) is produced by Haber's process for industrial use.
  $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
- Industrial preparation of nitric acid by ostwald's process
  $4NO_2(g) + O_2(g) + 2H_2O(l) \rightarrow 4HNO_3(aq)$
- Similarly contact process is used for industrial preparation of sulphuric acid that involves following steps of combination reaction
  (i) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$
  (ii) $H_2SO_4(l) + SO_3(g) \rightarrow H_2S_2O_7(l)$
  (iii) $H_2S_2O_7(l) + H_2O(l) \rightarrow \underset{\text{(Conc)}}{2H_2SO_4(l)}$
- Manufacturing of ethanol is usually done by acid catalysed hydration of ethylene.
  $C_2H_4(g) + H_2O(g) \rightarrow CH_3CH_2OH(l)$

1. Which of the given process involves only combination reaction of elements?

a. Ostwald process

b. Haber's process

c. Contact process

d. Manufacture of C_2H_5OH

2. Which of the given process will involve the combination reaction of compounds with element ?

a. Manufacture of C_2H_5OH

b. Haber's process

c. Contact process

d. Ostwald process

3. Which of the given process will involve combination reaction of compounds only?

a. Contact process

b. Haber's process

c. Manufacture of C_2H_5OH

d. Ostwald process

Case-Based-III: Following sequence of reaction is given

$$X + H_2SO_4 \rightarrow Na_2SO_4 + Y + H_2O$$
$$\downarrow Ca(OH)_2$$
(Milky precipitate)

Answer the following questions on the basis of above reaction sequence

1. Write the chemical formula of X.

a. Na_2CO_3 b. NaOH

c. $NaHCO_3$ d. NaCl

2. Write the name of product Y

a. Sodium carbonate

b. Carbon dioxide

c. Hydrogen

d. Hydrogen peroxide

3. Write the chemical name of Z.

a. Sodium chloride

b. Calcium hydroxide

c. Calcium carbonate

d. Sodium carbonate

Multi Correct MCQ's

1. $Fe + S \longrightarrow FeS$ is an example of

a. Combination reaction

b. Redox reaction

c. Decomposition reaction

d. Single displacement reaction

2. $2Mg + O_2 \longrightarrow 2MgO$ is an example of

a. Combination reaction

b. Synthesis reaction

c. Displacement reaction

d. Redox reaction

3. For the given reaction, identify the gaseous product that is formed. $H_2O \xrightarrow{el^-}$

a. H_2 b. CO_2

c. O_2 d. H_2O

4. What are composition of basic copper carbonate?

a. $CuCl_2$ b. $CuCO_3$

c. $Cu(OH)_2$ d. $CuSO_4$

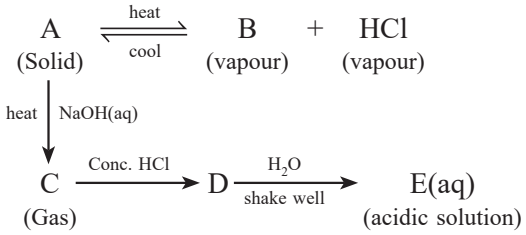
5. Redox reaction are those that involves

a. Oxidation b. Reduction

c. Transfer of electrons d. Transfer of protons

Olympiad & NTSE Type Questions

1. The schematic diagram is given below.



Which of the following is a correct statement? **[NTSE 2017]**

a. A and E are chemically same.

b. A and D are chemically same.

c. D and E are chemically same.

d. C and E are chemically same.

2. Which of the following is a feasible reaction? **[NTSE 2017]**

a. $Ba(s) + K_2SO_4(aq) \rightarrow BaSO_4(aq) + 2K(s)$

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

c. $Mg(s) + Na_2SO_4(aq) \rightarrow MgSO_4(aq) + 2Na(s)$

d. $Cu(s) + MgSO_4(aq) \rightarrow CuSO_4(aq) + Mg(s)$

3. The reaction that differs from the rest of the reaction given is: **[NTSE 2016]**

a. Formation of calcium oxide from limestone

b. Formation of aluminium from aluminium oxide

c. Formation of sodium carbonate from sodium hydrogen carbonate

d. Formation of mercury from mercuric oxide

4. Compound A on strong heating in a boiling tube gives off reddish brown fumes and a yellow residue. When the aqueous solution of A is treated with a few drops of sodium hydroxide solution, a white precipitate appeared. Identify the cation and anion present in the compound A. **[NTSE 2015]**

