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PART – I

Teko CLASSES ....the support

CHEMICAL REACTIONS & CHEMICAL EQUATIONS

1.1 INTRODUCTION:

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

1.2 CHEMICAL ACTION OR REACTION:

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

1.2 (a) Characteristics of a Chemical Reaction:

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

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

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

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

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

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

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

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

- When red lead oxide is heated strongly it forms yellow coloured lead monoxide and gives off oxygen gas.

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

- When copper carbonate (green) is heated strongly it leaves behind a black residue.

$CuCO_3\ (s)$	$\xrightarrow{heat}$	$CuO(s)$	+	$CO_2\ (g)$
Copper carbonate		Copper oxide		Carbon dioxide
(Green)		(Black)		

-

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

-

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

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

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

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

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

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

- $BaCl_2$ (aq) + dill H_2SO_4 $\longrightarrow$ $BaSO_4$ (s) + 2HCl (aq)
  Barium chloride; Barium sulphate (White precipitate)

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

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

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

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

(B) Exothermic reaction : A chemical reaction which is accompanied by the release of heat energy is called exothermic reaction.

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

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

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

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

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

- Two volumes of hydrogen gas react with one volume of oxygen gas to from water.

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

or when electric current is passed through water it splits into its elements.

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

• NH_3 (g)	+	HCl (g)	$\longrightarrow$	NH_4Cl (s)
Ammonia		Hydrochloric acid		Ammonium Chloride

1.3 CHEMICAL EQUATIONS :

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

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

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

A Chemical reaction can be summarised by chemical equation.

1.3 (a) Types of Chemical Equations :

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

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

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

In a word equation

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

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

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

For e.g. Burning of magnesium in oxygen to form magnesium oxide may be written as follows :
$Mg + O_2 \longrightarrow MgO$


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Symbol equations are always written from the word equations.

1.3 (b) Unbalanced and Balanced Chemical Equations :

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

$$Mg + O_2 \longrightarrow MgO$$

An unbalanced equation is also called skeletal equation.

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

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

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

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

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

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

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

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

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

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

- Make the equations more informative if possible.

Example :

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

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

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

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

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

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

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

II : On inspection, the number of O atoms in the reactant (H_2O) is 1 while in the product (Fe_3O_4), these are 4. To balance the atoms, put coefficient 4 before H_2O on the reactant side. The partially balance equation may be written as
$Fe + 4H_2O \rightarrow Fe_3O_4 + H_2$
III : In order to equate H atoms, put coefficient 4 before H_2 on the product side, As a result, the H atoms on both side on of the equation become 8 and are thus balanced. The partially balanced equation may now be written as
$Fe + 4H_2O \rightarrow Fe_3O_4 + H_2$
IV : In order to balance the Fe atoms, put coefficient 3 before Fe on the reactant side. The equation formed may be written as -
$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$
V : on final inspection, the number of atoms of all the elements on both sides of the equation are equal. Therefore, the equation is balanced.

1.3 (c) Writing State Symbols:

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

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

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

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

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

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

1.3 (d) Significance of State Symbols:

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

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

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

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

1.3 (e) Specialties of Chemical Equation :

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

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

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

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

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

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

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

For example

$Mg + 2HCl \rightarrow MgCl_2 + H_2(\uparrow)$

In the above reaction one atom of Mg displaces two atoms of hydrogen, so valency of magnesium is two.

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

1.3 (f) Limitations of Chemical Equations :

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

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

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

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

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

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

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

The above limitations are rectified in the following manner –

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

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

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

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

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

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

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

DAILY PRACTIVE PROBLMES # 1

OBJECTIVE DPP-1.1

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

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

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

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

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

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

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

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

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

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

SUBJECTIVE DPP-1.2

1. Balance the following equations -

   (i) $HgO \longrightarrow Hg + O_2$

   (ii) $C_4H_{10}(g) + O_2(g) \longrightarrow CO_2(g) + H_2O(\ell)$

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

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

4. Write the balanced chemical equations for the following chemical reactions -

   (i) Aqueous solution of sulphuric acid and sodium hydroxide reacts to from aqueous sodium sulphate an water.

   (ii) Phosphorus burns in chlorine gas to from phosphorus pentachloride.

5. Write the balance chemical equations for the following reactions -

   (i) Zinc carbonate (s) $\longrightarrow$ Zinc oxide (s) + Carbon dioxide (g)

   (ii) Potassium bromide (aq) + Barium iodide (aq) $\longrightarrow$ Potassium iodide (aq) + Barium bromide (aq)

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

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

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

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

CHEMICAL REACTIONS & CHEMICAL EQUATIONS

2.1 TYPES OF CHEMICAL REACTIONS:

2.1 (a) Addition Reactions :

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

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

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

Addition reactions may be formed in the following conditions -

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

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

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

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

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

Other Example of synthesis reactions are -

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

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

For eg.

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

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

For eg.

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

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

2.1 (b) Decomposition Reaction :

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

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

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

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

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

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

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

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

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

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

Decomposition reaction is just opposite of the addition reaction.

2.1 (c) Displacement Reactions :

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

For eg.

(i) Zinc displaces hydrogen from sulphuric acid.
$Zn\,(s) + \text{dill. } H_2SO_4\,(aq) \longrightarrow ZnSO_4\,(aq) + H_2\uparrow$

(ii) Iron displaces copper from a copper sulphate solution.
$Fe\,(s) + CuSO_4(aq) \longrightarrow FeSO_4\,(aq) + Cu$

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

2.1 (d) Double Displacement :

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

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


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Acid base neutralisation reactions are double displacement reactions.

DAILY PRACTICE PROBLEMS # 2

OBJECTIVE DPP-2.1

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

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

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

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

5. Match the following -

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

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

6. Which of the following reactions is/are a double displacement reactions (s) ?

(i) $AgNO_3 + NaBr \longrightarrow NaNO_3 + AgBr$

(ii) $BaCl_2 + H_2SO_4 \longrightarrow BaSO_4 + 2HCl$

(iii) $As_4O_4 + 3H_2S \longrightarrow As_2S_3 + 3H_2O$

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

(A) (i) & (ii) (B) only (iii) (C) only (iv) (D) (i) to (iv) all

7. $AgNo_3$ (a) + NACl (Aq) $\longrightarrow$ AgCl (s) + $NaNO_3$ (Aq)

Above reaction is a -

(A) precipitation reaction (B) dboule displacement reaction

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

8. $H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

Above equation is a

(i) neutralization reaction (ii) double displacement reaction)

(iii) decomposition reaction (iv) addition reaction

(A) (i) to (iv) all (B) (i) and (ii)

(C) (i) and (iii) (D) (ii) and (iv)

9. $Zn + H_2SO_4$ (dil) $\longrightarrow ZnSO_4 + H_2\uparrow$

Above equation is a=

(A) Decomposition (B) Single displacement reaction

(C) Combination reaction (D) Synthesis reaction

10. The reaction in which two compounds exchange their ions to form two new compounds is-

(A) a displacement reaction (B) a decomposition reaction

(C) an addition reaction (D) a double displacement reaction

SUBJECTIVE DPP-2.2

1. Classify the following reactions -

(i) $N_2 + O_2 \longrightarrow 2NO$ - Heat (ii) $2HgO \longrightarrow 2Hg + O_2$

(iii) $Na_2SO_4 + BaCl_2 \longrightarrow 2NaCl + BaSO_4$ (iv) $CuSO_4$ (aq.) + Zn $\longrightarrow ZnSO_4$ (aq.) + Cu

(v) $NH_3 + HCl \longrightarrow NH_4Cl$

2. Differentiate between combination and synthesis reaction with example.

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

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

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

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

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

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

CHEMICAL REACTIONS & CHEMICAL EQUATIONS

3.1 OXIDATION AND REDUCTION :

3.1 (a) Oxidation :

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

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

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

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

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

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

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

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

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

3.1 (b) Reduction :

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

(i) Gain of hydrogen.
For eg.

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

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

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

(iii) Loss of oxygen atom.
For eg.

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

(iv) Loss of electronegative radical.
For eg.

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

3.2 REDOX REACTIONS :

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

Reduction

$$CuO + H_2 \longrightarrow Cu + H_2O$$

Oxidation

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

3.2 (a) Electronic Interpretation of Oxidation:

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

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

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

3.2 (b) Electronic Interpretation of Reduction :

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

For example

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

$2Mg + O_2 \rightarrow 2MgO$

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

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

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

3.3 EFFECT OF OXIDATION REACTIONS IN EVERYDAY LIFE :

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

3.3 (a) Combustion Reactions:

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

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

Methane

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

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

Butane

All combustion reactions are of exothermic nature and are accompanied by release of heat energy. The human body may be regarded as a furnace or machine in which various food stuffs that we eat undergo combustion or oxidation. The heat energy evolved keeps our body working. Carbohydrates such as glucose, fructose, starch etc. Are the major source of energy to the human body. They undergo combustion with the help of oxygen that we inhale to form carbon dioxide and water. For example.

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

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

3.3 (b) Respiration :

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

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

3.3 (c) Harmful Effects of Combustion :

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

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

Quite often, when we open the bonnet of a car after a long time, we find a deposit around the terminals of the battery. This is an example of corrosion. Black coating on the surface of silver and green layer on the surface of copper are the examples of corrosion. In case of iron, corrosion is called rusting. Rust is a chemical substance brown in colour and is formed by the chemical action of moist air (containing O_2 and H_2O) on iron. It is basically an oxidation reaction and the formula of rust is Fe_2O_3, xH_2O. It is very slow in nature and once started keeps on.

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

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

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

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

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

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

DAILY PRACTICE PROBLESM # 3

OBJECTIVE DPP-3.2

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

   Chlorine may be regarded as -

   (A) an oxidising agent (B) a reducing agent
   (C) a catalyst (D) providing an inert medium

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

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

   Here hydrogen sulphide is acting as -

   (A) an oxidising agent (B) a reducing agent
   (C) a dehydrating agent (D) a catalyst

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

   (A) Gain or addition of electronegative radical
   (B) Removal of hydrogen atom.
   (C) Removal or loss of electropositive radical or element
   (D) None of these

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

   (A) redox reaction (B) synthesis reaction
   (B) neutralisation (D) analysis reaction

5. Which of the following is an example of oxidation reaction ?
(A) $Sn^{+2} - 2e^{-} \rightarrow Sn^{+4}$ (B) $Fe^{+3} + e^{-} \rightarrow Fe^{+2}$
(C) $Cl_2 + 2e^{-} \rightarrow 2Cl$ (D) None of these

6. In the process of burring of magnesium in air, magnesium undergoes -
(A) reduction (B) sublimation (C) oxidation (D) all of these

7. A substance which oxidises itself and reduces other is known as-
(A) an oxidising agent (B) a reducing agent (C) Both of these (D) None of these

8. Oxidation is a process which involves -
(A) addition of oxygen (B) removal of hydrogen
(C) loss of electrons (D) All are correct

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

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

SUBJECTIVE DPP-3.2

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

2. Can oxidation occur without reduction ? Explain

3. Explain the terms oxidation and reduction with examples.

4. What is rancidity? Example with example.

5. What do you mean by corrosion ?

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

ANSWERS

OBJECTIVE DPP 1.1

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

SUBJECTIVE DPP 1.1

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

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

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

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

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

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

OBJECTIVE DPP 2.1

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

OBJECTIVE DPP 2.1

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

4. Decomposition reaction

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

   (X) grey

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

OBJECTIVE DPP 3.1

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

SUBJECTIVE DPP 3.1

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

➤ACIDS,BASES AND SALTS➤

4.1 ACIDS :

Substances with sour taste are regarded as avoids. Lemon juice, vinegar, grape fruit juice and spoilt milk etc. taste sour since they are acidic. Many substances can be identified as acids based on their taste but some fo the acids like sulphuric acid have very strong action on the skin which means that they are corrosive in nature. In such case it would be according to modern definition-

An acid may be defined as a substance which release one or more H^+ ions in aqueous solution.

Acids are mostly obtained from natural sources. One the basis of their source avids are of two types -

(a) Mineral acids **(b) Organic acids**

4.1 (a) Mineral Acids :

Acids which are obtained from rocks and minerals are called mineral acids.

4.1 (b) Organic Acids :

Acids which are present in animals and plants are known as organic acids. A list of commonly used acids along with their chemical formula and typical uses, is given below -

Name	Type	Chemical Formula	Where found or used
Carbonic acid	Mineral acid	H_2CO_3	In soft drinks and lends fizz, In stomach as gastric juice, used in tanning industry
Nitric acid	Mineral Acid	HNO_3	Used in the manufacture of explosives. (TNT, Nitroglycerine) and fertilizers (Ammonium nitrate, Calcium nitrate, Purification of Au, Ag.)
Hydrochloric acid	Mineral Acid	HCI	In purification of common salt, in textile industry as bealching agent, to make aqua regia mixture of Hu2HNO3 in ration of 3 : 1
Sulhuric acid	Mineral Acid	H_2SO_4	Commonly used in car batteries, in the manufacture of fertilizers (Ammonium sulphate, super phosphate) detergents etc, in paints, plastics, drugs, in manufacture of artificial silk, in petroleum refining.
Phosphoric acid	Mineral Acid	H3PO4	Used I antirust paints and in fertilizers.
Formic acid	Organic Acid	$HCOOH(CH_2O_2)$	Found in the stings of ants and bees, used in tanning leather, in medicines for treating gout disease of jointly.
Acetic acid	Organic Acid	$CH_3COOH(C_2H_4O_2)$	Fount in vinegar used a solvent in the manufacture of dyes and perfumes.
Lactic acid	Organic Acid	$CH_3CH(OH)COOH(C_3H_6O_3)$	Responsible for souring of milk in curd.
Benzoic acid	Organic Acid	C_6H_5COOH	Used as a food preservation.
Critic acid	Organic Acid	C_6H_8O	Present in lemons, oranges and citrus fruits.

4.1 (c) Chemical Properties of Acids:

1. Action with metals: Dilute acids like dilute HCl and dilute H_2SO_4 react with certain active metals to evolve hydrogen gas.

$2Na(s) + 2HCl\,(dilute) \longrightarrow 2NaCl(aq) + H_2\,(g)$

$Mg(s) + H_2SO_4\,(dilute) \longrightarrow MgSO_4\,(aq) + H_2(g)$

Metals which can displace hydrogen from dilute acids are known as avtive metals. e.g. Na, K, Zn, Fe, Ca, Mg etc.

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

The active metals which lie above hydrogen in the activity series are electropositive in nature. Their atoms lose electrons to form positive ions and these electrons are accepted by H^+ ions of the acid. As a result, H_2 is evolved.

For e.g.

$Zn(s) \longrightarrow Zn^{2+}\,(aq) + 2e^-$

$ZH^+(aq) + SO_4^{2-}(aq) + 2e^- \longrightarrow H_2\,(g) + SO_4^{2-}\,(aq)$

$Zn(s) + 2H^+\,(aq) \longrightarrow Zn^{++}(aq) + H_2(g)$

2. Action with metal oxides : Acids react with metal oxides to form salt and water. These reactions are mostly carried out upon heating.

For e.g.

$ZnO(s)\ +\ 2HCl(aq) \longrightarrow ZNCl_2(aq)\ +\ H_2O\,(\ell)$

$MgO(s)\ +\ H_2SO_4(aq) \longrightarrow MgSO_4(aq)\ +\ H_2O\,(\ell)$

$CuO(s)\ +\ 2HCl(dil.) \longrightarrow CuCl_2(aq)\ +\ H_2O\,(\ell)$

(Block) (Bluish green)

3. Action with metal carbonates and metal bicarbonates : Both metal carbonates and bicarbonates react with acids to evolve CO_2 gas and form salts.

For e.g.

