CHEMICAL REACTION AND EQUATION

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- Neutralization Reaction
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- Exothermic and Endothermic Reaction
- Precipitation Reaction
- Double Displacement
- Oxidation and Reduction Reaction
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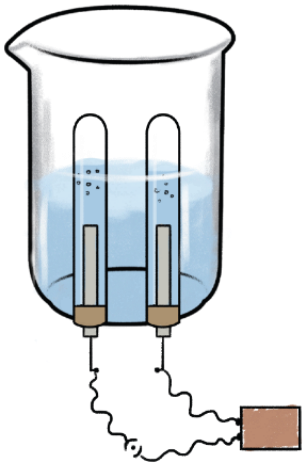


Chemical Reaction & Equation

Chemical Reaction

Chemical reaction is the process by which two or more substance react with each other to form new substance with different properties.

These are the following changes to determine that the following changes to determine that the chemical reaction has taken place.

- Change in State
- Change in Colour
- Evolution of Gas
- Change in temperature
- Formation of Precipitate

Chemical Equation

A chemical equation is the symbolic representation of a chemical reaction in the form of symbols and formula

Magnesium + Oxygen Magnesium $\longrightarrow$ Magnesium oxide

i. The substance which take part in a chemical reaction are called reactants.

ii. The New produced as a result of chemical reaction are called products

(Products formed have properties, which are entirely different from those of the reactant)

When a magnesium ribbon is heated, it burns in air with dazzling white flame to from a

Magnesium + Oxygen $\xrightarrow{\text{Heat}}$ Magnesium Oxide Powder

i. Mg and O are reactant

ii. MgO is a product which is a white coloured powder

Mg Ribbon is cleaned by Rubbing with a sand paper. This is done to remove the protective layer of magnesium oxide from the surface of magnisum ribbon.

Chemical Reactions in Daily life

1. Souring of Milk
2. Cooking of Food
3. Digestion of food
4. Respiration
5. Rusting of Iron
6. Burning of Fuels
7. Ripening of fruits are all chemical changes involving chemical reaction.

Balanced and Unbalanced Chemical Equation

1. Unbalanced Chemical Equation

Has an unequal number of atoms of one or more elements in the reactant and products-

$H_2 + O_2 \rightarrow H_2O$

Reactant	Product
No. of H = 2	No. of H = 2
No. of O = 2	No. of O = 1

So, the above equation is unbalanced equation it means that, an unbalanced equation has unequal masses of various element in rectant and products but, we know that according to "Law of conservation of mass"

"mass can neither be created nor destroyed in a chemical reaction"

So, this means that total mass of all the rectant must be equal to the total mass of the product this is the reason why balancing of chemical reaction is imp

Balancing of Chemical Equation

The process of making the number of different type of atoms equal on both the sides of an equation.

$H_2 + O_2 \longrightarrow H_2O$

	Reactant	Product
No. of H Atom	2	2
No. of O Atom	2	1

No. of Hydrogen Atom are balanced but, oxygen atoms are not balanced

Balanced Chemical Equation

$H_2 + O_2 \longrightarrow 2H_2O$

	Reactant	Product
No. of H	2	4
No. of O	2	2

Now, no. of oxygen atoms are equal both the sides but, no. of hydrogen atoms are Not Balanced

$2H_2 + O_2 \longrightarrow 2H_2O$

	Reactant	Product
No. of H	4	4
No. of O	2	2

Now, the above reaction is balanced

2. Balance the following chemical equation

i. $Fe + H_2O \longrightarrow Fe_3O_4 + H_2$

	Reactant	Product
No. of Fe Atoms	1	Fe = 3
No. of H Atoms	2	H = 2
No. of O Atoms	1	O = 4

$3Fe + H_2O \longrightarrow Fe_3O_4 + H_2$

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

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

comp. balanced chemical equation

But; to make a chemical equation more informative the physical states of the rectants and products are mentioned along with their chemical formula.

Liquid state represented by = (g)

Solid State represented = (s)

Liquid state represented = (l)

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

ii. Write a balanced equation of the reaction methane burns in oxygen to form carbondioxide and water.

$CH_4 + O_2 \longrightarrow CO_2 + H_2O$

	Reactant	Product
No. of C	1	1
No. of H	4	2
No. of O	2	3

$CH_4 + O_2 \longrightarrow CO_2 + 2H_2O$

	Reactant	Product
No. of C	1	1
No. of H	4	4
No. of O	2	4

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

	Reactant	Product
No. of C	1	1
No. of H	4	4
No. of O	4	4

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

3. An aqueous solution of sodium hydroxide to an aqueous solution of copper sulphate, copper hydroxide is precipitated and sodium sulphate remain in the solution.