a. Copper (II) and nitrate

b. Lead (II) and chloride

c. Zinc and sulphate

d. Lead (II) and nitrate

5. The equation

$Cu + aHNO_3 \rightarrow Cu(NO_3)_2 + bNO_2 + 2H_2O$

The values of (a) and (b) are-

a. 3 and 5 b. 8 and 6

c. 4 and 2 d. 7 and 1

6. Match the items of Column I with the items of the Column II **[NTSE 2014]**

Column I	**Column II**
(1) $NH_4OH + CH_3COOH \rightarrow CH_3COONH_4 + H_2O$	(p) Thermal decomposition
(2) $2AgBr \rightarrow 2Ag + Br_2$	(q) Thermite reaction
(3) $ZnCO_3 \rightarrow ZnO + CO_2$	(r) Photochemical reaction
(4) $2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$	(s) Neutralization reaction

a. 4-(q); 3-(s); 2-(p); 1-(r)

b. 3-(p); 1-(q); 3-(r); 4-(s)

c. 2-(q); 4-(p); 1-(r); 3-(s)

d. 1-(s); 2-(r); 3-(p); 4-(q)

7. Which of the following statement is incorrect?

a. Metals that are placed at bottom of activity series like Cu, Ag, Au cannot displace H from acids

b. In reactivity series metal are arranged in order of increasing reactivity.

c. Silver cannot displace Cu form $Cu(NO_3)_2$

d. Zinc displaces Cu from $CuSO_4$

8. State the endothermic process from the given reaction

a. Addition of conc. HCl to water

b. $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$

c. $H_2O(l) \longrightarrow H_2O(g)$

d. $CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(aq)$

9. A test tube along with calcium carbonate in it intially weighed 30.08 g. A heating experiment was performed on this test tube till calcium carbonate completely decomposed with evolution of a gas. Loss of weight during this experiment was 4.40 g. What is the weight of the empty test tube in this experiment? **[NTSE 2018]**

a. 20.08 g b. 21.00 g

c. 24.50 g d. 2.008 g

10. A dilute $FeSO_4$ was gradually added to the beaker containing acidified permanganate solution. The light purple colour of the solution fades and finally disappears. State the correct explanation from the following for the observation?

a. $KMnO_4$ is an oxidising agent, it oxidises $FeSO_4$

b. $FeSO_4$ acts as an oxidising agent and oxidises MnO_4^-

c. The colour disappears due to dilution, no reaction is involved

d. $KMnO_4$ is an unstable compound and decomposes in the presence of $FeSO_4$ to give a colourless compound

11. Three beakers labelled as A, B and C were taken each containing 15 mL of water. A small amount of NaOH, anhyd. $CuSO_4$ and NaCl were added to the beakers A, B and C, respectively. It was observed that there was an increase in the temperature of the solutions contained in beakers A and B whereas, in case of beaker C, the temperature of the solution falls. Which statements is/are correct?

I. In beakers A and B, exothermic process has occurred.

II. In beakers B and C, endothermic process has occurred.

III. In beaker C, the exothermic process has occurred.

IV. In beaker C, endothermic process has occurred.

a. Only I b. Only II

c. I and IV d. II and III

12. The reaction that is used for the preparation of oxygen gas in the laboratory is given below

$$2KClO_3(s) \xrightarrow[\text{catalyst}]{\text{heat}} 2KCl(s) + 3O_2(g)$$

The correct statement(s) is/(are) about the reaction is:

a. It is a decomposition reaction and endothermic in nature

b. It is a neutralisation reaction

c. It is a decomposition reaction and heat is released

d. It is a photochemical decomposition reaction and exothermic in nature

13. Oxygen gas reacts with hydrogen to produce water. The reaction is represented by the equation:

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

The above reaction is an example of **[NTSE 2014]**

(i) Oxidation of hydrogen

(ii) Reduction of oxygen

(iii) Reduction of hydrogen

(iv) Redox reaction

a. (i), (ii) and (iii) b. (ii), (iii) and (iv)

c. (i), (iii) and (iv) d. (i), (ii) and (iv)