$CaCO_3(s)\ +\ 2HCl(aq) \longrightarrow CaCl_2(aq)\ +\ H_2O\,(\ell)\ +\ CO_2(g)$

Calcium carbonate Calcium chloride

$2NaHCO_3(s)\ +\ H_2SO_4(aq) \longrightarrow Na_2SO_4(aq)\ +\ H_2O(aq)\ +\ CO_2(g)$

Sodium bicarbonate Sodium sulpahte

4. Action with bases : Acids react with bases to give salts and water.

$HCl\ +\ NaOH \longrightarrow NaCl\ +\ H_2O$

4.1 (d) Strong and Weak Acids :

(i) Strong acids : Acids which are completely ionised in water are known as strong acids.
For e.g.
Hydrochloric acid (HCl), sulphuric acid (H_2SO_4), nitric acid (HNO_3) etc. are all strong acids.

$$HCl + Water \longrightarrow H^+(aq) + Cl^-(aq)$$
$$H_2SO_4 + Water \longrightarrow 2H^+(aq) + SO_4^{2-}(aq)$$

(ii) Weak acids: Acids which are weakly ionised in water are known as weak acids.
For e.g.
Carbonic acids (H_2CO_3), phosphoric acid (H_3PO_4), formic acid (HCOOH), acetic acid (CH_3COOH) are weak acids.

$$CH_3COOH + Water \longrightarrow CH_3COO^-(aq) + H^+ (aq)$$

In general MINERAL acids are STRONG acids while ORGANIC acids are WEAK acids.

4.2 Base :

Substances with bitter taste and soapy touch are regarded as bases. Since many bases like sodium hydroxide and potassium hydroxide have corrosive action on the skin and can even harm the body, so according to the modern definition -
a base may be defined as a substance capable of releasing one or more OH^- ions in aqueous solution.

4.2 (a) Alkalies :

Some bases like sodium hydroxide and potassium hydroxide are water soluble. These are known as alkalies. Therefore water soluble bases are known as alkalies eg. KOH, NaOH. A list of a few typical bases along with their chemical formulae and uses is given below-

Name	Commercial Name	Chemical Formula	Uses
Sodium hydroxide	Caustic Soda	NaOH	In manufacture of soap, paper, pulp, rayon, refining of petroleum etc.
Potassium hydroxide	Caustic Sba	KHO	In alkaline storage batteries, manufacture of soap, absorbing CO_2 gas etc.
Calcium hydroxide	Slaked lime	$Ca(OH)_2$	In manufacture of bleaching powder softening of hard water etc.
Magnesium hydroxide	Mil of Magnesia	$Mg(OH)_2$	As an antacid to remove acidity from stomach
Aluminum hydroxide	-	$Al(OH)_3$	As foaming agent in fire extinguishers.
Ammonium hydroxide	-	NH_4OH	In removing greases stains from cloths and in cleaning window panes.

4.2 (b) Chemical Properties :

1. Action with metals : Metals like zinc, tin and aluminum react with strong alkalies like NaOH (caustic soda), KOH (caustic potash) to evolve hydrogen gas.

$$Zn(s) + 2NaOH(aq) \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2(aq)} + H_2(g)$$

$$Sn(s) + 2NaOH(aq) \longrightarrow \underset{\text{Sodium stannite}}{Na_2SnO_2(aq)} + H_2(g)$$

$$2Al(s) + 2NaOH + 2H_2O \longrightarrow \underset{\text{Sodium meta aluminate}}{2NaAlO_2(aq)} + 3H_2(g)$$

2. Action with non-metallic oxides: Acids react with metal oxides, but bases react with oxides of non-metals to form salt and water.

For e.g.

$$2NaOH(aq) + CO_2(g) \longrightarrow Na_3CO_3(aq) + H_2O(\ell)$$

$$Ca(OH)_2(s) + SO_2(g) \longrightarrow CaSO_3(aq) + H_2O(\ell)$$

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

4.2 (c) Strong and Weak Bases :

(i) Strong base : A base contains one or more hydroxyl (OH) groups which it releases in aqueous solution upon ionisation. Bases which are almost completely ionised in water, are known as strong bases.

For e.g.

Sodium hydroxide (NaOH), potassium hydroxide (OH) groups which it releases in aqueous solution upon ionisation. Bases which are almost completely ionised in water, are known as strong bases.

$NaOH(s) + Water \longrightarrow Na^+ (aq) + OH^-(aq)$

$KOH(s) + Water \longrightarrow K^+ (aq) + OH^- (aq)$

Both NaOH and KOH are deliquescent in nature which means that they absorb moisture from air and get liquefied.

(ii) Weak bases : Bases that are feebly ionised on dissolving in water and reduce a low concentration of hydroxyl ions are called weak bases.

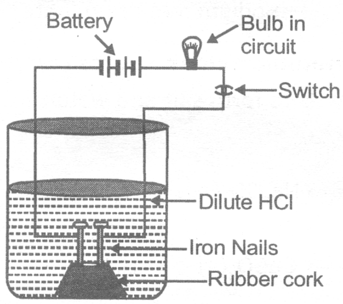
eg. Ca(OH)2, NH_4OH

4.3 CONDUCTING NATURE OF ACID AND BASE SOLUTIONS :

Acids are the substances which contain one or more hydrogen atoms in their molecules which they can release in water as H^+ ions. Similarly, bases are the substances which contain one or more hydroxyl groups in their molecules which they an release in water as OH^- ions. Since the ions are the carries of charge therefore, the aqueous solutions of both acids and bases are conductors of electricity.

Experiment :

In a glass beaker, take a dilute solution of hydrochloric acid (HCl). Fix two small nails of iron in a rubber cork in the beaker as shown in the figure. Connect the nails to the terminals of a 6 volt battery through a bulb. Switch on the current and bulb will start glowing. This shows that the electric current has passed through the acid solution. As the current is carried by the movement of ions, this shows that is solution HCl has ionised to give H^+ and Cl^- ions. Current will also be in a position to pass if the beaker contains in it dilute H_2SO_4 (H^+ ions are released in aqueous solution). Similarly, aqueous solutions containing NaOH or KOH will also be conducting due to release of OH^- ions.



Bulb will not glow if glucose ($C_6H_{12}O_6$) or ethyl alcohol (C_2H_6O) solution is kept in the beaker. This means that both of them will not give any ions in solution.

4.4 COMPARISON BETWEEN PROPERTIES OF ACIDS AND BASES :

Acids	Bases
1. Sour in taste. 2. Change colours of indicators et. Litmus turns from blue to red, phenolphthalein remains colourless. 3. Shows electrolytic conductivity in aqueous solution. 4. Acidic properties disappear when reacts with bases (Neutralisation). 5. Acids decompose carbonate salts.	1. Bitterness in taste. 2. Change colours of indicators eg, litmus turns from red to blue, phenolphthalein furns from colourless to pink. 3. Shows electrolytic conductivity in aqueous solutions. 4. Basic properties disappear when reacts with acids (Neutralisation). 5. No decomposition of carbonate salts by bases.

4.5 ROLE OF WATER IN THE INISATION OF ACIDS AND BASES :

Substances can act as acids and bases only in the presence of water in aqueous solution. In dry state which is also called anhydrous state, these characters cannot be shown Actually, water helps in the ionisation of acids or base by separating the ions. This is also known as dissociation and is explained on the basis of a theory called Arrhenius theory of acids and bases.

In the dry state, hydrochloric acid is known as hydrogen chloride gas i.e. HCl(g). It is not in the position to give any H^+ ions. Therefore, the acidic character is not shown. Now, let us pass the gas through water taken in a beaker with the help of glass pipe. H_2O molecules are of polar nature which means that they have partial negative charge (δ^{+}) on oxygen atom and partial positive charge (δ^{-}) on hydrogen atoms. They will try to form a sort of envelope around the hydrogen atoms as well as chlorine atoms present in the acid and thus help in their separation as ions. These ions are said to be hydrated ions.

$$HCl(g) + Water \longrightarrow \underset{\text{(Hydrated ions)}}{H^{+}(aq) + Cl^{-}(aq)}$$

The electrical current is carried through these ions. The same applied to other acids as well as bases. Thus we conclude that -

(i) acids can release H^+ ions only in aqueous solution.

(ii) base can release OH^- ions only in aqueous solution.

(iii) hydration helps in the release of ions from acids and bases.

4.6 DILUTION OF ACIDS AND BASES :

Acids and bases are mostly water soluble and can be diluted by adding the required amount of water. With the addition of water the amount of acid or base per unit volume decrease and dilution occurs. The process is generally exothermic in nature. A concentrated acid like sulphuric acid or nitric acid is to be diluted with water. Acid should be added dropwise to water taken in the container with constant stirring.

DAILY PRACTICE PROBLEMS # 4

OBJECTIVE DPP - 4.1

1. The acid used in making of vinegar is -
(A) Formic acid (B) Acetic acid (C) Sulphuric acid (D) Nitric acid

2. Common name of H_2SO_4 is-
(A) Oil of vitriol (B) Muriatic acid (C) Blue vitriol (D) Green vitriol

3. $CuO + (X) \longrightarrow CuSO_4 + H_2O$. Here (X) is-
(A) $CuSO_4$ (B) HCl (C) H_2SO_4 (D) HNO_3

4. Which of the following is the weakest base ?
(A) NaOH (B) NH_4OH (C) KOH (D) $Ca(OH)_2$

5. Reaction of an acid with a base is known as-
(A) decomposition (B) combination (C) redox reaction (D) neutralization

6. When CO_2 is passed through lime water, it turns milky; The milkiness is due to the formation of -
(A) $CaCO_3$ (B $Ca(OH)_2$ (C) H_2O (D) CO_2

7. Caustic soda is the common name for-
(A) $Mg(OH)_2$ (B) KOH (C) $Ca(OH)_2$ (D) NaOH

8. Antacids contain -
(A) Weak base (B) Weak acid (C) Strong base (D) Strong acid

9. Calcium hydroxide (slaked lime) is used in -
(A) Plastics and dyes (B) Fertilizers (C) Antacids (D) White washing

10. Acids gives -
(A) H^+ in water (B) OH^- in water (C) Both (A) & (B) (D) None of these

11. H_2CO_3 is a -
(A) strong acid (B) weak acid (C) strong base (D) weak base

SUBJECTIVE DPP- 4.2

1. Equal amounts of calcium are taken in test tubes (A) and (B). Hydrochloric acid (CHI) is added to test tube (A) while acetic acid (CH_3COOH) is added to test tube (B). In which case, fizzing occurs more vigorously and why ?

2. Give the name of two mineral acids and their uses.

3. What effect does concentration of H^+ (aq) have on acidic nature of the solution?

4. What do you understand by organic acids? Give the name of the organic acids and their sources.

5. Which gas is usually liberated when an acid reacts with metal? Illustrate with an example how will you test the presence of the gas?

➤ACIDS, BASES AND SALTS➤

5.1 INDICATORS:

Indicator indicated the nature of particular solution whether acidic, basic or neutral. Apart from this, indicator also represents the change in nature of the solution from acidic to basic and vice versa. Indicators are basically coloured organic substances extracted from different plants. A few common acid base indicators are

5.1 (a) Litmus :

Litmus is a purple dye which is extracted from 'lichen' a plant belonging to variety Thallophytic. It can also be applied on paper in the form of strips and is available as blue and red strips. A blue litmus strip, when dipped in an acid solution acquires red colour. Similarly a red strip when dipped in a base solution becomes blue.

5.1 (b) Phenolphthalein :

It is also an organic dye and acidic in nature. In neutral or acidic solution, it remains colourless while in the basic solution, the colour of indicator changes to pink.

5.1 (c) Methyl Orange :

Methyl orange is an orange coloured dye (yellow) and basis in nature. In the acidic medium the colour of indicator becomes red and in the basic or natural medium, it colour remains unchanged.

5.1 (d) Red Cabbage Juice :

It is purple in colour in natural medium and turns red or pink in the acidic medium. In the basic or alkaline medium, its colour changes to green.

5.1 (e) Turmeric Juice :

It is yellow in colour and remains as such in the neutral and acidic medium. In the basic medium its colour becomes reddish or deep brown.

Sample	Blue litmus solution	Red litmus solution	Phenolphthalein	Methyl orange
HCl	Changes to red	No colour change	Remains colourless	Changes to red
HNO_3	Changes to red	No colour change	Remains colourless	Changes to red
NaOH	No colour change	Changes to blue	Changes to light pink	No changes in colour
KOH	No colour change	Changes to blue	Changes to light pink	No changes in colour

Litmus is obtained from LICHEN plant.

5.2 NEUTRALISATION :

It may be defined as a reaction between acid and base present in aqueous solution to form salt and water.

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

Basically neutralision is the combination between H^+ ions of the acid with OH^- ions of the base to form H_2O.

For e.g.

$H^+(aq) + Cl^-(aq) + Na^+ (aq) + OH^- (aq) \longrightarrow Na^+(aq) + Cl^-(aq) + H_2O(\ell)$

$H^+(aq) + OH^-(aq) \longrightarrow H_2O(\ell)$

Neutralisation reaction involving an acid and base is of exothermic nature. Heat is evolved in all naturalisation reactions. If both acid and base are strong, the value of heat energy evolved remains same irrespective of their nature.

For e.g.

$HCl\ (aq) + NaOH\ (aq) \longrightarrow NaCl\ (aq) + H_2O(\ell) + 57.1\ KJ$

(Strong acid) (Strong base)

$HNO_3\ (aq) + KOH(aq) \longrightarrow KNO_3(aq) + H_3O(\ell) + 57.1\ J$

(Strong acid) (Strong base)

Strong acids and strong bases are completely ionised of their own in the solution. No energy is needed for their ionisation. Since the action of base and anion of acid on both sides of the equation cancels out completely, the heat evolved is given by the following reaction -

$H^+\ (aq) + OH^-\ (aq) \longrightarrow H_2O(\ell) + 57.1\ KJ$

5.3 APPLICATIONS OF NEUTRALISATION :

(i) People particularly of old age suffer from acidity problems in the stomach which is caused mainly due to release of excessive gastric juices containing HCl. The acidity is neutralised by antacid tablets which contain sodium hydrogen carbonate (baking soda), magnesium hydroxide etc.

(ii) The sting of bees and ants contain formic acid. Its corrosive and poisonous effect can be neutralised by rubbing soap which contains NaOH (an alkali).

(iii) The stings of wasps contain an alkali and its poisonous effect can be neutralised by an acid like acetic acid (present in vinegar).

(iv) Farmers generally neutralise the effect of acidity in the soil caused by acid rain by adding slaked lime (Calcium hydroxide) to the soil.

5.4 pH SCALE :

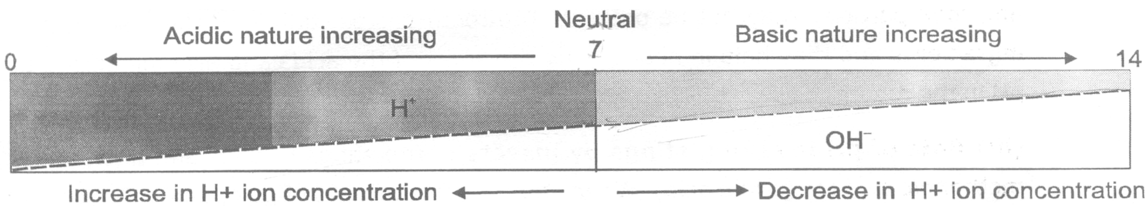
A scale for measuring hydrogen ion concentration in a solution called pH scale, has been developed by S.P.L. sorrensen. The P in pH stands for potenz' in German meaning power. On the pH scale we can measure pH from O (very acidic) to 14 (very alkaline). pH should be thought of simply as a number which indicates the acidic or basic nature of solution. Higher the hydrogen ion concentration, Lower is the pH scale.

Characteristic of pH scale are -

(i) For acidic solution, pH < 7

(ii) For alkaline solution, pH > 7

(iii) For neutral solution, pH = 7



5.4 (a) Universal Indicator Papers for pH Values :

Indicators like litmus, phenolphthalein and methyl orange are used in predicting the acidic and basic characters of the solutions. However universal indicator papers have been developed to predict the pH of different solutions. Such papers represent specified colours for different concentrations in terms of pH values.

The exact pH of the solution can be measured with the help of pH meter which gives instant reading and it can be relied upon.

pH values of a few common solutions are given below -

Solution	Approximate pH	Solution	Approximate pH
Gastric juices	1.0 – 3.0	Pure water	7.0
Lemon juices	2.2 - 2.4	Blood	7.36 – 7.42
Vinegar	3.0	Baking soda solution	8.4
Bear	4.0 – 5.0	Sea water	9.0
Tomato juice	4.1	Washing soda solution	10.5
Coffee	4.5 – 5.5	Lime water	12.0
Acid rain	5.6	House hold ammonia	11.9
Milk	6.5	Sodium hydroxide	14.0
Saliva	6.5 – 7.5		

5.4 (b) Significance of pH in daily life :

(i) pH i our digestive system : Dilute hydrochloric acid produced in our stomach helps in the digestion of food. However, excess of acid causes indigestion and leads to pain as well as irritation. The pH of the digestive system in the stomach will decrease. The excessive acid can be neutralised with the help of antacid which are recommended by the doctors. Actually, these are group of compounds (basic in nature) and have hardly and side effects. A very popular antacid is 'Milk of Magnesia' which is insoluble magnesium hydroxide. Aluminum hydroxide and sodium hydrogen carbonate can also be used for the same purpose. These antacids will bring the pH of the system back to its normal value. The pH of human blood varies between 7.36 to 7.42. it is maintained by the soluble bicarbonates and carbonic acid present in the blood. These are known as

buffers.