$CuSO_4(aq) + Na(OH)(aq) \longrightarrow Cu(OH)_2 + Na_2SO_4$

	Reactant	Product
No. of Cu	1	1
No. of S	1	1
No. of O	5	6
No. of Na	1	2
No. of H atoms	1	2

$CuSO_4(aq) + 2NaOH(aq) \longrightarrow Cu(OH)_2 + Na_2SO_4$

	Reactant	Product
No. of Cu Atoms	1	1
No. of S Atoms	1	1
No. of Na Atoms	2	2
No. of O Atoms	1	6
No. of H atoms	2	2

$CuSO_4(aq) + 2NaOH(aq) \longrightarrow Cu(OH)_2(s) + Na_2SO_4(aq)$

This is the comp. Balanced equation.

iii. Write the balanced equation for the following

Hydrogen + Chlorine $\longrightarrow$ Hydrogen Chloride

$2H + Cl_2 \longrightarrow 2HCl$

	Reactant	Product
No. of H Atoms	1	1
No. of Cl Atoms	2	1

iv. Sodium metal react with water to form sodium hydroxide and hydrogen

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

	Reactant	Product
No. of Na Atoms	1	1
No. of H Atoms	2	3
No. of O Atoms	1	1

$$Na + 2H_2O \longrightarrow 2NaOH + H_2$$

v. Barium Chloride + Aluminium Sulphate ⟶ Barium sulphate + Aluminium chloride

$$BaCl_2 + Al_2(SO_4)_3 \longrightarrow Ba(SO_4) + AlCl_3$$

Balanced Equation

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

Information Conveged by a Chemical Equation

1. The Name of various reactants and the products
2. The formula of the reactents and the products
3. The relative amount (in mol) of the rectants and products.
4. The physical state of reactant and product
5. Heat change during the reaction
6. The specific conditions necessary for the reactions.

Type of Chemical Reaction

1. Combination Reaction
2. Decomposition Reaction
3. Displacement Reaction
4. Double Displacement Reaction
5. Oxidation and Reduction Reaction
6. Exothermic and Endothermic
7. Precipitation Reaction
8. Neutralization $R \propto n$
9. Oxidation and Reduction Reaction

1. Combination Reaction

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

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

Magnesium oxygen $\xrightarrow{\text{Combination}}$ Magnesium oxide

2. Burning of Coal

$$C(s) + O_2(g) \longrightarrow CO_2(aq)$$

3. Formation of Water

$$H_2(g) + O_2(g) \longrightarrow H_2O(aq)$$

4. Calcium oxide when reacts vigorously with water, produces slaked lime.

$$CaO(s) + H_2O(l) \longrightarrow Ca(OH)_2(aq) + \text{Heat} \uparrow$$

$$Ca(OH)_2 + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$$

- Slaked Lime is used to white wash the walls. Sulked lime when applied to the walls, they react slowly with CO_2 present in the air to form a shiny thin layer of $CaCO_3$

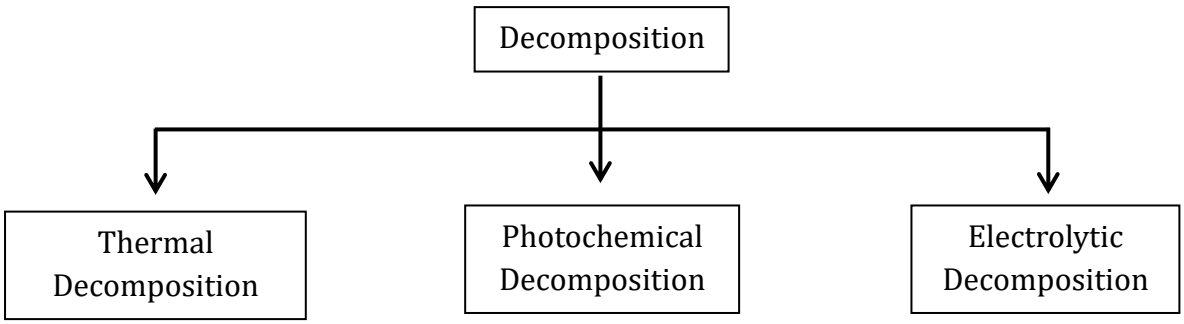
  Chemical formula of marble is also $CaCO_3$

Decomposition Reaction

Example:

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

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



A) Thermal Decomposition

When a decomposition reaction is out by heating

i. $CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g)$

ii. $FeSO_4 \cdot 7H_2O(s) \xrightarrow[\Delta]{\text{Heat}} FeSO_4(s) + 7H_2O$

iii. $2FeSO_4(s) \xrightarrow[\text{Heat}]{\Delta} Fe_2O_3(s) + SO_2(g) + SO_3(g)$

B) Photochemical Decomposition

If the energy of sunlight carry out decomposition reaction; it is called photochemical decomposition

i. $2H_2O_2(l) \xrightarrow{\text{Sunlight}} 2H_2O(l) + O_2(g)$

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

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

C) Electrolytic Decomposition

If the Electric Current is used to carryout decomposition reaction.