14. A metal carbonate X on treatment with a mineral acid liberates a gas which when passed through aqueous solution of a substance Y gives back X. The substance Y on reaction with the gas obtained at anode during electrolysis of brine gives a compound Z which can decolorise coloured fabrics. The compounds X, Y and Z respectively are **[NTSE 2013]**

a. $CaCO_3$, $Ca(OH)_2$, $CaOCl_2$

b. $Ca(OH)_2$, CaO, $CaOCl_2$

c. $CaCO_3$, $CaOCl_2$, $Ca(OH)_2$

d. $Ca(OH)_2$, $CaCO_3$, $CaOCl_2$

15. In the balanced chemical equation:

(a lead nitrate + b aluminium chloride $\rightarrow$ aluminium c nitrate + d lead chloride)

Which of the following alternatives is correct? **[NTSE 2018]**

a. a = 1, b = 2, c = 2, d = 1

b. a = 4, b = 3, c = 3, d = 4

c. a = 2, b = 3, c = 2, d = 3

d. a = 3, b = 2, c = 2, d = 3

Explanations

Subjective Questions

Very Short Answer Type Questions

1. Black precipitate of CuS.

$CuSO_4 + H_2S \rightarrow CuS\downarrow + H_2SO_4$

2. A chemical reaction is balanced on the basis of law of conservation of mass.

3. It is because water contains hydrogen and oxygen in the ratio of 2 : 1.

4. (a) $\underset{(\text{Carbon})}{C} + O_2 \longrightarrow CO_2 + H_2O$

5. As the properties of compound (H_2O) are different from properties of its constituting elements, i.e. H_2 and O_2. So, H_2O is used in extinguishing fire.

6. The most important condition necessary for a chemical change is the formation of new products.

7. Quicklime reacts with water to form slaked lime and produces lot of heat and hissing sound.

$$\underset{\substack{\text{Quicklime}\\(\text{Calcium oxide})}}{CaO(s)} + \underset{\text{Water}}{H_2O(l)} \longrightarrow \underset{\substack{\text{Slaked lime}\\(\text{Calcium hydroxide})}}{Ca(OH)_2(s)} + \text{heat} + \text{hissing sound}$$

8. Photochemical reaction: The reaction which occurs in presence of light is known as photochemical reaction.

9. $AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$

10. $2Pb(NO_3)_2 \longrightarrow 2PbO + 4NO_2 + O_2$

11. The reaction which represent a chemical change is called a chemical reaction

12. Sulphur

13. The basic difference is that in physical change, no new substance is formed, while in a chemical change, new substance(s) is/are formed.

14. (a) $CaCO_3 \longrightarrow CaO + CO_2\,(gas)$

(b) $\underset{(\text{blue})}{CuSO_4} + Fe \longrightarrow \underset{(\text{green})}{FeSO_4} + Cu$

15. Silver chloride becomes grey. It is a photochemical decomposition reaction.

$2AgCl \xrightarrow{\text{sunlight}} 2Ag + Cl_2$

Short Answer Type Questions

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

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

2. (a) $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$

(b) $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$

3. (i) $6CO_2(g) + 6H_2O(l) \xrightarrow{\text{Sunlight}} C_6H_{12}O_6(s) + 6O_2(g)$

(ii) In desert plants the stomata are open at night. They take carbon dioxide at night and is stored in the form of acid and that is used during day time for photosynthesis.

4. Yellow precipitate of lead iodide PbI_2 is formed. It is precipitation reaction.

It is also known as double displacement reaction.

$Pb(NO_3)_2\,(aq) + 2KI\,(aq) \longrightarrow PbI_2(s) + 2KNO_3(aq)$

5. (i) It is because zinc has displaced copper from $CuSO_4$. Zinc metal has been used to form zinc sulphate, thus, number of holes were noticed.

(ii) $\underset{}{Zn(s)} + \underset{\text{Blue}}{CuSO_4(aq)} \longrightarrow \underset{\text{Colourless}}{ZnSO_4(aq)} + Cu(s)$

6. $3BaCl_2(aq) + A1_2(SO_4)_3(aq) \longrightarrow 3BaSO_4(s) + 2AlCl_3(aq)$

This reaction is classified as double displacement as well as precipitation reaction

7. Those reactions in which both oxidation and reduction takes place simultaneously are called redox reactions.

(i) PbO gets reduced and C gets oxidised in the following reaction.