(ii) pH change leads to tooth decay : The white enamel coating on our teeth is of insoluble calcium phosphate which is quite hard. It is not affected by water. However, when the pH in the mouth falls below 5.5 the enamel gets corroded. Water will have a direct access to the roots and decay of teeth will occur. The bacteria present in the mouth break down the sugar that we eat in one form or the other to acids, Lactic acid is one these. The formation of these acids causes decrease in pH. It is therefore advisable to avoid eating surgery foods and also to keep the mouth clean so that sugar and food particles may not be present. The tooth pastes contain in them some basic ingredients and they help in neutralising the effect of the acids and also increasing the pH in the mouth.

(iii) Role of pH in curing stings by insects: The stings of bees and ants contain methanoic acid (or formic acid). When stung, they cause lot of pain and irritation. The cure is in rubbing the affected area with soap. Sodium hydroxide present in the soap neutralises acid injected in the body and thus brings the pH back to its original level bringing relief to the person who has been stung. Similarly, the effect of stings by wasps containing alkali is neutralised by the application of vinegar which is ethanoic acid (or acetic acid)

(iv) Soil pH and plant growth : The growth of plants in a particular soil is also related to its pH. Actually, different plants prefer different pH range for their growth. it is therefore, quite important to provide the soil with proper pH for their healthy growth. Soils with high iron minerals or with vegetation tend to become acidic. This soil pH can reach as lows as 4. The acidic effect can be neutralised by 'liming the soil' which is carried by adding calcium hydroxide. These are all basic in nature and have neutralising effect. Similarly, the soil with excess of lime stone or chalk is usually alkaline. Sometimes, its pH reaches as high as 8.3 and is quite harmful for the plant growth. In order to reduce the alkaline effect, it is better to add some decaying organic matter (compost or manure). The soil pH is also affected by the acid rain and the use of fertilizers. Therefore soil treatment is quite essential.

DAILY PRACTICE PROBLEMS # 5

OBJECTIVE DPP-5.1

1. A solution turns red litmus blue. Its pH is likely to be-
(A) 2 (B) 4 (C) 7 (D) 10

2. If pH of any solution is equal to zero then solution will be-
(A) acidic (B) basic (C) neutral (D) none of these

3. Methyl orange is -
(A) an acidic indicator (B) a basic indicator (C) a neutral indicator (D) none of these

4. pH of Blood is-
(A) 6.4 (B) 7.4 (C) 4.7 (D) 6.4

5. If ph of solution is 13, means that it is-
(A) weakly acidic (B) weakly basic (C) strongly acidic (D) strongly basic

6. Which is a base and not an alkali ?
(A) NaOH (B) KOH (C) $Fe(OH)_3$ (D) None is true

7. Energy released in neutralisation reaction which occurs between strong acid and strong base is-
(A)57.8 kJ (B) 57.1 kJ (C) hNO_3 (D) $H_2C_2O_4$

9. A solution has pH 9. On dilution the pH value
(A) decreases (B) increases (C) remain same (D) none of these

SUBJECTIVE DPP-5.2

1. Five solutions A,B,C,D and E when tested with universal indicator shows pH as 5, 3, 13, 7 and 9 respectively. Which solution is -

   (a) neutral.

   (b) strongly alkaline.

   (c) strongly acidic.

   (d) weakly alkaline.
   (e) weakly acidic.
   Arrange the pH in decreasing order of H^+ ion concentration.

2. What will you observe when-

   (i) red litmus paper is introduced into a solution of sodium sulphate ?

   (ii) methyl orange is added to dilute hydrochloric acid ?

   (iii) a drop of phenolphthalein is added to solution of lime water ?

   (iv) blue litmus is introduced into a solution of ferric chloride ?

3. Give two applications of pH in our daily life.

4. Explain why ?

   (i) Aqueous solution of sodium acetate has pH more than 7.

   (ii) Aqueous solution of copper sulphate has pH less than 7.

   (iii) Aqueous solution of Potassium nitrate has pH value 7.

6.1 SALTS :

A substance formed by neutralization of an acid with a base is called a salt.

For e.g.

$Ca\ (OH)_2 + H_2SO_4 \rightarrow CaSO_4 + H_2O$

$2Ca(OH)_2 + 4HNO_3 \rightarrow 2Ci(NO_3)_2 + 2H_2O$

$NaOH + HCl \rightarrow NaCl + H_2O$

6.2 CLASIFFICATION OF SALTS :

Salts have been classified on the basis of chemical formulae as well as pH values.

6.2 (a) Classification Based on Chemical Formulae :

(i) Normal salts : A normal salt is the one which does not contain any ionsable hydrogen atom or hydroxyl group. This means that it has been formed by the complete neutralisation of an acid by a base.
For e.g. NaCl, KCl, $NaNO_2$, $K_2\ SO_4$ etc.

(ii) Acidic salts : an acidic salt still contains some replaceable hydrogen atoms, This means that the neutralisation of acid by the base is no complete. For example, sodium hydrogen sulphate ($NaHCO_4$), sodium hydrogen carbonate ($NaHCl_3$) etc.

(iii) Basic salts : A basic salt still contains some replaceable hydroxyl groups. This means that the neutralisation of base by the acid is not complete. For example, basic lead nitrate Pb (OH) NO_3. basic lead chloride, Pb(OH)Cl etc.

6.2 (b) Classification Based on pH Values :

Salts are formed by the reaction between acids and bases. Depending upon the nature of the acids and bases or upon the pH values, the salt solutions are of three types.

(i) Neutral salt solutions : Salt solutions of strong acids and strong bases are neutral and have pH equal to 7. They do not change the colour of litmus solution.
For e.g. : NaCl, $NaNO_3$, Na_2SO_4 etc.

(ii) Acidic salt solutions : Salt solutions of strong acids and weak bases are of acidic nature and have pH less than 7. They change the colour of blue litmus solution to red.

For e.g. $(NH_4)_2SO_4$, NH_4Cl etc.
In both these salts, the base NH_4OH is weak while the acids H_2SO_4 and HCl are strong.

(iii) Basic salt solutions : Salt solutions of strong bases and weak acids are of basic nature and have pH more than 7. They change the colour of red litmus solution to blue.

For e.g. Na_2CO_3, K_3PO_4 etc.
In both the salts, bases NaOH and KOH are strong while the acids H_2CO_3 and H_3PO_4 are weak.

6.3 USES OF SALTS :

(i) As a table salt,

(ii) In the manufacture of butter and cheese.

(iii) In leather Industry.

(iv) In the manufacturing of washing soda and baking soda.

(v) For the preparation of sodium hydroxide by electrolysis of brine.

(vi) Rock salt is spread on ice to melt it in cold countries.

SOME IMPORTANT CHEMICAL COMPOUNDS :

6.4 SODIUM CHLORIDE - COMMON SALT (TABLE SALT) :

Sodium chloride (NaCl) also called common salt or table salt is the most essential part of our diet. Chemically it is formed by the reaction between solutions of sodium hydroxide and hydrochloric acid. Sea water is the major source of sodium chloride where it is present in disserved form along with other soluble salts such as chlorides and sulphates of calcium and magnesium. it is separated by some suitable methods. Deposits of the salts are found in different part of the world and is known as rock salt. When pure, it is a white crystalline solid, However, it is often brown due to the presence of impurities.

6.4 (a) Uses :

(i) Essential for life : Sodium chloride is quite essential for life. Biologically, it has a number of function to perform such as in muscle contraction, in conduction of nerve impulse in the nervous system and is also converted in hydrochloric acid which helps in the digestion of food in the stomach. When we sweat, there is loss of sodium chloride along with water. It leads to muscle cramps. Its loss has to be compensated suitably by giving certain salt preparations to the patient. Electrol powder is an important substitute of common salt.

(ii) Raw material for chemical: Sodium chloride is also a very useful raw material for different chemical. A few out of these are hydrochloric acid (HCl), washing soda ($Na_2CO_3.10H_2O$), baking soda ($NaHCO_3$) etc. Upon electrolysis of a strong solution of the salt (brine), sodium hydroxide, chlorine and hydrogen are obtained. Apart from these, it is used in leather industry for the leather tanning. In severe cold, rock salt is spread on icy roads to melt ice. it is also used as fertilizer for sugar beet.

6.4 (b) Electrolysis of aqueous solution of NaCl :

$$2NaCO\,(s) + 2H_2O\,(\ell) \xrightarrow{\text{Electrolysis}} 2NaOH(aq) + Cl_2(g) + H_2(g)$$

reaction takes place in two steps

(i) $2Cl^- \longrightarrow Cl_2(g) + 2e^-$ (anode reaction)

(ii) $2H_2O + 2e^- \longrightarrow H_2 + OH^-$ (cathode reaction)

6.5 WASHING SODA :

Chemical name :

Sodium carbonate decahydrate

Chemical formula : $Na_2CO_3, 10H_2O$

6.5 (a) Recrystallization of sodium carbonate:

Sodium carbonate is recrystallized by dissolving in water to get washing soda it is a basic salt.

$$\underset{\text{Sodium carbonate}}{Na_2CO_3} + 10H_2O \longrightarrow \underset{\text{Washing soda}}{Na_2CO_3, 10H_2O}$$

6.5 (b) Uses :

(i) It is used as cleansing agent for domestic purposes.

(ii) It is used in softening hard water and controlling the pH of water.

(iii) It is used in manufacture of glass.

(iv) Due to its detergent properties, it is used as a constituent of several dry soap powders.

(v) It also finds use in photography, textile and paper industries etc.

(vi) It is used in the manufacture of borax ($Na_2B_4O_7 . 10H_2O$)

6.6 BAKING SODA :

Baking soda is sodium hydrogen carbonate or sodium bicarbonate ($NaCHO_3$).

6.6 (a) Preparation :

It is obtained as an intermediate product in the preparation of sodium carbonate by Solvay process. In this process, a saturated solution of sodium chloride in water is saturated with ammonia and then carbon dioxide gas is passed into the liquid. Sodium chloride is converted into sodium bicarbonate which, being less soluble, separates out from the solution.

$$2NH_3\,(g) + H_2O\,(\ell) + CO_2\,(g) \longrightarrow (NH_4)_2\,CO_3(aq)$$

$$(NH_4)_2CO_3\,(aq) + 2NaCl(aq) \longrightarrow Na_2CO_3\,(aq) + 2NH_4Cl(aq)$$

$$Na_2CO_3(aq) + H_2O\,(\ell) + CO_2\,(g) \longrightarrow 2NaHCO_3(s)$$

6.6 (b) Properties :

(i) It is a white, crystalline substance that forms an alkaline solution with water. The aqueous solution of sodium bicarbonate is neutral to methyl orange but gives pink colour with phenolphthalein orange. (Phenolphthalein and methyl orange are dyes used as acid-base indicators.)

(ii) When heated above 543 K, it is converted into sodium carbonate.

$$2NaHCO_3\,(s) \longrightarrow Na_2CO_3\,(s) + CO_2\,(g) + H_2O\,(\ell)$$

6.6 (c) Uses :

(i) It is used in the manufacture of baking powder. Baking powder is a mixture or potassium hydrogen tartar ate and sodium bicarbonate. During the preparation of bread the evolution of carbon dioxide causes bread the evolution of carbon dioxide causes bread to rise (swell).

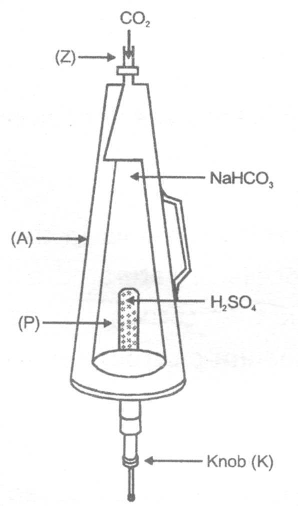
$$\begin{array}{l} CH(OH)COOK \\ | \\ CH(OH)COOH \end{array} + NaHCO_3 \longrightarrow \begin{array}{l} CH(OH)COOK \\ | \\ CH(OH)COONa \end{array} + CO_2 + H_2O$$

(ii) It is largely used in the treatment of acid spillage and in medicine as soda bicarb, which acts as an antacid.

(iii) It is an important chemical in th textile, tanning, paper and ceramic industries.

(iv) It is also used in a particular type of fire extinguishers. The following diagram shows a fire extinguisher that uses $NaHCl_3$ and H_2SO_4 to produce CO_2 gas. The extinguisher consists of a conical metallic container (A) with a nozzle (Z) at one end. A strong solution of $NaHCO_3$ is kept in the container. A glass ampoule (P) containing H_2SO_4 is attached to a knob (K) and placed inside the $NaHCO_3$ solution. The ampoule can be broken by hitting the knob. As soon as the acid comes in contact with the $NaHCO_3$ solution, CO_2 gas is formed. When enough pressure in built up inside the container, CO_2 gas rushes out through the nozzle (A). Since CO_2 does not support combustion, a small fire can be put out by pointing the nozzle towards the fire. The gas is produced according to the following reaction.

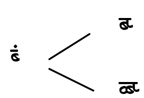
$2NaHCO_3\,(aq) + H_3SO_4\,(aq) \longrightarrow Na_2SO_4\,(aq) + 2H_2O\,(\ell) + 2CO_2(g)$



Fire Extinguisher

6.7 BLEACHING POWDER :

Bleaching powder is commercially called 'chloride of lime or' chlorinated lime'. It is principally calcium oxychloride having the following formula :



Bleaching powder is prepared by passing chlorine over slaked lime at 313 K.

$Ca(OH)32\,(aq) + Cl_2(g) \xrightarrow{313\text{ K}} Ca(OCl)Cl\,(s) + H_2O(g)$

Slaked lime Bleaching powder

Actually beaching powder is not a compound but a mixture of compounds : $CaOCl_2$, $4H_2O$, $CaCl_2$. $Ca(OH)_2$. H_2O

6.7 (a) Uses :

(i) It is commonly used as a bleaching agent in paper and textile industries.

(ii) It is also used for disinfecting water to make water free from germs.

(iii) It is used to prepare chloroform.

(iv) It is also used to make wool shrink-proof.

6.8 PLASTER OF PARIS :

6.8 (a) Preparation :

It is prepared by heating gypsum ($CaSO_4 . 2H_2O$) at about
373 k in large seel pots with mechanical stirrer ,
or in a revolving furnace .

$$\underset{\text{Gypsum}}{2(CaSO_4,2H_2O)} \xrightarrow{373\ K} \underset{\text{Plaster of Parries}}{(CaSO_4)_2, H_2O} + 3H_2O$$

$$\text{or } CaSO_4, 2H_2O \longrightarrow CaSO_4, \frac{1}{2} H_2O + \frac{3}{2} H_2O$$

The temperature is carefully controlled, as at higher temperature
gypsum is fully dehydrated . The properties of dehydrated gypsum are completely
different from those of plaster of Paris.

6.8 (b) Properties :

(i) Action with water : When it is dissolved in water , it gets crystallized and forms gypsum

$$CaSO_4, \frac{1}{2} H_2O + \frac{3}{2} H_2O \longrightarrow CaSO_4,2H_2O$$

6.8 (c) Uses :

When finely powered Plaster of Parries is mixed with water and made into a paste, it quickly sets into a hard mass. In the process, its volume also increases slightly. These properties find a number of uses. Addition of water turns Plaster of Parries back into gypsum.

(i) It is used in the laboratories for sealing gaps where airtight arrangement is required.

(ii) It is also used for making toys, cosmetic and casts of statues.

(iii) It is used as a cast for setting broken bones.

(iv) It also find use in making moulds in pottery.

(iv) It is also used for making surfaces smooth and for making designs on walls and ceilings.