Example: Electrolysis of water

It is the decomposition of water into oxygen and hydrogen gas, when an electric current is passed through water containing few drops of Dilute sulphuric Acid.

$$2H_2O(l) \xrightarrow[\text{Decomposition}]{\text{Electrolytic}} 2H_2(g) + O_2(g)$$

Q. Why few drops of H_2SO_4 acid are added to water before electrolsis. Why?

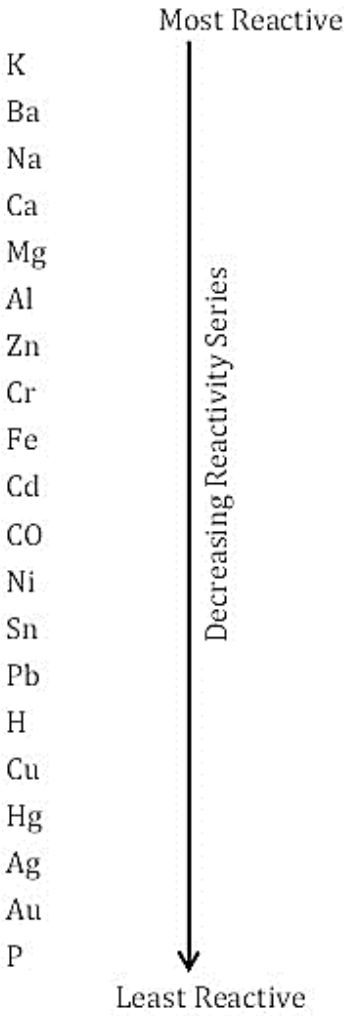
NCERT exercise

Sol. Water is a poor conductor of electricity; and acid dissociate to make it good Conductor.

Displacement Reaction

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

Reactivity series of Metals



1. $2AgNO_3(aq) + Cu(s) \longrightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

2. $2Fe(s) + 4H_2O(g) \longrightarrow Fe_3O_4(s)$

Double Displacement Reaction

Two compounds react by exchange of ions to form two new compounds.

1. $Na_2SO_4(aq) + BaCl_2 \longrightarrow BaSO_4 \downarrow + NaNO_3(aq)$

2. $AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl \downarrow + NaNO_3(aq)$

3. $2KI + Pb(NO_3)_2(aq) \longrightarrow PbI_2 \downarrow + 2KNO_3(aq)$

Exothermic and Endothermic Reactions

A) Exothermic Reaction

The reaction in which heat is released along with the formation of product are called exothermic reaction

Example:

i. Oxidation of Methane (Combustion of methane)

$CH_4(g) + 2O_2(g) \longrightarrow CO_2 \uparrow + 2H_2O(l) + \text{Heat} \uparrow + \text{Light}$

Production of heat and light are essential production of combustion.

ii. Respiration

- During digestion, the food is broken down to form glucose.
- Glucose then combine with oxygen in the cell of our body and provide energy this reaction is known as respiration.

iii. Decomposition of vegetable matter into compost.

B) Endothermic Reaction

The reaction in which energy is absorbed by the rectant to complete the reaction is known as Endothermic Reaction

Example:

Decomposition Reaction Require, energy for breaking down the rectants. Therfore, these are endothemic reaction.

i. $Ba(OH)_2(aq) + 2NH_4Cl(aq) \longrightarrow BaCl_2(aq)2NH_3(g) + 2H_2O(l)$

ii. Decomposition of Silver Bromide.

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

Precipitation Reaction

The reaction in which an insoluble substance formed, is called precipitation reaction and the insoluble substance is known as precipitate.

$NaCl(aq) + AgNO_3(aq) \longrightarrow NaNO_3(aq) + AgCl \downarrow$

Neutralization Reaction

The Reaction in which, Acid Reacts with base to form salt and water essentially in dilute aqueous solution is known as Neutralization Reaction.