(ii) MnO_2 gets reduced and HCl gets oxidised in the given reaction.

8. The colour of ferrous sulphate $FeSO_4$ is pale green. The colour changes into reddish brown on heating due to formation of iron (III) oxide Fe_2O_3.

9. (i) $\underset{\text{Colourless}}{Pb(NO_3)_2(aq)} + \underset{\text{Colourless}}{2KI(aq)} \longrightarrow \underset{\text{Yellow ppt.}}{PbI_2(s)} + 2KNO_3(aq)$

(ii) $CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2 + \text{heat}$

In this reaction heat is released

10. (a) White precipitate of barium sulphate is formed.

$$\underset{\text{White ppt.}}{BaCl_2(aq)} + Na_2SO_4(aq) \longrightarrow \underset{\text{White}}{BaSO_4(s)} + 2NaCl(aq)$$

(b) It is because iron displaces copper from $CuSO_4$ to form $FeSO_4$ which is pale green.

$$\underset{\text{Blue}}{Fe(s) + CuSO_4(aq)} \longrightarrow \underset{\text{Pale green}}{FeSO_4(aq)} + Cu(s)$$

11. 'Al' is reducing agent in the reaction.

'Al is more reactive than Mn so, 'Al' displaces Mn from its oxide MnO_2.

Long Answer Type Questions

1. (1) $Pb(COOCH_3)_2(aq) + 2HCl(dil.) \longrightarrow PbCl_2(s) + 2CH_3COOH(l)$

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

(3) $Fe_2O_3(s) + 3CO(g) \longrightarrow 2Fe(s) + 3CO_2(g)$

(4) $2Na(s) + 2C_2H_5OH(l) \longrightarrow 2C_2H_5ONa(l) + H_2(g)$

2.

(a) The two ways by which rancidity can be prevented by:

(i) Adding antioxidants to food containing fat and oil, e.g. BHA is added to butter as antioxidant.

(ii) By packaging fat and oil containing foods in nitrogen gas.

(b) (i) By electrolysis molten NaCl is decomposed to form sodium metal.

$$\underset{\substack{\text{Sodium chloride}\\\text{(molten)}}}{2NaCl} \xrightarrow[\text{Current}]{\text{Electric}} \underset{\text{Sodium melal}}{2Na} + \underset{\text{Chlorine}}{Cl_2\uparrow}$$

(ii) Aluminium metal is obtained by electric decomposition of bauxite ore mixed with cryolite.

(iii) In thermal decomposition carbonate ores are decomposed to give metal oxide that on reduction give metal

3. (1) Pb_3O_4 (Red lead). It is also called Sindur used by married ladies. It is an oxidant (oxidising agent).

(2) O_2 is oxidising agent.

(3) $CuSO_4$ is oxidising agent.

(4) V_2O_5 is oxidising agent.

(5) H_2O is oxidising agent.

4. (a) Balanced chemical equation has an equal number of atoms of different elements in the reactants and products. According to law of conservation of mass, matter can neither be created nor be destroyed in a chemical reaction.

(b) (i) $P_4(s) + 10Cl_2(g) \longrightarrow 4PCl_5(s)$

(ii) $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l) + \text{heat energy}$

(iii) $C_6H_{12}O_6(s) + 6O_2(g) \longrightarrow 6CO_2\ (aq) + 6H_2O(l) + \text{energy}$

5. The substance 'A' is calcium oxide (CaO), element is calcium. Calcium oxide is used in cement industry. Calcium is present in bones in form of calcium phosphate $Ca_3(PO_4)_2$.

Calcium oxide dissolves in water forming alkali which turns red litmus blue.