6.9 HYDRATED SATLS - SALTS CONTAINING WATER OF CRYSTALLISATION:

Certain salts contain definite amount of some H_2O molecules loosely attached to their own molecules. These are known as hydrated salts and are of crystalline nature. The molecules of H_2O present are known as 'water of crystallisation'.

In colourd crystalline and hydrated salts, the molecules of water of crystallisation also account for their characteristic colours. Thus, upon heating of hydrated salt, its colour changes since molecules of water of crystallisation are removed and the salt becomes anhydrous, For example, take a few crystals of blue vitriol i.e. hydrated copper sulphate in a dry test tube or boiling tube. Heat the tube from below. The salt will change to a white anhydrous powder and water droplet will appear on the walls of the tube. Cool the tube and add a few droops of water again. The white anhydrous powder will again acquire blue colour.

$CuSO_4 . 5H_2O \xrightarrow{\Delta} CuSO_4 + 5H_2O$

Copper sulphate (Hydrated) Copper sulphate (Anhydrous)

DAILY PRACTICE PROBLEMS # 6

OBJECTIVE DPP-6.1

1. A salt derived from strong acid and weak base will dissolve in water to give a solution which is -
(A) acidic (B) basic (C) neutral (D) none of these

2. Materials used in the manufacture of bleaching powder are -
(A) lime stone and chlorine (B) quick lime and chlorine
(C) slaked lime and HCl (D) slaked lime and chlorine

3. Bleaching powder gives smell of chlorine because it-
(A) is unstable (C) gives chlorine on exposure to atmosphere
(C) is mixture of chlorine and slaked lime (D) contains excess of chlorine

4. Baking powder contains, baking soda and-
(A) potassium hydrogen tartarate (B) calcium bicarbonate
(C) sodium carbonate (D) vinegar

5. Plaster of pairs is made from-
(A) lime stone (B) slaked lime (C) quick lime (D) gypsum

6. Setting of plaster of Paris takes place due to-
(A) oxidation (B) reduction (C) dehydration (D) hydration

7. Chemical formula of baking soda is-
(A) $mGSO_4$ (B) Na_2CO_3 (C) $NaHCO_3$ (D) $MgCO_3$

8. The chemical name of marble is -
(A) calcium carbonate (B) Magnesium carbonate
(C) calcium chloride (D) calcium sulphate

9. Washing soda has the formula -
(A) $Na_2 CO_3, 7H_2O$ (B) $Na_2CO_3, 10H_2O$ (C) Na_2CO_3,H_2O (D) Na_2CO_3

10. The raw materials required for the manufacture of $NaHCO_3$ by Solvay process are -
(A) $CaCl_2$, $(NH_4)_2 CO_3$, NH_3 (B) $NH_4Ci,NaCl_2Ca(OH)_2$
(C) $NaCl_2,(NH_4)_2CO_3,NH_3$ (D) $NaCO,NH_3CaCO_3,H_2O$

11. Plaster of Paries hardens by-
(A) giving off CO_2. (B) changing into $CaCO_3$.
(C) combining with water (D) giving out water.

12. The difference in number of water molecules in gypsum and plaster of paris is-
(A) 5/2 (B) 2 (C) ½ (D) 3/2

SUBJECTIVE DPP-6.2

1. Give chemical names of the following compounds. Also state one use in each case.
(i) Washing soda (ii) Baking soda (iii) Bleaching powder

2. Explain why-
(i0 common salt becomes sticky during the rainy season ?

(ii) blue vitriol changes to white upon heating ?

(iii) anhydrous calcium chloride is used in desiccators ?

(iv) if a bottle full of concentrated sulphuric acid is left open in the atmosphere by accident the acid starts flowing out of the bottle of its own ?

3. How will you prepare the following ? Give chemical reactions also.

(i) Plaster of Paris from Gypsum.

(ii) Bleaching powder from slaked lime.

(iii) Baking soda from brine.

ANSWERS

OBJECTIVE DPP - 4.1

Ques.	1	2	3	4	5	6	7	8	9	10	11
Ans	B	A	C	B	D	A	D	A	D	A	B

OBJECTIVE DPP- 5.1

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

OBJECTIVE DPP -6.1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12
Ans	A	D	B	A	D	D	C	A	B	D	C	D

➤METALS AND NON-METALS⮜

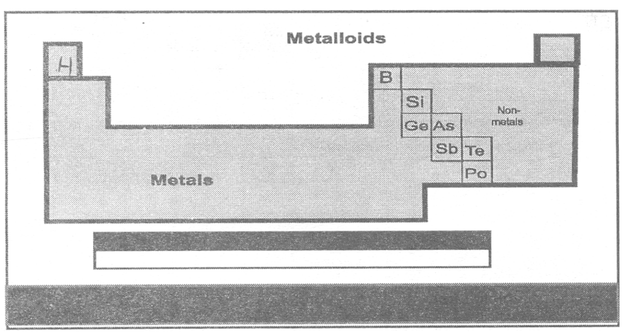
7.1 INTRODUCTION:

There are 118 chemical elements known at present. One the basis of their properties, all these elements can be broadly divided into two main groups: Metals and Non-Metals. A majority of the known elements are metals. All the metals are solids, except mercury, which is a liquid metal. There are 22 non-metals, out of which, 10 non-metals are solids, one non-metal (bromine) is liquid and the remaining 11 non-metals are gases.

7.2 POSITION OF METALS AND NON-METALS IN THE PERIODIC TABLE :

The metals are placed on the left hand side and in the centre of the periodic table. One the other hand, the non-metals are placed on the right hand side of the periodic table. This has been shown in the figure. It may be noted that hydrogen (H) is an exception because it is non-metal but is placed on the left hand side of the periodic table.

Metals and non-metals are separated from each other in the periodic table by a zig-zag line. The elements close to zig-zag line show properties of both the metals and the non-metals. They show some properties of metals and some properties of non-metals. These are called metalloids. The common examples of metalloids are boron (B), silicon (Si), germanium (Ge), arsenic (As), antimony (Sb), tellurium (Te) and polonium (Pi).



In general, the metallic character decreases on going from left to right side in the periodic table. However, on going down the group, the metallic character increases.

The elements at the extreme left of the periodic table are most metallic and those on the right are least metallic or non-metallic.

7.3 GENERAL PROPERTIES OF METALS AND NON-METALS :

7.3 (a) Electronic Configuration of Metals :

The atoms of metals have 1 to 3 electrons in their outermost shells. For example, all the alkali metals have one electron in their outermost shells (lithium 2, 1; sodium 2,8,1: potassium 2,8,8,1 etc.)
Sodium, magnesium and aluminum are metals having 1,2 and 3 electrons respectively in their valence shells. Similarly, other metals have 1 to 3 electron in their outermost shells.

It may be noted that hydrogen and helium are exception because hydrogen is a non-metal having only electron in the outermost shell (K shell) of its atom and helium is also a non-metal having 2 electron in the outermost shell (K shell).

7.3 (b) Physical Properties of Metals:

The important physical properties of metals are discussed below:

(i) Metals are solids at room temperature: All metals (except mercury) are solids at room temperature.

MERCURY is a liquid at room temperature.

(ii) Metals are malleable: metals are generally malleable. Malleability means that the metals can be beaten with a hammer into very thin sheets without breaking. Gold and silver are among the best malleable metals. Aluminum and copper re also highly malleable metals.

(iii) Metals are ductile : It means that metals can be drawn (stretched) into this wires. Gold and silver are the most ductile metals. Copper and aluminum are also very ductile, and therefore, these can be drawn into this wires which are used in electrical wiring.

(iv) Metals are good conductors of heat and electricity: All metals are good conductors of heat. The conduction of heat is called thermal conductivity. Silver is the best conductor of heat. Copper and aluminum are also good conductors of heat and therefore, they are used for making household utensil. Lead is the poorest conductor of heat. Mercury metal is also poor conductor of heat.
Metals are also good conductors of electricity. The electrical and thermal conductivities of metals are due to the presence of free electrons in them. Among all the metals, silver is the best conductor electricity. Copper and aluminum are the next best conductors of electricity. Since silver is expensive, therefore, copper and aluminum are commonly used for making electric wires.

(v) Metals are lustrous and can be polished: Most of the metals have shine and they can be polished. The shining appearance of metals is also known as metallic lustre. For example, gold, silver and copper metals have metallic lustre.

Store in your memory

SILVER is best conductor of heat and electricity.

(vi) Metals have high densities : Most of the metals are heavy and have high densities. For example, the density of mercury metal if very high (13.6 g cm^{-3}). However, there are some exceptions. Sodium, potassium, magnesium and aluminum have low densities. Densities of metals are generally proportional to their atomic masses. The smaller the metal atom, the smaller it its density.

(vii) Metals are hard : Most of the metals are hard. But all metals are not equally hard. Metals like iron, copper, aluminum etc. are quite hard. They cannot be cut with a knife. Sodium and potassium are common exceptions which are soft and can be easily cut with a knife.

(viii) Metals have high melting and boiling points : Most of the metals (except sodium and potassium) have high melting and boiling points.

Tungsten has highest melting point (3410^{0}C) among all the metals.

(ix) Metals are rigid : Most of the metals are **rigid** and they have **high** tensile strength.

(x) Metals are sonorous: Most of the metals are **sonorous** i.e., they make sound when hit with an object.

7.3 (c) Electronic Configuration of Non-Metals :

The atoms and non-metals have usually 4 to 8 electrons in their outermost shells. For example, Carbon (At. No6), Nitrogen (At. No. 7), Oxygen (At. No.8), Fluorine (At. No. 9) and Neon (At. No. 10) have respectively 4,5,6,7,8 electrons in their outermost shells.

7.3 (d) Physical Properties Of Non-Metals:

The important physical properties of non-metals are listed below :

(i) Non-metals are brittle.

(ii) Non- metals are not ductile.

(iii) Non-metals are bad conductor of heat and electricity. (Exception: Graphite is a good conductor because of the presence of free electrons.)

(iv) Non-metals are not lustrous and cannot be polished. (Exception: Graphite and Iodine are lustrous non-metals.)

(v) Non-metals may be solid, liquid, or gases at room temperature.

(vi) Non-metals are generally soft. (Exception: Diamond, an allotropic from of non-metal Carbon, is the hardest natural substance known).

(vii) Non-metals have generally low melting and boiling points. (Exception: Graphite another allotropic form of Carbon, has a melting point of about 3730^{0}C).

(viii) Non-metals have low densities. (Exception : Iodine has high density).

Store in your memory

Graphite is a good conductor of electricity, lustrous and has very high melting point.

7.3 (e) Chemical Properties of Metals :

The atoms of the metals have usually 1, 2 or 3 electrons in their outermost shells. These outermost electrons are loosely held by their nuclei. Therefore, the metal atoms can easily lose their outermost electrons to from positively charged ions. For example, sodium metal can lose outermost one electron to form positively charged ions, Na^+. After losing the outermost electron, it gets stable electronic configuration of the noble gas (Ne : 2, 8), Similarly, magnesium can lose two outermost electron to from Mg^{2+} ions and aluminum can lose its three outermost electrons to from Al^{3+} ions.

$$\underset{(2,\,8,\,1)}{Na} \longrightarrow \underset{(2,\,8)}{Na^+ + e^-}$$

$$\underset{(2,\,8,\,2)}{Mg} \longrightarrow \underset{(2,\,8)}{Mg^{2+} + 2e^-}$$

$$\underset{(2,\,8,\,3)}{Al} \longrightarrow \underset{(2,\,8)}{Al^{3+} + 3e^-}$$

The metal atoms lose electrons and form positively charged ions, therefore, the metals are called electropositive elements.

Some of the important chemical properties of metals are discussed below :

(i) Reaction with oxygen : Metals react with oxygen to from **oxides.** These oxides are **basic** in nature. For example, sodium metal reacts with oxygen of the air and form sodium oxide.

]

$$4\,Na(s) + O_2(g) \longrightarrow \underset{\text{Sodium oxide}}{2\,Na_3O(s)}$$

Sodium oxide reacts with water to form and alkali called sodium hydroxide. Therefore, sodium oxide is a basic oxide.

$$Na_2O(s) + H32O\,(\ell) \longrightarrow \underset{\text{Sodium hydroxide}}{2NaOH(aq)}$$

Due to the formation of sodium hydroxide (which is an alkali), the solution of sodium oxide in water turns red litmus blue (common property of all alkaline solutions).

When metal oxides are dissolved in water, they give alkaline solutions.

Similarly, magnesium is a metal and it reacts with oxygen to form magnesium oxide. However, magnesium is less reactive than sodium and therefore, heat is required for the reaction.

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

Thus, when a metal combines with oxygen, it loses its valence electrons and forms positively charged metal ions. We can say that oxidation of metal takes palace.

Reactivity of metals with oxygen:

All metals **do not react** with oxygen with **equal ease.** The reactivity of oxygen depends upon the nature of the metal. Some metals **react** with oxygen even at **room temperature, some react on on heating** while still **others react** only on strong heating.

For example :

(A) Metals like sodium, potassium and calcium react with oxygen even at room temperature to form their oxides.

$4Na(s)$ +	$O_2(g)$	$\longrightarrow$	$2\,Na_2O(s)$
Sodium	Oxygen		Sodium oxide
$4K\,(s)$ +	$O_2(g)$	$\longrightarrow$	$2K_2O(s)$
Potassium	Oxygen		Potassium oxide
$2Ca(s)$ +	$O_2(g)$	$\longrightarrow$	$2\,CaO(s)$
Calcium	Oxygen		Calcium oxide

(B) Metals like magnesium and zinc do not react with oxygen at room temperature. They burn in air only on strong heating to from corresponding oxides.

$2Mg(s)$ +	$O_2(g)$	$\xrightarrow{\text{Heat}}$	$2MgO(s)$
Magnesium	Oxygen		Magnesium oxide
$2\,Zn(s)$ +	$O_2(g)$	$\xrightarrow{\text{Heat}}$	$2\,ZnO(s)$
Zinc	Oxygen		Zinc oxide

(C) Metals like iron and copper do not burn in air even on strong heating. However, they react with oxygen only on prolonged heating.

$3Fe(s)$ +	$2O_2(g)$	$\xrightarrow{\text{Heat}}$	$Fe_3O_4(s)$
Iron	Oxygen		Iron (II, III) oxide
$2\,Cu(s)$ +	$O_2(g)$	$\xrightarrow{\text{Heat}}$	$2CuO(s)$
Copper	Oxygen		Copper (II) oxide

(ii) Reaction with water : Metals react with water to form metal oxide or metals hydroxide and hydrogen. The reactivity of metals towards water depends upon the nature of the metals. Some metals react even with cold water, some react with water only on heating while there are some metals do not react even with steam. For example,

(A) Sodium and potassium metals react vigorously with cold water to form sodium hydroxide and hydrogen gas is liberated.

$2\,Na(s)$ +	$2H_2O\,(\ell)$	$\longrightarrow$	$2NaOH(aq)$	+	$H_2(g)$
Sodium	Cold water		Sodium hydroxide		Hydrogen
$2K\,(s)$ +	$2H_2O\,(\ell)$	$\longrightarrow$	$2KOH\,(aq)$	+	$H_2\,(g)$
Potassium			Potassium hydroxide		Hydrogen

The reaction between sodium and water is so violent that the hydrogen evolved catches fire.

(B) Calcium reacts with cold water to form calcium hydroxide and hydrogen gas. The reaction is **less violent.**

$Ca\,(s)$ +	$2H_2O\,(\ell)$	$\longrightarrow$	$Ca\,(OH)_2\,(aq) + H_2(g)$
Calcium	Cold water		calcium hydroxide

(C) Magnesium reacts very slowly with cold water but reacts rapidly with hot boiling water forming magnesium oxide and hydrogen.

$Mg\,(s)$ +	$H_2O\,(\ell)$	$\longrightarrow$	$MgO(s)$ +	$H_2(g)$
Magnesium	Boiling water		Magnesium oxide	

(D) Metals like zinc and aluminum react only with steam to form their corresponding oxides oxide hydrogen.

$Zn(s)$	+	$H_2O(g)$	$\longrightarrow$	$ZnO(s)$	+	$H_2(g)$
Zinc		Steam		Zinc oxide		
$2Al\ (s)$	+	$3H_2O(g)$	$\longrightarrow$	$Al_2O_3\ (s)$	+	$3H_2(g)$
Aluminum		Steam		Aluminum oxide		

(E) Iron metal does not react with water under ordinary conditions. The reactions occurs only when steam is passed over red hot iron and the products are iron (II, III) oxide and hydrogen.