Acid + Base $\longrightarrow$ Salt + Water + Heat

Example:

$HCl(aq) + NaOH(aq) \longrightarrow NaCl(aq) + H_2O$

Oxidation and Reduction Reaction

A) Oxidation

Addition of oxygen $\qquad 2Cu + O_2 \xrightarrow{\Delta} 2CuO$

Removal of Hydrogen

B) Oxidising Agent (Oxidant)

Any substance which adds oxygen or help to remove hydrogen is known as oxidising agent.

[Help in oxidation, but Reduces itself]

C) Reduction

Addition of Hydrogen

Removal of oxygen

$CuO + H_2 \longrightarrow Cu + H_2O$

D) Reducing Agent

Any substance which removes oxygen and or adds Hydrogen.

$2H_2S + O_2 \longrightarrow 2S + 2H_2O$

$CuO + C \longrightarrow Cu + CO$

$FeO + CO \longrightarrow Fe + CO_2$

Oxidation and Reduction in terms of Electron

Oxidation is loss of electrons

Reduction is gain of electrons

Redox Reactions

The chemical reaction in which oxidation as well as reduction takes palce simultaneously

Effect of Oxidation in Everyday Life

A) Rancidity

Food Material containing Fat and oil, when left for long time become Rancid

i.e., smell and taste place due to oxidation of food.

Preventions:

In order to prevent oxidation, we have to use some Anti-Oxidants like

- Sodium Benzoate

- BHA (Butylated hydroxyanisol)
- BHT (Butylated hydroxytoluene)
- Usually chips packets are flused with nitrogen gas

Q. **i) Why is respiration considered as an exothermic reaction?** **NCERT Exercise**
ii) Write chemical name and the formula of the brown gas produced during thermal decomposition of lead nitrate.
iii) Why do chips manufactures flush bags of chips with gas such as nitrogen?

Sol. i) The glucose produced in our body during digestion combines with oxygen in the cells of our body during digestion combines with oxygen in the cells of our body and provides energy. The special name of this reaction is respiration. Thus respiration is an exothermic process because energy is produced during this process.

$$C_6H_{12}O_{6(aq)} + 6O_{2(g)} \longrightarrow 6CO_{2(g)} + 6H_2O_{(l)} + \text{Energy}$$

ii) $\underset{\text{Lead nitrate}}{2Pb(NO_3)_2} \xrightarrow{\text{Heat}} \underset{\text{Lead monoxide}}{2PbO_{(s)}} + \underset{\substack{\text{Nitrogen dioxide} \\ \text{(Brown fumes)}}}{4NO_{(g)}} + \underset{\text{Oxygen}}{O_{2(g)}}$

Brown gas evolved is nitrogen dioxide (NO_2).

iii) Chips manufacturers usually flush bags of chips with gas such as nitrogen because atmospheric oxygen can react with chips which may cause change in colour, change in taste. So to cut the contact between air and the chips, nitrogen gas is used which do prevent its oxidation.

B) Corrosion :

The degradation of metals by the action of air, moisture on their surface is called corrosion.

Rusting of Iron (Sub Heading)

$$2\text{Fecs} + \frac{3}{2}O_2(g) + XH_2O(l) \rightarrow Fe_2O_3.XH_2O$$

Prevention of Rusting of Iron

1. By painting
2. By greasing or oiling
3. By galvanisation {depositing of thin layer of Zn metal on Fe object} more Reactive Zn metal react with Atmosphere and form Zinc oxide.

Oxidation of other Metals (like copper and silver)

Silver (Ag) and Cu lose their lusture by gaining Black and Green coating of silver sulphide and Basic copper carbonate.

Silver Sulphide → Black

Copper Carbonate → $Cu_2Co_3/CuCo_3$

$$2Cu + CO_2(g) + O_2(g) + H_2O(l) \rightarrow CuCO_3 + Cu(OH)_2(s)$$

So, we can say that "slow eating up of Metals by the Action of Air.

Important NCERT Questions

Q1. a) State the law that is followed by balancing a chemcial equation.

b) Balance the following chemical equation:

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

Sol. a) Law of conservation of mass is followed for balancing a chemical equation which states that mass can neither be created nor destroyed in a chemical reaction. That is, the total mass of the elements present in the products of a chemical reaction has to be equal to the total mass of the elements present in the reactants in a balanced equation.

b) $2Na_{(s)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_{2(g)}$

Q2. Explain the significance of photosynthesis. Write the balanced chemical equation involved in the process.

Sol. Photosynthesis means synthesis with the help of light. It is the process that gives life to all living beings.

Photosynthesis is a process by which plants utilize carbon dioxide and water in the presence of sunlight to produce glucose and oxygen.