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

6. (a) (i) $2H_2O \xrightarrow{\text{electricity}} 2H_2(g) + O_2$

(ii) $CaCO_3 \xrightarrow{\text{heat}} CaO + CO_2$

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

(b) Copper can displace silver from $AgNO_3$ because copper is more reactive than Ag

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

Integer Type Questions

1. –1

Let the oxidation no. of oxygen in H_2O_2 be x

$(x \times 2) + ((+1) \times 2) = 0$

$\Rightarrow 2x + 2 = 0$

$\Rightarrow x = -1$

2. +2

In $K_4[Fe(CN)_6]$:

$4 \times 1 + x + 6 \times (-1) = 0$

$4 + x - 6 = 0$ or $x = +2$

3. –1

4. +1

Oxidation no. of chlorine in ClO^- ion-

$x + (-2) = -1$

$\Rightarrow x = -1 + 2 = +1$

5. Zero

Multiple Choice Questions

Level-I

1. **(b)** Silver react with H_2S in air to form silver sulphide $2Ag + H_2S \longrightarrow Ag_2S + H_2$.

2. **(a)** Aluminium is less reactive than Mg. So it will react with $MgSO_4$ solution.

3. (a) $\underset{(X)}{Fe} + H_2O + O_2 \longrightarrow \underset{\substack{(Y)\\ \text{Reddish Brown}}}{Fe_2O_3 \cdot xH_2O}$

4. (b) $Mg + CuSO_4(aq) \longrightarrow MgSO_4(aq) + Cu$

blue colour white

5. (a) AgCl is sensitive to sunlight if it stored in normal bottle, decomposition takes place.

6. (a) Rancidity is oxidation of oils & fats.

7. (a) $\underset{(Conc.)}{Cu + HNO_3} \longrightarrow Cu(NO_3)_2 + \underset{\substack{\text{Nitrogen}\\ \text{dioxide}}}{NO_3} + O_2$

8. (d) Displacement reactions are redox in nature.

9. (c) $\underset{(Blue)}{Zn + CuSO_4(aq)} \longrightarrow \underset{(Colourless)}{ZnSO_4(aq)} + Cu$

10. (a) Chloro-fluoro carbons (CFCs) are called freons.

11. (d) Pungent smelling, brown fumes are evolved due to formation of NO_2 gas and yellow coloured residue of lead oxide (PbO) is left.

$2Pb(NO_3)_2(s) \xrightarrow{\Delta} 2PbO(s) + 4NO_2(g) + O_2(g)_{(1)}$

yellow

12. (d) In this reaction HCl is oxidised to Cl_2, while MnO_2 is reduced to $MnCl_2$.

13. (c) $2H_2O(l) \xrightarrow{Current} 2H_2(g) + O_2(g)$

Electrolysis of water is on example of decomposition reaction.

14. (c) $2Fe + 6HCl \rightarrow \underset{\substack{\text{(Iron (II)}\\ \text{chloride)}}}{2FeCl_2} + 3H_2\uparrow$

15. (b) $2Cu(NO_3)_2 \xrightarrow{\Delta} 2CuO + 4NO_2 + O_2$

16. (c) Zinc nitrate is formed in the reaction $Zn + 2AgNO_3 \rightarrow Zn(NO_3)_2 + 2Ag$

17. (a) MnO_2 is oxidising agent because it is removing hydrogen from HCl to form Cl_2.

18. (b) Iodine is purple in colour

19. (c) $\underset{\text{Lime Stone}}{CaCO_3} \xrightarrow{Heat} \underset{\text{Quick lime}}{CaO} + CO_2$

$\underset{\text{Quick lime}}{CaO} + H_2O \xrightarrow{Heat} \underset{\text{Slaked lime}}{Ca(OH)_2}$

20. (d) It is an example of displacement reaction. In this reaction Al metal displaces iron from Fe_2O_3 when reaction takes place in aqueous solution.

21. (c) $Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2 + Heat$

When Mg gets dissolve in hot water, it forms $Mg(OH)_2$.

22. (c) As iron is placed above copper in reactivity series. So Cu will not displace Fe from its solution.

23. (d) This reaction is double displacement and precipitation as well because insoluble silver chloride AgCl gets precipitated out.

24. (a) In this reaction H_2 gets oxidised and CuO reduced to Cu. So both oxidation and reduction take place

25. (d) Water gas $\rightarrow CO + H_2$

26. (a) Sodium benzoate is used as food preservative.

27. (b) A neutralization reaction is also known double displacement reaction. In this two reactants mutual exchange their ions to give two new products. For example

$2HCl(aq) + BaSO_4(aq) \rightarrow BaCl_2(aq) + H_2SO_4$

28. (d) Respiration is oxidation and exothermic process.

29. (b) When a Mg ribbon is burnt in air, the ash formed is of magnesium oxide that is white in colour.