$3Fe(s)$	+	$4H_2O(g)$	$\longrightarrow$	$Fe_3O_4(s)$	+	$4H_2(g)$
Iron (Red hot)		Steam		Iron (II,III) oxide		Hydrogen

(F) Metals like copper, silver and gold do not react with water even under strong conditions. The order of reactivities of different metals with water is :

Na > Mg > Zn > Fe > Cu

Reactivety with water decreases

(iii) Reaction with dilute acids : Many metals react with dilute acids and liberate hydrogen gas. Only less reactive metals such as copper, silver, gold etc. do into liberate hydrogen from dilute acids. The reactions of metals with dilute hydrochloric acid (HCl) and dilute sulphuric acid (H_2SO_4) are similar. With dil. HCl, they given metal chlorides and hydrogen whereas with dil. H_2SO_4, they give metal sulphates and hydrogen.

Dilute nitric acid (HNO_3) is an oxidising agent which oxidises metals, but does not produce hydrogen.

The reactivity of different metals is different with the same acid. For example:

(A) Sodium, magnesium and calcium react violently with dilute hydrochloric acid (HCl) or dilute sulphuric acid (H_2SO_4) liberating hydrogen gas and corresponding metal salt.

$2Na(s)$	+	$2HCl\ (aq)$	$\longrightarrow$	$2NaCl(aq)$	+	$H_2(g)$
Sodium		Hydrochloric acid		Sodium chloride		Hydrogen
$2Na(s)$	+	$H_2SO_4(aq)$	$\longrightarrow$	$Na_2SO_4(aq)$	+	$H_2(g)$
Sodium		Sulphuric acid		Sodium sulphate		Hydrogen

Similarly,

$Mg\ (s)$	+	$2HCl\ (aq)$	$\longrightarrow$	$MgCl_2(aq)$	+	$H_2(g)$
Magnesium		Hydrochloric acid		Magnesium chloride		Hydrogen
$Mg(s)$	+	$H_2SO_4(aq)$	$\longrightarrow$	$MgSO_4\ (aq)$	+	$H_2(g)$
Magnesium		Sulphuric acid acid		Magnesium sulpahte		Hydrogen

$Zn(s)$	+	$2HCl(aq)$	$\longrightarrow$	$ZnCl_2(aq)$	+	$H_2(g)$
Zinc		Hydrochloric acid		Zinc chloride		Hydrogen
$Zn(s)$	+	$H_2SO_4(aq)$	$\longrightarrow$	$ZnSO_4(aq)$	+	$H_2(g)$
Zinc		Sulphuric acid		Zinc sulphate		Hydrogen

Similarly,

$2Al\ (s)$	+	$6HCl\ (aq)$	$\longrightarrow$	$2AlCl_3(aq)$	+	$3H_2(g)$
Aluminum		Sulphuric acid		Aluminum sulphate		Hydrogen

(B) Iron react slowly with dilute HCl or dil. H_2SO_4 and therefore, it is less reactive than zinc and aluminum.

$Fe(s)$	+	$2HCl(aq)$	$\longrightarrow$	$FeCl_2(aq)$	+	$H_2(g)$
Iron		Hydrochloric acid		Ferrous chloride		Hydrogen
$Fe(s)$	+	$H_2SO_4(aq)$	$\longrightarrow$	$FeSO_4(aq)$	+	$H_2(g)$
Iron		Sulphuric acid		Ferrous sulphate		Hydrogen

(C) Copper does not react with dill. HCl or dill H_2SO_4.

$Cu(s) + HCl\ (aq) \longrightarrow$ No reaction

$Cu(s) + H_2SO_4(aq) \longrightarrow$ No reaction

Therefore copper is even less reactive that iron.

The order of reactivity of different metals with dilute acid:

Na > Mg > Al > Zn > Fe > Cu

Reactivity with dill acids decreases from sodium to copper.

(iv) Reactions of metals with salt solutions: When a more reactive metals is placed in a salt solution of less reactive metal, then the more reactive metal displaces the less reactive metal from its salt solution. For example, we will take a solution of copper sulphate (blue coloured solution) and put a strip of zinc metal in the solution. It is observed that the blue colour of copper sulphate fades gradually and copper metals are deposited on the zinc strip. this means that the following reaction occurs :

$Zn(s)$	+	$CuSO_4\ (aq)$	$\longrightarrow$	$ZnSO_4(aq)$	+	$Cu(s)$
Zinc		Copper sulphate (Blue solution)		Zinc sulphate (Colourless solution)		Copper

Here, zinc displaces copper from its salt solution.
However, if we take zinc sulphate solution and put a string of copper metal in this solution, no reaction occurs.

$ZnSO_4(aq)$	+	$Cu(s)$	$\longrightarrow$	No reaction
Zinc sulphate		Copper		

This means that **copper cannot displace zinc** metal from its solution. Thus, we can conclude that zinc is more reactive than copper. However, if we put gold or platinum strip in the copper sulphate solution, then copper is not displaced by gold or platinum. Thus, gold and platinum are less reactive than copper.

7.4 REACTIVITY SERIES OF METALS:

7.4 (a) Introduction:

We have learnt that some metals are chemically very reactive while others are less reactive or do not react at all.
On the basis of reactivity of different metals with oxygen, water acids as well as displacement reactions, the metals have been arranged in the decreasing order of their reactivities.
The arrangement of metals in order of decreasing reactivities is called reactivity series or activity series of metals.
The activity series of some common metals is given in Table. In this table, the **most reactive metal** is placed at the **top** whereas the **least reactive** metal is placed at the **bottom.** As we go down the series the chemical reactivity of metals decreases.

REACTIVITY SERIES OF METALS

	Lithium	Li	Most reactive metal
	Potassium	K	
	Barium	Ba	
डमजंसे उवतम तमंबजपअम जींद ीलकतवहमद	Sodium	Na	
	Calcium	Ca	
	Magnesium	Mg	
	Aluminum	Al	
	Zinc	Zn	
	Iron	Fe	
	Nickel	Ni	
	Tin	Sn	
	Lead	Pb	
	भ्लकतवहमद	भ्	
डमजंसे समे तमंबजपअम जींद ीलकतवहमद	Copper	Cu	
	Mercury	Hg	
	Silver	Ag	
	Gold	Au	
	Platinum	Pt	Least reactive metal

7.4 (b) Reasons for Different Reactivities:

In the activity series of metals, the basis of reactivity is the tendency of metals to lose electrons. If a metals can lose electrons easily to form positive ions, it will react readily with other substances. Therefore, it will be a reactive metal. On the other hand, if a metal loses electrons less rapidly to form a positive ion, it will react slowly with the other substances. Therefore, such a metal will be less reactive. For example, alkali metals such as sodium and potassium lose electrons very readily to from alkali metal ions, therefore, they are very reactive.

7.4 (c) Displacement of Hydrogen from Acids by Metals :

All metals above hydrogen in the reactivity series (i.e. more active than hydrogen) like zinc, magnesium, nickel can liberate hydrogen from acids like HCl and H_2SO_4. These metals have greater tendency to lose electrons than hydrogen. Therefore, the H^+ ions in the acids will accept electrons and give hydrogen gas as :

$M \longrightarrow M^+ (aQ) + e^-$
Metals
$H^+ (aq) + e^- \longrightarrow H$
(From acid)
$H + H \longrightarrow H_2\uparrow$

The metals which are below hydrogen in the reactivity series (i.e. les reactive than hydrogen) like copper, silver, gold cannot liberate hydrogen form acids like HCl, H_2SO_4 etc. These metals have lesser tendency to lose electrons than hydrogen. Therefore, they cannot lose electrons to H^+ ions.

7.4 (d) Reactivity Series and Displacement Reactions :

The reactivity series can also explain displacement reactions. In general, a more **reactive metal** (placed higher in the activity series) can displace the less reactive metal from its solution. For example, zinc, displaces copper form its solution.

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

7.4 (e) Usefulness of Activity Series:

The activity series is very useful and it gives the following information:

(i) The metal which is higher in the activity series is more reactive than the other. Lithium is the most reactive and platinum is the least reactive.

(ii) The metals which have been placed above hydrogen are more reactive than hydrogen and these can displace hydrogen from its compounds like water and acids to liberate hydrogen gas.

(iii) The metals which are placed below hydrogen are less reactive than hydrogen and these cannot displace hydrogen from its compounds like water and acids.

(iv) A more reactive metal (placed higher in the activity series) can displace the less reactive metal from its solution.

(v) Metals at the top of the series are very reactive and, therefore, they do not occur free in nature. The metals at the bottom of the series are least reactive and, therefore, they normally occur free in nature. For example, gold, present in the reactivity series is found in Free State in nature.

DAILY PRACTIVE PROBLESM # 7

OBJECTIVE DPP -7.1

1. Which of the following properties is not a characteristic of metals ?
(A) Metallic lusture (B) High density
(C) Hardness (D) Low melting and boiling point

2. Which of the following metals generally occur in liquid sate ?
(A) Mercury (B) Bromine (C) Gallium (D) A & C both

3. Reactivity of zinc is______ than hydrogen.
(A) less (B) more
(C) equal (D) sometimes more sometimes less

4. $Zn + xHCl \longrightarrow ZnCl_2 + Z,$
In above equation A & x are
(A) H_2, 2 (B) Cl_2, 1 (C) H_2, 3 (D) H_2, 4

5. When sodium reacts with cold water, then the product formed will be-
(A) Na_2O (B) NaOH (C) Na_2CO_3 (D) All of these

6. What is the decreasing order of reactivity of following metals ?
Na, Al, Cu, Ag, Fe
(A) Na > K > Al > Cu > Ag > Fe (B) K > Na > Al > Cu > Fe > Ag
(C) K > Na > Al > Fe > Cu > Ag (D) K > Na > Al > Fe > Ag > Cu

7. When a metal is added to dilute HCl solution, there is no evolution of gas. Metals if -
(A) K (B) Na (C) Ag (D) Zn

8. On addition of which metal, copper sulphate solution (Blue colour) will be changed to colourless solution >
(A) Fe (B) Ag (C) Zn (D) Hg

9. $Zn + H_2O$ (Steam) $\longrightarrow A + B$
In the above equation (A) and (B) are
(A) Zn & H_3 (B) ZnH_2 & O_2 (C) ZnO_2 & O_2 (D) ZnO & H_2

10. Which of the following metals reacts vigorously with oxygen?
(A) Zinc (B) Magnesium (C) Sodium (D) Copper

SUBJECTVE DPP - 7.2

1. Describe the physical properties of metals >

2. Write the chemical equation of chemical reaction of zinc metal with the following -
(a) H_2SO_4 (b) H_2O (c) O_2

3. What is an activity series of metals ? Arrange the metals Zn, Mg. Al, Cu and Fe in the decreasing order of reactivity.

4. What would you observe when you put :
(i) some zinc pieces in the blue copper sulphate solution ?
(ii) some copper pieces in green ferrous sulphate solution ?

5. Name two metals which occur in nature in the free state.

6. Identify the most reactive and least reactive metal from the following -
Hg, Na, Fe, Ag.

7. Name a gas which is always produced when a reactive metal reacts with a dulute acid.
Write a chemical equation supporting your answer.

➤METALS AND NON-METALS◄

8.1 HOW METALS REACT WITH NON-METALS :

Octet Rule : Octet rule was given by **G.N. Lewis and W.Kossel in 1916.**
According to actet rule “an atom whose outermost shell contains 8 electrons (octet) is stable.”

This rule, however, does not hold good in case of certain small atoms like helium (He) in which presence of 2 electrons (duplet) in the outermost shell in considered to be the condition of stability.

Examples of elements whose atoms have fully filled or 8 e^- in their outermost shell are –

Element	Symbol	Atomic Number	Electronic configuration	No. of valence electrons
Neon	Ne	10	2,8	8
Argon	Ar	18	2,8,8	8
Krypton	Kr	36	2,8,18,8	8

All noble gases contain 8 valence electrons (except He in which 2 valence electrons are present) and are stable. They do not usually form bonds with other elements.

Atoms combine with one another to achieve the inert gas electron arrangement and become stable. Atoms from chemical bonds to achieve stability by acquiring the inert gas configuration or by completing their octet or duplet (in case of small atoms) in outermost shell. An atom can achieve the inert gas electron arrangement in three ways -

(i) by losing one or more electrons .

(ii) by gaining one or more electrons.

(iii) by sharing one or more electrons.

Store in your memory

Noble gases do not usually from bonds with other elements. because they are stable. So. atoms of elements have the tendency to combine with one another to achieve the inert gas configuration.

8.2 CONCEPT OF IONIC BOND :

Except the elements of group 18 of the periodic table all the elements for the remaining group, at normal temperature and pressure, are not stable in independent state. These elements from stable compounds either by combining with the other atoms or with their own atoms. When in gross electronic configuration of the elements there are 8 electrons present then these elements do not take part in the chemical reaction because atoms containing 8 electrons in their outermost shell are associated with extra stability and less energy.

Atoms with other electronic configuration, which do not contain eight electrons in their outermost shell, are unstable and to achieve the stability they chemically combine in such a manner that they achieve eight electrons in their outermost shell.

Two or more than two types of atoms mutually combine with each other to achieve stable configuration of eight valence electrons. Attempt to achieve eight electrons in the outermost orbit of a element is the reason behind its chemical reactivity or chemical bonding.

8.3 IONIC OR ELECTROVALENT BOND:

This bond is formed by the atoms of electropositive and electronegative elements. Electropositive elements lose electrons in chemical reaction and electronegative elements gain electrons in chemical reaction. When an atom of electropositive element come in contact with that of an electronegative element then the electropositive atom loses electron & becomes positively charged, while the electronegative atom gains the electron to become negatively charged. Electrostatic force of attractions works between the positively and negatively charged ions due to which both ions are bonded with each other. As a result, a chemical bond is produced between the ions, which is known as Ionic or Electrovalent compound.

Number of electrons donated or accepted by any element is called Electrovalence.

In an ionic compound every cation is surrounded by a fixed number of anions and every **anion is** surrounded by a fixed number of cations and they are bonded in a **fixed geometry** in a three dimensional structure.

Example : Sodium chloride compound.

Sodium atom (Electropositive element) by losing an electron from its outermost orbit, gets converted into a cation and attains noble gas like stable configuration.

Energy required for this process is called "ionization potential."

$$\overset{\times}{Na} + IE \longrightarrow Na^{+} + e^{-}$$

(2, 8, 1) (2, 8)

Chlorine atom (Electronegative element) accepts the electron donated by sodium atom in its outermost orbit and forms chloride anion.
In this process energy is released which is known as "electron affinity."

$:\ddot{\underset{..}{Cl}}: + e^- \longrightarrow :\ddot{\underset{..}{Cl}}:^- + EA$

(2, 8, 7) (2, 8, 8)

Due to the opposite charges on the Na^+ and Cl^- ions, they are bonded by electrostatic force of attraction to from NaCl compound.

$Na^+ + Cl^- \longrightarrow [Na]^+ [Cl]^-$ or NaCl

Here electrovalent of sodium and chlorine atom is one.

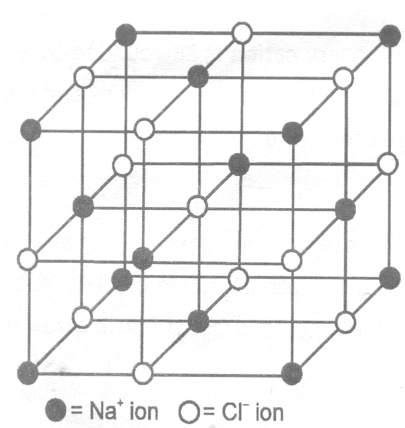
For the formation of ionic bond, it is necessary that the ionization potential of electropositive element should be less and the electron affinity of electronegative element should be high.

8.3 (a) Properties of Ionic Compounds:

(i) Ionic compounds consist of ions: All ionic compounds consist of positively and negatively charged ions and not molecules. For example, sodium chloride consists of Na^+ and Cl^- ions, magnesium fluoride consists of Mg^{2+} and F^- ions and so on.

(ii) Physical nature : Ionic compounds are solid and relatively hard due to strong electrostatic force of attraction between the ions of ionic compound.