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \underset{\text{Glucose}}{C_6H_{12}O_6} + 6O_2 + 6H_2O$$

Q3. Calcium oxide reacts vigorously with water to produce slaked lime.

C $CaO_{(S)} + H_2O_{(l)} \longrightarrow Ca(OH)_{2(aq)}$

This reaction can be classified as

(A) Combination reaction **(B) Exothermic reaction**

(C) Endothermic reaction **(D) Oxidation reaction**

Which of the following is a correct option?

a) (A) and (C) **b) (C) and (D)**

c) (A), (C) and (D) **d) (A) and (B)**

Sol. The reaction between CaO and H_2O to form $Ca(OH)_2$ is an exothermic combination reaction.

Q4. When hydrogen sulphide gas is passed through a blue solution of copper sulphate, a black precipitate of copper sulphide is obtained and the sulphuric acid so formed remains in the solution. The reaction is and example of a

a) combination reaction **b) displacement reaction**

c) decomposition reaction **d) double displacement reaction.**

Sol. $CuSO_4 + H_2S \rightarrow CuS + H_2SO_4$

It is a double displacement reaction as in this reaction $CuSO_4$ and H_2S reacting by exchange of Cu^{2+} and H^+ ions to from two new compounds i.e., CuS and H_2SO_4.

Q5. In a double displacement reaction such as the reaction between sodium sulphate solution and barium chloride solution:

(A) exchange of atoms takes place **(B) exchange of ions takes place**

(C) a precipitate is produced **(D) an insoluble salt is produced**

The correct option is

a) (B) and (D) **b) (A) and (C)**

c) only (B) **d) (B), (C) and (D)**

Sol. In this reaction exchange of Na^+ and Ba^{2+} ions takes place forming $BaSO_4$ which is a white precipitate i.e., an insoluble salt.

$Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4 \downarrow + 2NaCl$

Q6. In which of the following, the identity of initial substance remains unchanged?

a) Curdling of milk

b) Formation of crystals by process of crystallisation

c) Fermentation of grapes

d) Digestion of food

Sol. Formation of crystals is a physical change rest others are chemical change.

Q7. Study the following equation of a chemical reaction:

$H_2 + Cl_2 \longrightarrow 2HCl$

i) Identify the type of reaction.

ii) Write a balanced chemical equation of another example of this type of reaction.

Sol. i) Combination reaction.

ii) Another example of combination reaction is

$$\underset{\text{Sodium}}{2Na_{(s)}} + \underset{\text{Chlorine}}{Cl_{2(g)}} \longrightarrow \underset{\text{Sodium chloride}}{2NaCl_{(s)}}$$

Q8. Identify the type of reaction taking place in each of the following cases and write the balanced chemical equation for the reactions.

a) Zinc reacts with silver nitrate to produce zinc nitrate and silver.

b) Potassium iodide reacts with lead nitrate to produce potassium nitrate and lead iodide.

Sol. a) It is a displacement reaction.

$$\underset{\text{Zinc}}{Zn} + \underset{\text{Silver nitrate}}{2AgNO_3} \longrightarrow \underset{\text{Zince nitrate}}{Zn(NO_3)_2} + \underset{\text{Silver}}{2Ag}$$

b) Refer to answer 15.

Q9. You might have noted that when copper powder is heated in a China dish, the reddish brown surface of copper powder becomes coated with a black substance.

a) Why has this black substance formed?

b) What is the black substance?

c) Write the chemical equation of the reaction that takes place.

d) How can the black coating on the surface be turned reddish brown?

Sol. a) The black substance is formed because copper combins with oxygen.

b) The black substance is copper oxide (CuO).

c) $\underset{\text{Copper}}{\underset{\text{(Reddish brown)}}{2Cu_{(s)}}} + \underset{\text{Oxygen}}{\underset{\text{(From air)}}{O_{2(g)}}} \longrightarrow \underset{\text{Copper (II)oxide}}{\underset{\text{(Black)}}{2CuO_{(s)}}}$

d) The black coating on the surface can be turned reddish beown by passing hydrogen gas over the hot copper oxide.

Q10. Name the type of chemical reaction represented by the following equation:

i) $\mathbf{CaO + H_2O \longrightarrow Ca(OH)_2}$

ii) $\mathbf{3BaCl_2 + Al_2(SO_4)_3 \longrightarrow 2AlCl_3 + 3BaSO_4}$

iii) $\mathbf{2FeSO_4 \xrightarrow{Heat} Fe_2O_3 + SO_2 + SO_3}$

Sol. i) Combination reaction

ii) Precipitation reaction or double displacement reaction.

iii) Thermal decomposition reaction.