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

30. (a) The green colour of ferrous sulphate crystals converts into brownish black ferric oxide and smell of burning sulphur is evolved due to SO_2 and SO_3.

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

Level-II

1. (c) At reaction temperature, both hydrogen and oxygen are in gaseous forms which react together to produce water (H_2O) in liquid form.

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

A B Y X

colourless yellow ppt.

3. (c) $\underset{(X)}{HCl} + \underset{(Y)}{Na_2CO_3} \longrightarrow \underset{(Z)}{NaCl} + \underset{(D)}{CO_2} + H_2O$

$NaCl + H_2O + CO_2 + NH_3 \longrightarrow \underset{\text{(Baking soda)}}{NaHCO_3} + NH_4Cl$

X is HCl and Y is Na_2CO_3.

4. (a) $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2$

H_2 produce burn with poping sound. $ZnCl_2$ is colourless solution

5. (b) Rusting of iron is an example of oxidation reaction.

6. (d) $\underset{\substack{(A)\\ \text{yellow}}}{S} + O_2 \longrightarrow \underset{\text{(Pungent smelling gas)}}{SO_2\uparrow}$

$\underset{(B)}{SO_2} + H_2O \rightleftharpoons \underset{\text{Sulphurous acid}}{H_2SO_3}$

Thus A is S and B is SO_2

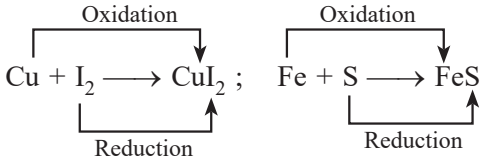
7. (a) $Mg + Cl_2 \rightarrow MgCl_2 \rightarrow Mg(OH)_2$

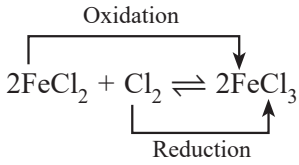
(Water soluble)

$MgCl_2$ is ionic compound (ionic compound will have high melting and boiling point)

8. (b) Heat is required to decompose calcium carbonate. This reaction is endothermic reaction as reaction proceeds with absorption of heat.

9. **(c)** The reaction in which both reduction and oxidation are involved are known as redox reactions.

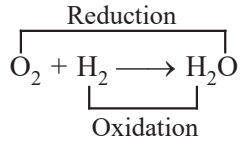


10. **(c)** 

Oxidising agent are those substance that donate electrons while reducing agent are those substance that accepts electrons.

Thus, Cl_2 acts as an oxidising agent.

11. **(a)** Especially AgCl/AgBr undergo decomposition in the presence of sunlight to give silver metal and a halogen gas (chlorine or bromine gas).

12. **(b)** 

13. **(c)** $CH_3CN \xrightarrow{Na/C_2H_5OH} \underset{(X)}{CH_3CH_2NH_2} \xrightarrow{HNO_2} \underset{(Y)}{CH_3CH_2OH} \xrightarrow{[O]} \underset{(Z)}{CH_3CHO}$

14. **(d)** $CuSO_4 + H_2S \rightarrow CuS + H_2SO_4$ is an example of double decomposition type of reaction.

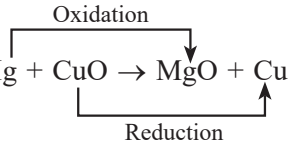
15. **(a)** The reaction that occur in test tube I is: $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

Carbon dioxide is the colouless gas that is evolved in test tube (I)

In test tube (II), no reaction will occur.

16. **(d)** All the statements given are correct.

17. **(b)** $Na_2CO_3 + CO_2 + H_2O \rightarrow 2NaHCO_3$

18. **(a)** v. 

ii. Copper is displaced by Mg.

Thus option (a) is correct

19. **(b)** $aP_4 + bCl_2 \rightarrow cPCl_5$

$P_4 + 10\ Cl_2 \rightarrow 4\ PCl_5$

Thus, in the reaction a, b and c are 1, 10 and 4 respectively

Assertion & Reason Type Questions

1. **(c)** Assertion is correct but Reason is incorrect.

Sn^{4+} is more stable than Sn^{2+}. Therefore, Sn^{2+} gets oxidised to Sn^{4+} by losing 2 electrons when it reacts with mercuric chloride, i.e., $SnCl_2$ act as an reducing agent.