(iii) Crystal structure : X-ray studies have shown that ionic compounds do not exist as simple single molecules as Na^+Cl^-, This is due to the fact that the forces of attraction are not restricted to single unit such as Na^+ and Cl^- but due to uniform electric field around and ion, each ion is attracted to a large number of other ions. For example, one Na^+ ion will not attract only one Cl^- ion but it can attract as many negative charges as it an. Similarly, the Cl^- ion will attract several Na^- ions. As a result, there is a regular arrangement of these ions in three dimensions as shown in diagram. Such a regular arrangements is called crystal lattice.

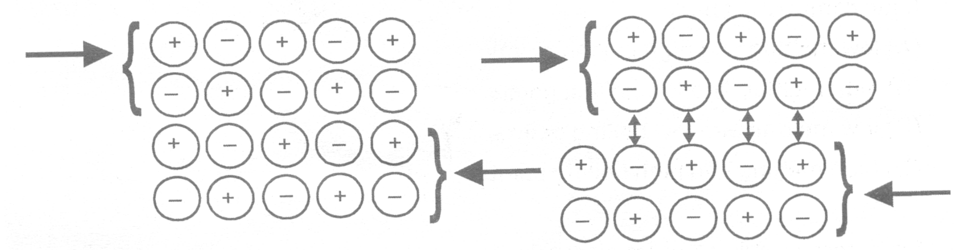


Lattice structure of Sodium chloride

(iv) Melting point and boiling point : Strong electrostatic force of attraction if present between ions of opposite charges. To break the crystal lattice more energy is required so their melting points and boiling points are high.

(v) Solubility : Ionic compounds are generally soluble in polar solvents like water and insoluble in no - polar solvents like carbon tetrachloride, benzene, ether alcohol etc.

(vi) Brittle nature: Ionic compounds on applying external force or pressure are broken into small pieces, such substances are known as brittle and this property is known as brittleness. When external force is applied on the ionic compound, layers of ions slide over one another and particles of the same charge come near to each other as a result due to the strong repulsion force, crystals of compounds are broken.



BRITTLE NATURE OF IONIC COMPOUNDS

(vii) Electrical conductivity : Electrical conductivity in any substance is due to the movement of free electrons of ions. In metals electrical conductivity is due to the free movement of valency electrons. As ionic compound exhibits electrical conductivity due to the movement of ions either in the fused state or in the soluble state in the polar solvent. But in the solid state due to strong electrostatic force of attraction free ions are absent so they are insulator in the solid state.

DAILY PRACTIVE PROBLEMS # 8

OBJECTIVE DPP - 8.1

1. Octet rule was given by -
(A) Rutherford (B) Soddy (C) Lewis & Kossel (D) None of these

2. Exception of octet rule is -
(A) K (B) Ca (C) N (D) He

3. Ionic bond is formed by -
(A) loss of electrons only. (B) gain of electrons only.
(C) loss and gain of electrons both. (D) sharing of electrons.

4. Ionic bond is formed between -

(A) two electropositive elements.

(B) two electronegative elements.

(C) Electropositive & electronegative elements.

(D) None of these

5. During formation of ionic bond -

(A) there is force of repulsion between two negative ions.

(B) there is force of repulsion between two positive ions.

(C) there is force of attraction between positive & negative ions.

(D) none of these.

6. In the formation of ionic bond, cation is formed by-
(A) gain of electron (s). (B) loss of electron(s).
(C) sharing of electron(s). (D) None of these

7. Ionic compound have -

(A) low melting and high boiling points.

(B) high melting and low boiling points.

(C) low melting and low boiling points.

(D) high melting and high boiling points.

8. Ionic compounds conduct electricity in-
(A) solid state (B) fused state.
(C) gaseous state. (D) Do not conduct electricity at all.

9. Ionic compounds are soluble in-
(A) water (B) benzene (C) ether (D) alcohol

10. Physical nature of most of the ionic compounds is-
(A) solid (B) liquid (C) gas (D) May exist in any state.

SUBJECTIVE DPP - 8.2

1. Define octet rule.

2. Define electrovalency.

3. Explain the brittle nature of ionic compounds.

4. Why ionic compounds have high melting and boiling points ?

5. Why ionic compounds show electrical conductivity is fused or soluble state ?

➤METALS AND NON-METALS➤

9.1 OCCURRENCE OF METALS :

All metals are present in the earth's crust either in the free state or in the form of their compounds. Aluminum is the most abundant metal in the earth's crust. The second most abundant metal is iron and thier one is calcium.

9.1 (a) Native and Combined State of Metals :

Metals occur in the crust of earth in the following two states -

(i) Native state of free state: A metal is said to occur in a free or a native state when it is found in the crust of the earth in the elementary or uncombined form.
The metals which are very uncreative (lying at the bottom of activity series) are found in the free stae. These have no tendency to react with oxygen and are not attacked by moisture, carbon dioxide of air or other no-metals. Silver, copper, gold and platinum are some examples of such metals.

(ii) Combines state : A metal is said to occur in a combined state if it is found in nature in the form of its compounds. e.g. Sodium, magnesium etc. Copper and silver are metals which occur in the free state as well as in the combined state.

9.2 MINERALS AND ORES :

The natural substances in which metals or their compounds occur either in native state or combined state are called minerals.
The minerals are not pure and contain different types of other impurities. The impurities associated with minerals are collectively known as gangue or matrix.
The mineral from which the metal can be conveniently and profitably extracted, is called an ore.
For example, aluminum occurs in the earth's crust in the form of two minerals, bauxite (Al_2,O_3. $2H_2O$) and caly (Al_2O_3. $2SiO_2$. $2H_2O$). Out of these two, aluminum can be conveniently and profitably extracted from bauxite. So, bauxite is an are of aluminum.

Oxygen is the most abundant element on earth's crust.

9.2 (a) Types of Ores :

The most common ores of metals are oxides, sulphides, carbonates, sulphates, halides, etc. In general, very uncreative metals (such as gold, silver, platinum etc.) occur in elemental form or Free State.

(i) Metals which are only slightly reactive occur as sulphides (e.g., CuS, Pbs etc.).

(ii) Reactive metals occur as **oxides** (e.g., MnO_2, AO_2O_3 etc.)

(iii) Most reactive metals occur as salts as **carbonates, subparts, halides** etc.

SOME COMMON ORES ARE LISTED IN THE TABLE

Nature	Metal	Name of the ore	Composition
Oxide ores	Aluminum	Bauxite	$Al_2O_3.2H_2O$
	Copper	Cuprite	Cu_2O
	Iron	Magnetite	Fe_3O_4
		Heamatite	Fe_2O_3
Sulphide ores	Copper	Copper pyrites	$CuFeS_2$
		Copper glance	Cu_2S
	Zinc	Zinc blende	Zns
	Lead	Galena	PbS
	Mercury	Cinnabar	HgS
Carbonate ores	Calcium	Limestone	$CaCO_3$
	Zinc	Calamine	$ZnCO_3$
Halide ores	Sodium	Rock salt	NaCl
	Magnesium	Carnallite	$KCl. MgCl_2. 6H_2O$
	Calcium	Fluors par	CaF_2
	Silver	Horn silver	AgCl
Sulphate ores	Calcium	Gypsum	$CSO_4 2H_2O$
	Magnesium	Epsom salt	$MgSO_4.7H_2O$
	Barium	Barytes	$BaSO_4$
	Lead	Anglesite	$PbSO_4$

9.3 METALLURGY:

The process of extracting pure metals from their ores and then refining them for use is called metallurgy.
In other words, the process of metallurgy involves extraction of metals from their ores and then refining them from use. The ores generally contain unwanted impurities such as sand, stone, earthy particles, limestone, mica, etc., these are called gangue or matrix.

The process of metallurgy depends upon the nature of the ore, nature of the metals and they types of impurities present. Therefore, there is not a single method for the extraction of all metals. However, most of the metals can e extracted by a general procedure which involves the following steps.

Various steps involved in metallurgical processes are -

(a) Crushing and grinding of the ore.

(b) Concentration of the ore or enrichment of the ore.

(c) Extraction of metal from the concentrated ore.

(d) Refining or purification of the impure metal.

These steps are briefly discussed below -

9.3 (a) Crushing and Grinding of Ore :

Most of the ores occur as big rocks in nature. They are broken into small pieces with the help of crusher. These pieces are then reduced to fine powder with the help of a ball mill or a stamp mill.

9.3 (b) Concentration of Ore or Enrichment of Ore :

The process of removal of unwanted impurities (gangue) from the ore is called ore concentration or ore enrichment.

(i) Hydraulic washing (washing with water) :

Principle: This method is based upon the difference in the densities of the ore particles and the impurities (gangue).
Ores of iron, tin and lead are very heady and, therefore, they are concentrated by this method.

(ii) Front floatation process:

Principle: this method is based on the principle of difference in the wetting properties of the ore and gangue particles with water and oil.
This method is commonly used for sulphide ores.

(iii) Magnetic separation :

Principle: This method depends upon the difference in the magnetic properties of the ores and gangue.
This method is used for the concentration of **heamatite**, an ore of iron.


Store in your memory

The froth floatation process if commonly used for the sulphide ores copper, zinc, lead etc.

DIALY PRACTICE PROBLEMS # 9

OBJECTIVE DPP - 9.1

1. Which of the following is/are oxide ore(s) ?
(A) Bauxite (B) Cuprite (C) Haematite (D) All of these

2. Horn silver is a/an -
(A) sulphate ore (B) halide ore (C) sulphide ore (D) oxide ore

3. Carnallite is -
(A) KCl, $MgCl_2$ (B) KCl. $MgCl_2$, $3H_2O$ (C) KCl. $MgCl_2$. $6H_2O$ (D) KCl, $MgCl_2$, H_2O

4. Match column A with column B and select the correct option -

Column A	Column B
(Ore)	(Nature of ore)
(a) Copper glance	(i) Sulpahte ore
(b) Calamine	(ii) Halide ore
(c) Rock salt	(iii) Sulphide ore
(d) Epsom salt	(iv) Carbonate ore

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

5. Removal of impurities from ore is known as -
(A) crushing and grinding (B) concentration of ore
(C) minerals (D) gangue

6. Which of the following methods is used in the concentration of haematite ore ?
(A) Hydraulic washing (B) Magnetic separation
(C) Froth floatation process (D) None of these

7. Forth floatation method is used for the concentration of -
(A) oxide ores (B) sulphide ores (C) sulphate ores (D) halide ores

8. Which of the following methods is based on the principle of the difference in the wetting properties of the ore and gangue particles with water and oil ?
(A) Magnetic separation (B) Front floatation process
(C) Hydraulic washing (D) None of these

9. Which of the following is most abundant metal on the earth's crust ?
(A) Iron (B) Aluminum (C) Calcium (D) Oxygen

10. Which of the following metal is found in native state ?
(A) Sodium (B) Zinc (C) Gold (D) Iron

SUBJECTIVE DPP- 9.2

1. Explain the difference between ores and minerals ?

2. Comment on native and combined states of metals.

3. What is gangue ?

4. Which process is used for the enrichment of
(i) sulphide ores (ii) oxide ore

5. Give chemical compositions of the following ores -
(i) bauxite (ii) gypsum
(iii) galena (iv) rock salt

10.1 EXTRACTION OF THE METAL FROM THE CONCENTRATED ORE :

The metal is extracted from the concentrated ore by the following steps :

(a) Conversion of the concentrated ore into its oxide : The production of metal from the concentrated ore mainly involves reduction process. This can be usually done by two processes known as calcination and roasting process. The method depends upon the nature of the ore.

(b) Conversion of oxide to metal y reduction process

10.1 (a) Conversion of Ore into Metal Oxide :

These are briefly discussed below :

(i) Calcination : It is the process of heating the concentrated ore in the absence of air.

The calcination process is used for the following changes :

- to convert carbonate ores into metal oxide.
- to remove water from the hydrated ores.
- to remove volatile impurities from the ore.

For example

$ZnCO_3(s) \xrightarrow{\text{Calcination}}$	$ZnO(s)$ +	$CO_2(g)$
Zinc carbonate	Zinc oxide	carbon dioxide
$FeCO_3(s) \xrightarrow{\text{Calcination}}$	$FeO(s)$ +	$CO_2(g)$
Siderite	Iron (I) oxide	Carbon dioxide

(ii) Roasting : It is the process of heating the concentrated ore strongly in the presence of excess air. This process is used for converting sulphide ores to metal oxide. In this process, the following changes take place :

- the sulphide ores undergo oxidation to their oxides.
- moisture is removed
- volatile impurities are removed.

For example :

$2ZnS$	+	$3O_2 \xrightarrow{\text{Roasting}}$	$2ZnO(s)$	+	$2SO_2(g)$
Zing (Zinc blende ore)		Oxygen (From air)	Zinc oxide		Sulphur
$4FeS_2(s)$	+	$11O_2(g) \xrightarrow{\text{Roasting}}$	$2Fe_2O_3(s)$	+	$8SO_2(g)$
Iron pyrites		Oxygen	Ferric oxide		Sulphur Dioxide

Calcination is used for hydrated and carbonate ores and roasting is used for sulphide ores.

10.1 (b) Conversion of Metal Oxide to Metal:

The metal oxide formed after calcination or roasting is converted into metal by reduction. The method used for reduction of metal oxide depends upon the nature and chemical reactivity of metal.
The metals can be grouped into the following three categories on the basis for their reactivity:

- Metals of low reactivity.
- Metals of medium reactivity.
- Metals of high reactivity.

These different categories of metals are extracted by different technique. the different steps involved in separation are as follows :

(i) Reduction by heating : Metals placed low in the reactivity series are very less reactive. They can be obtained from their oxides by simple heating in air.

$$\underset{\text{Mercuric sulphide}}{2HgS(s)} + \underset{\text{Oxygen}}{3O_2(g)} \xrightarrow{\text{Roasting}} \underset{\text{Mercuric oxide}}{2HgO(s)} + \underset{\text{Sulphur dioxide}}{2SO_2(g)}$$

$$\underset{\text{Mercuric oxide}}{2HgO(s)} \xrightarrow{\text{Roasting}} \underset{\text{Mercury metal}}{2Hg(\ell)} + \underset{\text{Oxygen}}{O_2(g)}$$

(ii) Chemical Reduction (For metals in the middle of the reactivity series):
The metals n the middle of the reactivity series, such as iron, zinc, lead, copper etc. are moderately reactive. These are usually present as sulphides or carbonates. Therefore, before reduction the metal sulphides and carbonates must be converted to oxides. This is done by roasting and calcination. The oxides of these metals cannot be reduced by heating alone. Therefore, these metal oxides are reduced to free metal by using chemical agents like carbon, aluminum, sodium or calcium.

(A) Reduction with carbon : The oxides of moderately reactive metals (occurring in the meddle of reactivity series) like zinc, copper, nickel, tin, lead etc. can be reduced by using carbon as reducing agent.

$$\underset{\text{Zinc oxide}}{AnO(s)} + \underset{\text{Carbon (Reducing agent)}}{C(s)} \xrightarrow{\text{Heat}} \underset{\text{Zinc metal}}{Zn(s)} + \underset{\text{Carbon monoxide}}{CO(g)}$$

$Fe_2O_3(s)$	+	$3C(s)$	$\longrightarrow$	$2Fe(s)$ +	$3CO(g)$
Ferric oxide		Carbon		Iron Metal monoxide	Carbon

$PbO(s)$	+	$C(s)$	$\longrightarrow$	$Pb(s)$ +	$CO(g)$
Lead oxide		Carbon		Lead metal monoxide	Carbon

One disadvantage of using carbon as reducing agent is that small traces of carbon are added to metal as impurity. Therefore, it contaminates the metals.

Coke is very commonly used as a reducing agent because it is cheap.

(B) Reduction with carbon monoxide: Metals can be obtained from oxides by reduction with carbon monoxide in the furnace.

$Fe_2O_3(s)$	+	$3CO(g)$	$\xrightarrow{\text{Heat}}$	$2Fe(s)$ +	$3CO_2(g)$
Ferric oxide		Carbon monoxide		Iron dioxide	Carbon

(C) Reduction with aluminum : Certain metal oxides are reduced by aluminum to metals.

$3MnO_2$ (s)	+	$4Al(s)$	$\xrightarrow{\text{Heat}}$	$3Mn(s)$ +	$2Al_2O_3(s)$
Manganese dioxide		Aluminum		Manganese oxide	Aluminum

$Cr_2O_3(s)$	+	$2Al$ (s)	$\xrightarrow{\text{Heat}}$	$2Cr$ (s) +	Al_2O_3 (s)
Chromium oxide		Aluminum		Chromium	Aluminum oxide

Reduction of metals oxides with aluminum is known as aluminothermy or thermite process.

(iii) Reduction of electrolysis or electrolytic reduction : The oxide of **active metals** (which are high up in the activity series) are very **stable** and cannot be reduced by **carbon or aluminum.** These metals are commonly extracted by the **electrolysis** of their fused salts using suitable electrodes. This is also called **electrolytic reduction i.e.** reduction by electrolysis.
For example, aluminum oxide is very stable and aluminum cannot be prepared by reduction with carbon. It is prepared by the electrolysis of molten alumina (Al_2O_3).

Al^{3+}	+	$3e^-$	$\xrightarrow{\text{Heat}}$	Al
Aluminum ion (From molten alumina)		Electron (From cathode)		Aluminum (At cathode)

It may be noted that during electrolytic reduction of molten salts, the metals are always obtained at the cathode (negative electrode).

Store in your memory

The process of extraction of metals by electrolysis process is called electrometallurgy.

10.2 PURIFICATION OR REFINING OF METALS :

The metal obtained any of the above methods is usually impure and is known as **crude** metal. The process of purifying the crude metal is called **refining.**

10.2 (a) Liquation :

This method is use for refining the metals having low melting points, such as tin, lead, bismuth etc. This is based on the principle that the metal to be refined is easily fusible (melt easily (but the impurities do not fuse easily.

10.2 (b) Distillation:

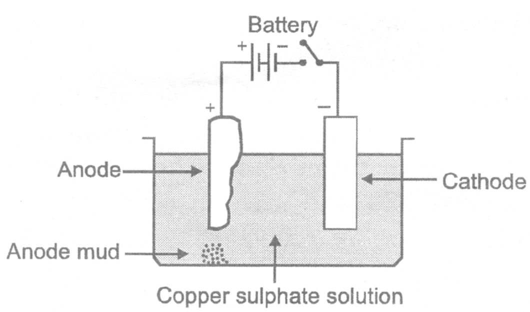
This method is used for the **purification of volatile metals** (which form vapours readily) such as mercury and zinc.

10.2 (c) Electrolytic Refining :

This is most general and widely used method for the refining of impure metals. Many metals such as copper, zinc, tin, nickel, silver, gold etc. are refined electrolytically. It is based upon the phenomenon of electrolysis. In this method, the crude metal is cast into thick rods and are made as anodes, while the thin sheets of pure metal are made as cathodes, An aqueous solution of some salt of the metal is used as an electrolyte. On passing current through the electrolyte, the pure metal from the anode dissolves into the electrolyte. An equivalent amount of pure metal from the electrolyte is deposited on the cathode. The soluble impurities go in the solution whereas the insoluble impurities settle down at the bottom of the node and are known as anode mud. In this way, the pure metal from anode goes into electrolyte and from electrolyte it goes to the cathode.

At anode : $\underset{\text{Copper (from impure anode)}}{Cu} \xrightarrow{\text{Oxidation}} Cu^{+2} + 2e^-$

At cathode : $\underset{\text{Copper ion}}{Cu^{2+} + 2e^-} \xrightarrow{\text{Reduction}} \underset{\text{Copper (deposited at cathode)}}{CU}$



In electrolytic refining impure metal is made anode and pure metal is made cathode.

Zone refining and Van Arkel method are used for obtaining metals (Si, Ge etc.) of very high purity for certain specific applications.

DAILY PRACTICE PROBLESM # 10

OBJECTIVE DPP - 10.1

1. Heating of concentrated ore in absence of air for conversion in oxide ore in known as -
(A) roasting (B) calcination (C) reduction (D) none of these

2. Process of roasting and calcination takes place in-
(A) bessemer converter. (B) blast furnace.
(C) reverberatory furnace. (D) electrolytic cell.

3. Which reducing agent is used in chemical reduction ?
(A) C (B) CO (C) Al (D) All of these

4. Which of the following is used in reduction of alumina ?
(A) Coke (B) Carbon monoxide (C) Aluminum (D) Electricity

5. For purification of which metal, liquation method is used ?
(A) Tin (B) Lead (C) Bismuth (D) All of these

6. Which method is used in purification of mercury ?
(A) Liquation (B) Distillation (C) Electrolytic refining (D) Chemical reduction

7. Which of the following methods is used for obtaining metals of very high purity ?
(A) Distillation (B) Zone refining (C) Liquation (D) Electrolytic refining

8. Which of the following methods is not used in purification of metals ?
(A) Calcination (B)Liquation (C) Distillation (D) None of these

9. Anode mud is obtained in which process?
(A) Roasting (B) Zone refining (C) Electrolytic refining (D) Calcination

10. In thermite process reducing agent is -
(A) C (B) Cl (C) Al (D) None of these

SUBJECTIVE DOO - 10.2

1. Describe methods of extraction of the metal from the concentrated ore ?

2. Define calcination.

3. Name a method for obtaining metals of very high purity.

4. Which method is used for refining of volatile metals ?

5. Name the products obtained when -
(i) zinc sulphide is roasted (ii) lime stone is calcined

11.1 CORROSION OF METALS :

Surface of many metals is easily attacked when exposed to atmosphere. The react with **air or water** present in the environment and form **undesirable compounds** on their surface. These undesirable compounds are generally **oxides.**
Thus, corrosion is a process of **deterioration** of metal as a result of its reaction with air or water (present in environment) surrounding it.

11.1 (a) Corrosion of Iron:

iron corrodes readily when exposed to **moisture** and gets covered with a **brown flaky** substance called **rust.** This is also called Rusting of Iron. Chemically, the rust if **hydrated iron (III) oxide,** $Fe_2O_3.XH_2O$.
Rusting is an **oxidation process** in which iron metal is slowly oxidized by the action of air (in presence of water). Therefore, rusting of iron takes place under the following conditions :

- Presence of air (or oxygen)
- Presence of water (moisture)

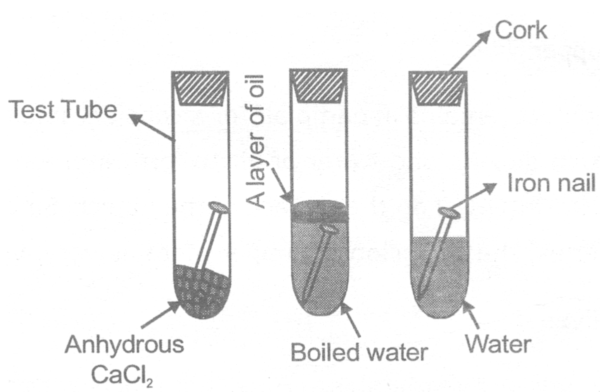
More the reactivity of the metal, the more will be the possibility of the metal getting corroded.

(i) Experiment to show that rusting of iron requires both air and water -
We take three test tubes and put one clean **iron nail** in each of the three test tubes :

(A) In the first test tube containing **iron nail,** we put some **anhydrous calcium chloride** to absorb water (or moisture) from the damp air present in the test tube and make it dry.

(B) In the second test tube containing iron nail, we put **boiled water** because boiled water does not contain any dissolved air or oxygen in it. **A layer of oil** is put over boiled water in the test tube to prevent the outside air from mixing with boiled water.

(C) In the third test tube containing an iron nail, we put **unboiled water** so that about two-third of the nail is immersed in water and the rest is above water exposed to damp air.
After one week, we observe the iron nails kept in all the three test tubes.



Rusting of iron

(ii) We will obtain the following observations from the experiment :

(A) No rust in seen on the surface of iron nail kept in dry air in the first test tube. This tells us that **rusting of iron** does not takes place in **air alone.**

(B) No rust is seen on the surface of iron nail kept in air free boiled water in the second test tube, This tells us that **rusting of iron** does not take place in **water alone.**

(C) Red brown rust is seen on the surface of iron nail kept in the presence of the air and water in the third test tube. This tells us that **rusting of iron** takes place in the presence of **both air and water** together.

(iii) Prevention of rusting

(A) Corrosion of metals can be prevented by coating the metal surface with a thin layer of **pant, varnish or grease.**

(B) Iron is protected from rusting by coating it with a thin layer of another metal which is more reactive that iron. This prevents the loss of electrons from iron because the active metal loses electrons in process of covering iron with **zinc** is called **galvanization.** Iron is also coated with other metals such as **tin** known as **tin coating.**

(C) By alloying: Some metals when alloyed with other metals become more resistant to corrosion. For example, when iron is alloyed with chromium and nickel, it form stainless steel. This is resistant to corrosion and does not rust at all.

(D) To decrease rusting of iron, certain **antirust solutions** are used. For example, solutions of **alkaline phosphates** are used as antirust solutions.

11.1 (b) Corrosion of Aluminum :

Due to the formation of a dull layer of aluminum oxide when exposed to moist air, the aluminum metal loses its shine very soon after use. This **aluminum oxide layer** is very tough and prevents the metal underneath from further corrosion (because moist air is not able to pass through this aluminum oxide layer). This means sometimes corrosion is useful.

11.1 (c) Corrosion of Copper

When a copper object remains in damp air for a considerable time, then copper reacts slowly with carbon dioxide and water of air to form a green coating of basic copper carbonate [$CuCO_3$, Cu(OH($_2$] on the surface of the object. Since copper metal is low in the reactivity series, the corrosion of copper metal is very, very slow.

11.1 (d) Corrosion of Silver :

Silver is a highly uncreative metal, so it does not reacts with oxygen of air easily. But, air usually contains a little of sulphur compounds such as hydrogen sulphide gas (H_2S), which react slowly with silver to form a **black coating of silver sulphide** (Ag_2S). Silver ornaments gradually turn black due to the formation of a thin silver sulphide layer on their surface and silver is said to be tarnished.

11.2 ALLOYS :

An alloy is a homogenous mixture of two or more metals or a metal and a non-metal. For example, iron is the most widely used metal. But it is never used in the pure form. this is because iron is very soft and stretches easily when not. But when it is mixed with a small amount of **carbon** (about 0.05%), it becomes **hard and strong**. The new form of iron is called **steel.**

11.2 (a) Objective of Ally Making :

Alloys are generally prepared to have certain specified properties which are not possessed by the contituent metals. The main objects of ally-making are :

(i) To increase resistance to corrosion : For example, stainless steel is prepared which has more resistant to corrosion than iron.

(ii) To modify chemical reactivity : The chemical reactivity of sodium is decreased by making an alloy with mercury which is known as sodium amalgam.

(iii) To increase the hardness: Steel, an alloy of iron and carbon is harder than iron.

(iv) To increase tensile strength: Magnesium is an alloy or magnesium and aluminum.
It has greater tensile strength as compared to magnesium and aluminum.

(v) To produce good casting: Type metal is an alloy of lead, tin and mercury.

(vi) To lower the melting point: For example, solder is an alloy of lead and tin (50) Pb and 50% Sn). It has a low melting point and is used for welding electrical wires together.

11.2 (b) Some Important Alloys :

The approximate composition and used of some important alloys are given below :
(i) Steel : Steel is an alloy of **iron and carbon** containing **0.1 to 1.5% carbon.** Steel is very **hard, tough and strong.** It is used for making rails, screws, girders, bridges, railway lines etc. Steel can also be used for the contraction for building, vehicles, ships etc.

(ii) Allow Steels : Steel obtained by the addition of some other elements such as chromium, vanadium, titanium, molybdenum, manganese, cobalt or nickel to carbon steel are called Ally Steel.

(iii) Alloys of Aluminum : This common alleys of aluminum are :

(A) Duralumin. It is an alloy containing aluminum, copper and traces of magnesium and manganese. Its percentage composition is - AO\l 95%, Cu = 4%, Mg = 0.5 % Mn = 0.5 % It is **stronger** than pure aluminum, Since duralumin is **light** and yet **strong,** it is used for making bodies of aircrafts, helicopter, jets and kitchenware's like pressure cookers etc.

(B) Magnesium. It is an alloy of **aluminum and magnesium** having the composition: Al - 95%, Mg = 5% It is very light and hard. It is more hard than pure aluminum. It is used for making light instruments, balance beams, pressure cookers etc.

(C) Alnico . It is an alloy containing aluminum, iron nickel, and cobalt. It is highly magnetic in nature and can be used for making powerful magnets.

(iv) Alloys of Copper: The important alloys of copper are Brass and Bronze.

(A) Brass - It is an alloy of copper and zinc having the composition = Cu = 80% Zn = 20% Brass is more malleable and more strong than pure copper. It is used for making cooking utensils, condenser sheets, pipes, hardware, nuts, bolts, screws, springs etc.

(B) Bronze - It is an alloy of copper and tin having the composition : Cu = 90% Sn = 10% Bronze is very though and highly resistant to corrosion. It is used for making utensils, statues, cooling pipes, coins, hardware etc.

(C) German Silver - It is an alloy of copper, zinc and nickel having the composition: Cu = 60%, Zn = 20%, Ni = 20%. It is used for making silverware, utensils and for electroplating.

(v) Alloying of Gold : Pure gold is very soft and cannot be used as such for jewellery. Therefore, it is generally alloyed with other metals commonly copper or silver to make it harder and modify its colour. The purity of gold is expressed as carats. Pure gold is of 24 carat. A 18 carat gold means that is contains 18 parts of gold is 24 parts by weight of alloy. Most of the jewellery is made of 22 carat gold.

Amalgams are **homogenous mixtures of a metal and mercury.** For example, sodium amalgam contains sodium and mercury.
Different amalgams are prepared according to their used. For example,

(i) Sodium amalgam is produced to decrease the chemical reactivity of sodium metal.
It is also used as a good reducing agent.

(ii) Tin amalgam is used for silvering cheap mirrors.

(iii) The process of amalgamation is used for the extraction of metals like godl or silver from their native ores.

DAILY PRACTICE PROBLESM # 11

OBJECTIVE DPP - 11.1

1. Pure gold is equal to -
(A) 24 carat (B) 100 carat (C) 22 carat (D) 1000 carat

2. Food cans are coated with tin and not with zinc because -
(A) zinc is costlier than tin. (B) zinc has higher melting point than tin.
(C) zinc is more reactive that tin. (D) zinc is less reactive than tin.

3. Chemical rust is -
(A) hydrated ferrous oxide (B) hydrated ferric oxide.
(C) only ferric oxide. (D) None of these

4. Which of the following methods is suitable for preventing an iron vessel from rusting ?
(A) Applying grease (B) Applying paint
(C) Applying a coating of zinc (D) All the above

5. Which of the following conditions are necessary for rusting of iron?
(A) Presence of water only (B) Presence of air only
(B) Presence of water and air both (D) None of these

6. Silver metal becomes black on exposure to air by the coating of -
(A) silver chloride (B) silver oxide
(C) silver sulphide (D) silver hydroxide

7. Alloys are a homogeneous mixture of -
(A) metals only (B) non - metals only
(C) metals or metals and non-metal (D) None of these

8. German silver is an alloy of -
(A) Cu and Ni (B) Cu, Sn and Ag (C) Cu, Zn and Ni (D) Cu, Ni, Fe and Mn

9. An alloy which does not contain copper is-
(A) magnalium (B) bronze (C) brass (D) german silver

10. Which of the following is not and alloy of aluminum ?
(A) Duralumin (B) Mangalium
(C) Alnico (D) All are alloys of aluminum.

SUBJECTIVE DPP - 11.2

1. What is an amalgam ?

2. Name an alloy of copper used for making utensils.

3. Why do we make alloys ? Give two reasons.

4. Ornaments made up of gold do not get corroded. Why ?

5. Iron nails are not rusted if kept in boiled distilled water for a long time. Explain.

ANSWERS

OBJECTIVE DPP - 7.1

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

SUBJECTIVE DPP - 7.2

Sol.3 Arrangement of metals in a vertical column in the decreasing order of their chemical reactivities is called metal activity series.
Mg, Al, Zn, Fe and Cu are metals in the order of their decreasing chemical activity.

Sol. 4. (i) the copper sulphate (blue) solution gradually faded to from colourless solution.
(ii) No change takes place. It is because copper is lower is metal activity series compared to iron.

Sol.5 Gold and Silver

Sol.6 Most reactive - Na and Least reactive - Ag

Sol.7 Hydrogen gas, Fe(s) + dill. $H_2SO_4 \longrightarrow FeSO_4(aq) + H_2(g)$

OBJECTIVE DPP - 8.1

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

SUBJECTIVE DPP - 8.2

Sol.4 Because of strong electrostatic force of attraction.