$Hg_2Cl_2 + SnCl_2 \rightarrow 2Hg + SnCl_4$

(grey ppt)

2. **(b)** The correct reason for given assertion is that corrosion occurs due to oxidation of iron.

3. **(a)** If both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

4. **(a)** As, heat is released along with the formation of products in exothermic reactions.

5. **(c)** Assertion is true but Reason is false. Photosynthesis process is known as an endothermic reaction as energy in the form of sunlight is absorbed by the green plants.

6. **(a)** Reason is the correct explanation of assertion. Lime water contains small amount of calcium hydroxide dissolved in it. It reacts with CO_2 gas to form a white precipitate of calcium carbonate.

$\underset{\text{(lime water)}}{Ca(OH)_2} + CO_2(g) \longrightarrow \underset{\text{(White ppt)}}{CaCO_3(s)} + H_2O(g)$

Case-Based Type Questions

Case-Based-I

1. **(b)** H_2O_2 is oxidised to O_2, hence acts as a reducing agent.

2. **(a)** H_2O_2 is reduced to H_2O and oxidises H_2S to S. Hence, it is acts as an oxidising agent.

3. **(b)** Mn^{7+} changes to Mn^{2+} by gaining 5 electrons (reduction).

Case-Based-II

1. **(b)** Haber's process is used for the manufacturing of ammonia that involves combination of elements nitrogen and Hydrogen.

2. **(d)** Ostwald's process of manufacturing of HNO_3. It involves combination of compounds i.e. NO_2, H_2O with element oxygen.

3. **(c)** Combination of ethylene and water produces ethyl alcohol

Case-Based-III

1. **(a)** Na_2CO_3-sodium carbonate

2. **(b)** Carbon dioxide-Y

3. **(c)** Calcium carbonate

$\underset{(X)}{Na_2CO_3} + H_2SO_4 \rightarrow Na_2SO_4 + \overset{(Y)}{CO_2} + H_2O$

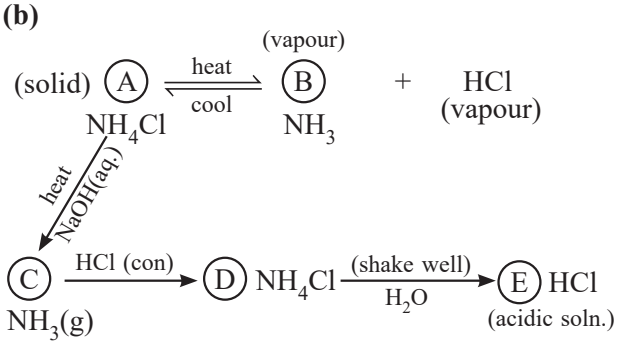
$CO_2 \xrightarrow{Ca(OH)_2} \underset{(Z)}{CaCO_3}$

Multi Correct MCQs

1. **(a,c)** It is an example of combination reaction as well as redox reaction in which oxidation and reduction take place.
2. **(a,c,d)** It is an example of combination reaction as well as redox reaction. Combination reactions are also known as synthesis reactions.
3. **(a,c)** Electrolysis of water gives hydrogen gas and oxygen gas.
4. **(b,c)** Basic copper carbonate contains copper carbonate and copper hydroxide.
5. **(a,b,c)** Redox reactions are those that involve both reduction and oxidation with transfer of electrons.

Olympiad & NTSE Type Questions

1. **(b)**



A = NH_4Cl; D = NH_4Cl

Therefore correct statement is: A and D are chemically same.

2. **(b)** $Zn(s) + 2AgNO_3(aq.) \rightarrow Zn(NO_3)_2$ (aq) + 2Ag(s).

This reaction is feasible as zinc is more reactive than silver. So, it will displace Ag from $AgNO_3$ to give zinc nitrate and silver

Reactivity order

Zinc > Iron > Tin > Lead > Hydrogen > Coper > Silver > Gold.

3. **(b)** (a), (c) and (d) are the example of thermal type of decomposition. Limestone ($CaCO_3$) is heated strongly to give calcium oxide and carbon dioxide.

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

When ($2NaHCO_3$) is heated to form sodium carbonate, carbon dioxide and water.

When mercuric oxide is heated, mercury and oxygen is formed.

$$2HgO \xrightarrow{\Delta} 2Hg + O_2$$

4. **(d)** $\underset{A}{Pb(NO_3)_2} \xrightarrow{\Delta} \underset{\text{Yellow}}{PbO} + \underset{\substack{\text{Reddish}\\\text{brown}\\\text{fumes}}}{2NO_2} + \frac{1}{2}O_2$

$Pb(NO_3)_2(aq) + 2NaOH(aq) \longrightarrow 2NaNO_3(aq) + \underset{\text{white ppt}}{Pb(OH)_2}$

$\therefore$ Compound is $Pb(NO_3)_2$

Ions that are present in compound are Pb^{2+} and NO_3^-

5. **(c)** $Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$
6. **(d)**
   (1) $NH_4OH + CH_3COOH \rightarrow CH_3COONH_4 + H_2O$
   It is a neutralization type of reaction in which acid is neutralized by base or vice-versa.
   (2) $2AgBr \rightarrow 2Ag + Br_2$ is an example of photochemical type of reaction which takes place in presence of light.
   (3) $ZnCO_3 \rightarrow ZnO + CO_2$ is an example of thermal decomposition reaction that takes place on heating a substance.
   (4) $\underset{\text{Thermite}}{\underbrace{2Al + Fe_2O_3}} \longrightarrow 2Fe + Al_2O_3$ is an example of thermite reaction. This reaction takes place in presence of heat and reduction-oxidation both take place.
7. **(b)** In activity series metals are arranged in decreasing order of the reactivity. The metals that are present at top of the series are highly reactive and they can displace the metals that present at the bottom.
8. **(c)** In this reaction, conversion of liquid to gas is an endothermic process.
9. **(a)** On thermal decomposition of $CaCO_3$

$$\underset{100\text{ g}}{CaCO_3} \xrightarrow{\Delta} \underset{56\text{ g}}{CaO} + \underset{44\text{ g}}{CO_2}$$

44g CO_2 is formed from 100g $CaCO_3$

4.40g CO is formed from $\frac{100}{44} \times 44$ = 10g $CaCO_3$

If weight of $CaCO_3$ is 10g, Thus, weight of empty test tube = 30.08 – 10.0 = 20.08 g

10. **(a)** Potassium permanganate ($KMnO_4$) in the presence of dil. H_2SO_4, i.e. in acidic medium, acts as a strong oxidising agent. In acidic medium, $KMnO_4$ oxidises ferrous sulphate to ferric sulphate.

$$2KMnO_4 + 8H_2SO_4 + \underset{\substack{\text{Ferrous}\\\text{sulphate}}}{10FeSO_4} \longrightarrow K_2SO_4 + \underset{\text{Ferric sulphate}}{5Fe_2(SO_4)_3} + 2MnSO_4 + 8H_2O$$

11. **(c)** As in case of beakers A and B, heat is given out, Thus, temperature became high, Thus, it is an exothermic reaction while in beaker C, heat is absorbed from water, Thus, temperature falls, Therefore, it is an endothermic process.

12. **(a)** In the given reaction, potassium chlorate ($KClO_3$) decomposes to give potassium chloride(KCl) and oxygen (O_2). In the given reaction heat is supplied for the reaction to take place. Thus, it is a decomposition reaction that is also endothermic in nature

13. **(d)** Oxidation is addition of oxygen to form oxides. Reduction is addition of hydrogen to form hydrides. In reaction,

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

In this reaction, both oxidation of hydrogen and reduction of oxygen take place.

14. **(a)**

$$\underset{(X)}{CaCO_3} + \text{mineral acid} \rightarrow CO_2 \uparrow \xrightarrow[(Y)]{Ca(OH)_2} \underset{(X)}{CaCO_3}$$

$$\underset{(Y)}{Ca(OH)_2} + Cl_2 \longrightarrow \underset{(Z)\text{ Bleaching power}}{CaOCl_2}$$

During electrolysis of brine, Cl_2 obtained at anode

15. **(d)** Balanced reaction is

$3Pb(NO_3)_2 + 2AlCl_3 \rightarrow 2Al(NO_3)_3 + 3PbCl_2$

Thus, a = 3, b = 2, c = 2, d = 3