Sol.5 Because of presence of free ions.

OBJECTIVE DPP - 9.1

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

SUBJECTIVE DPP - 9.2

Sol4 (i) Forth floatation process
(ii) Hydraulic washing

Sol. (i) Bauxite -$AO_2O_3.2H_2O$ (ii) Gypsum - $CaSO_2.2H_2O$
(iii) Galena - Pbs (iv) Rock salt - NaCI

OBJECTIVE DPP - 10.1

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

SUBJECTIVE DPP - 10.2

Sol.3 Zone refining and Van arkel method.

Sol.4 Distillation

Sol.5 (i) ZnO and SO_2(i) CaO and CO_2

OBJECTIVE DPP - 11.1

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

SUBJECTIVE DPP 11.2

Sol.2 Brass

Sol.4 Gold is noble metal and not affected by air and water.

Sol.5 Boiled distilled water does not contain air.

CONTENTS

PART – II

CARBON AND ITS COMPOUNDS

12.1 INTRODUCTION:

Organic compounds: The compounds like urea, sugars, fats, oils, dyes, proteins vitamins etc., which were isolated directly or indirectly from living or indirectly from living organism such as animals and plants were called organic compounds. The branch of chemistry which deals with the study of these compounds is called **ORGANIC CHEMISTRY.**

12.2 BONDING IN CARBON = THE COVALENT BOND :

Most carbon compounds are poor conductors of electricity. The boiling and melting points of the carbon compounds are low. Forces of attraction between these molecules of organic compounds are not very strong/ As these compound are largely non conductors of electricity hence the bonding in these compound does not give rise to any ions.

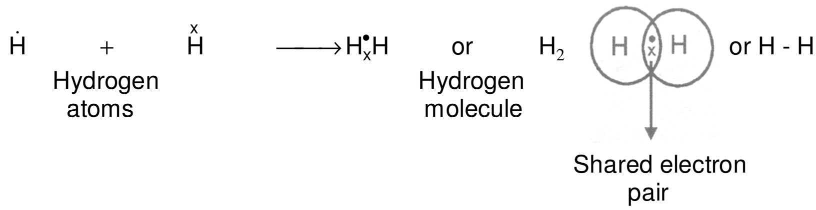
The reactivity of elements if explained at their tendency to attain a completely filled outer shell, that is, attain noble gas configuration. Element forming ionic compounds achieve this by either gaining or losing electrons from the outermost shell. In the case of carbon, it has four electrons in its outermost shell and needs to gain or lose four electrons to attain noble gas configuration. It is were to gain or lose electrons –

(i) it could gain four electrons forming **C^{4-} anion.** But it would be difficult for the nucleus with six protons to hold on to ten electrons, that is, four extra electrons.

(ii) It could lose four electrons forming **C^{4+} cation.** But it would require a large amount of energy to remove four electrons leaving behind a carbon cation with six protons in its nucleus holding on to just two electrons.

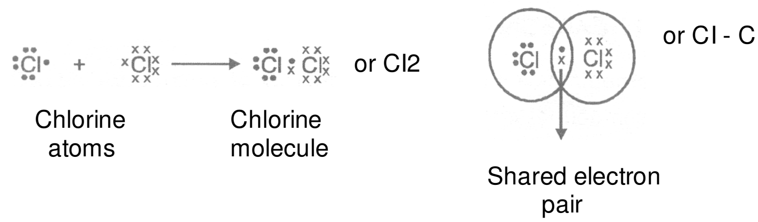
12.2 (a) Some Simple Molecules Formed by the Sharing of Valence Electrons are s follows:

(i) Hydrogen molecules: This is the simplest molecule formed by sharing of electrons. The atomic number of hydrogen is 1 and it has only one electron is its outermost K shell. It required only one more electron to complete the K shell. So, when two hydrogen atoms approach each other, the single electron of both the atoms form a shared pair. This may be represented as:

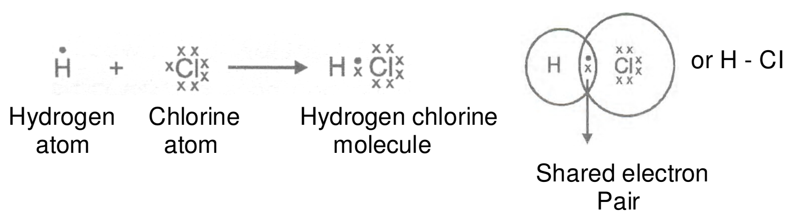


According to **Lewis notation,** the electrons in the valence shell are represented by dots and crosses. This method was proposed by **G.N.Lewis** and is known as Lewis representation or Lewis structure. The shared pair of electron (show x) is said to constitute a single bond between the two hydrogen atoms and is represented by a line between the two atoms. Pictorially, the molecule can be represented by drawing two **overlapping circles** around the symbols of the atoms and showing the shared pair of electrons in the overlapping part.

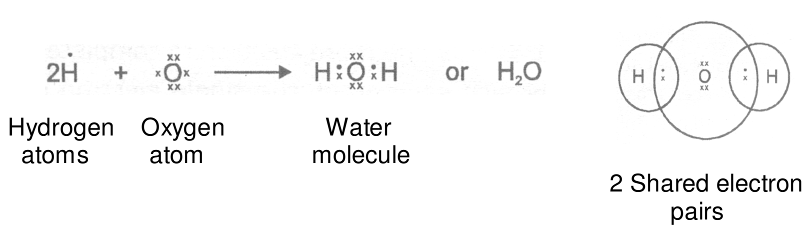
(ii) Chlorine molecule : Each chlorine atom has seven electrons in its outermost shell. When the two chlorine atoms come close together, an electron of both the atoms is shared between them.



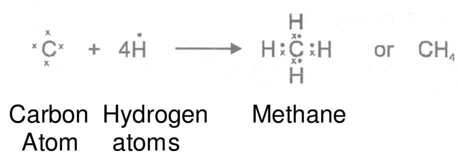
(iii) Hydrogen chloride molecule: It may be note that a covalent bond is not only formed between two similar atoms, but it may be formed between dissimilar atoms also. For example, hydrogen and chlorine form a covalent bond between their atoms. In HCl, hydrogen atom (1) has only one electron in its valence shell and chlorine atom (2,8,7) has seven electrons in its valence shell. Therefore, by mutual sharing of electron pair between hydrogen and a chlorine atom. Both the atoms acquit nearest noble gas configuration.

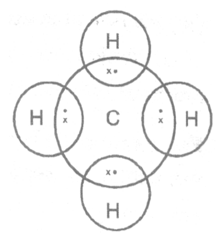


(iv) Formation of water molecule (H²O) : Each hydrogen atom has only one electron in its outermost shell. Therefore, each hydrogen atom required one more electron to achieve the stable configuration of helium (nearest noble gas). The oxygen atom has the electronic configuration 2,6 and has six electrons in its outermost shell. It needs two electrons to complete its octet. Therefore, one atom of oxygen shares its electrons with two hydrogen atoms.



(v) Formation of methane molecule (CH^4) : Methane (CH_4) is a covalent compound containing covalent bonds. Carbon atom has atomic number 6. Its electronic configuration is 2,4. It has four electrons in its valence shell and needs 4 more electrons to get the stable noble gas configuration. Hydrogen atom has one electron and needs one more electron to get stable electronic configuration of nearest noble bas, helium. Therefore, one atom of carbon shares its four electrons with four atoms of hydrogen to form four covalent bonds.





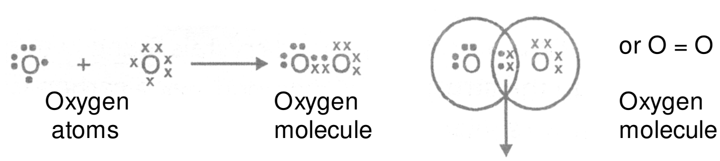
4 Shared electrons pairs

12.2 (b) Different Kinds of Covalent Bonds :

Electron pair shared between two atoms results in the formation of a covalent bond. This shared pair is also called bonding pair of electron.

- If two atoms share one electron pair, bond is known as single covalent bond and is represented by one dash (-)
- If two atoms share two electron pairs, bond is known as double covalent bond and is represented by two dashed (=).
- If two atoms share three electron pairs, bond is known as triple covalent bond and is represented by three dashes (=).

(i) Formation of double bond (oxygen molecule) : Two oxygen atoms combine to form oxygen molecule by sharing two electron pairs. Each oxygen atom (2, 6) has six electrons in the valence shell. It required two electrons to acquire nearest noble gas configuration. Therefore, both the atoms contribute two electrons each for sharing to form oxygen molecule. In the molecule, two electron pairs are shared and hence there is a double bond between the oxygen atoms.



2 Shared electrons pairs

(ii) Formation of triple bond (Nitrogen molecule) : Nitrogen atom has five electrons in its valence shell. In the formation of a nitrogen molecule, each of the following atoms provide three electrons to form three electrons pairs for sharing. Thus, a triple bond is formed between two nitrogen atoms.

3 Shared electron pairs

12.2 (c) Characteristic Properties of Covalent Compounds:

The important characteristic properties of covalent compounds are :

(i) Covalent compounds consist of molecules: The covalent compounds consist of molecules. They do not have ions. For example - hydrogen, oxygen, nitrogen etc. consist of H_2, O_2 and N_2 molecules respectively.

(ii) Physical state : Weak Vanderwaal's forces are present between the molecules of covalent compounds. So, covalent compounds are in **gaseous or liquid state at normal temperature and pressure.**

For example: Hydrogen, chlorine, methane, oxygen, nitrogen are gases while carbon tetrachloride, ethyl alcohol, ether, bromine etc. are liquids. Glucose, sugar, urea, iodine etc. are some solid covalent compounds.

(iii) Crystal structure - Covalent compounds exhibit both **crystalline and non crystalline** structure.

(iv) Melting point and boiling point: Energy required to break the crystal is less due to the presence of **weak Vanderwaal's force,** so their melting and boiling points are less.

(v) Electrical conductivity - Covalent compounds are **bad conductors** of electricity due to the **absence of free electrons or free ions.**

(vi) Solubility : Due to the **non - polar nature** of covalent compounds they are soluble in **non - polar solvents like benzene, carbon tetrachloride** etc. and insoluble in **polar solvents like water** etc.

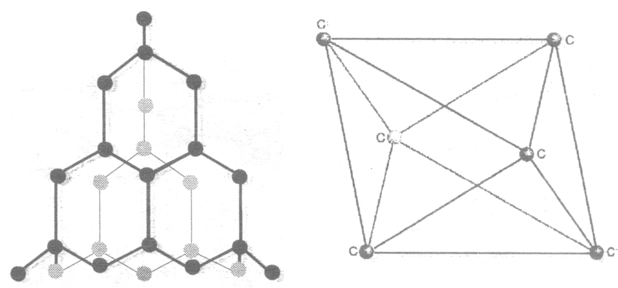
12.3 ALLOTROPIC FORMS OF CARBON :

Allotropy is the property by virtue of which an element exist in more than one form and each form has different physical properties but identical chemical properties. These different forms are called allotropes. The two common allotropic forms of carbon are diamond and graphite.

12.3 (a) Damon :

(i) Structure of Diamond : Diamond crystals found in nature are generally octahedral (eight faced). In the structure of diamond, each carbon i linked to four other carbon atoms forming regular and tetrahedral arrangement and this network of carbon atoms extends in three dimensions and is very rigid. This strong bonding is the cause of its hardness and its high density. This regular, symmetrical arrangement makes the structure very difficult to break. To separate one carbon atom from the structure, we have to break four strong covalent bonds.

Elements in which atoms are bonded covalently found in solid state. For example diamond, graphite, sulphur etc.



Three dimensional tetrahedral structure

(ii) Properties of Diamond :

(A) It occurs naturally in free state and has octahedral shape.

(B) It is the hardest natural substance known.

(C) It has high specific gravity (about 3.5).

(D) It is transparent, colourless and brittle solid.

(E) It has a high refractive index (about 2.4).

(F) It is non-conductor of electricity.

(iii) Uses of Diamond :

(A) They are used in jewellery because of their ability to reflect and refract light.

(B) Diamond is used in cutting glass and drilling rocks.

(C) Diamond has an extraordinary sensitivity to heat rays and due to this reason, it is used for making high precision thermometers.

(D) Diamond has the ability to cut out harmful radiations and due to this reason it is used for making protective windows for space probes.

(E) Diamond dies are used for drawing thin wires. Very thin tungsten wires of diameter less than one-sixth of the diameter of human hair have been drawn using diamond dies.

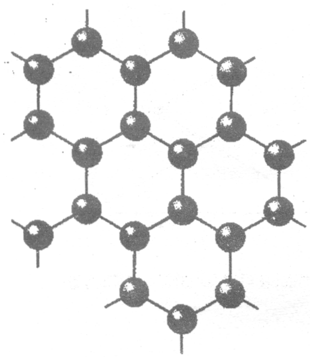
(F) Surgeons use diamond knives for performing delicate operations.

12.3 (b) Graphite:

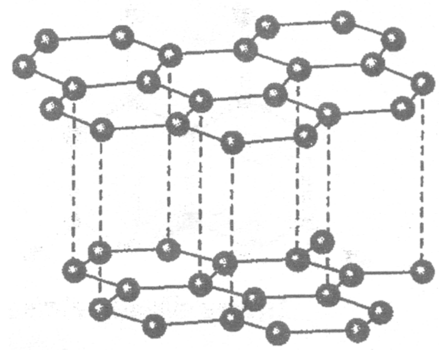
Graphite is an allotrope of carbon, which is black or bluish grey with a metallic lustre and or greasy feel. It occurs in igneous and metamorphic rocks, such as marble.

(i) Structure of Graphite :

Each carbon is bonded to only three neighboring carbon atoms in the same plane forming layers of hexagonal networks separated by comparatively larger distance. The different layers are held together by weak forces, called vanderwaal's forces. The layers can therefore, easily slide over one another. This makes graphite lubricating, soft and greasy to touch.



One layer



Showing how the layers fit together

Within each layer of graphite, every carbon atom is joined to three others by strong covalent bonds. This forms a pattern of interlocking hexagonal rings. The carbon atoms are difficult to separate from one another. So graphite also has high melting point.

However, the bonds between the layers are weak. The layers are able to slide easily over one another, rather like pack of cards. This makes graphite soft and slippery. When we write with a pencil, layers of graphite flake off and stick to the paper.

(ii) Properties of Graphite:

(A) It is soft and greasy in touch.

(B) Its specific gravity is 2.25 (generally).

(C) It is grayish black and opaque.

(D) It is a good conductor of heat and electricity.

(E) It occurs in hexagonal layers.

(F) It is stable and has high melting point.

(iii) Uses of graphite:

(A) It is used for making pencil lead, printer's ink, black paint etc.

(B) It is used as dry lubricant for heavy machinery.

(C) It is used in making crucibles for melting substances.

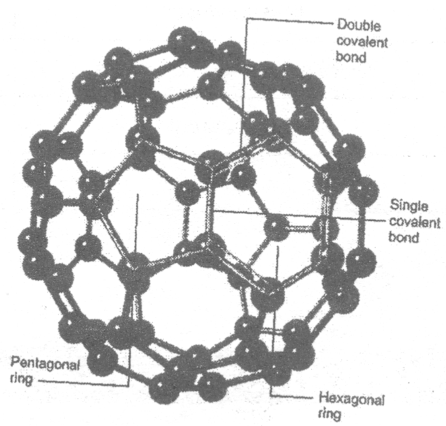
(D) It is used as an electrode in batteries and electric furnaces.

(E) It is used in nuclear reactors as moderator to regulate nuclear reactions.

(F) It is also used in making artificial diamonds.

12.3 (c) Fullerenes:

(i) Structure: Fullerene is naturally occurring allotrope of carbon in which 60 carbon atoms are linked to form a stable structure. Previously, only two forms of carbon (diamond and graphite) were known. The third allotrope of carbon, called fullerene was discovered in 1985 by Robert Curl, Herald Kroto and Richard Smalley.



STRUCTURE OF FULLERENE

The correctly suggested the cage structure as shown in the figure and named the molecule Buckminster fullerene after the architect Buckminster Fuller, the inventor of the Geodesic dome, which resembles the molecular structure of C_{60}. Molecules of C_{60} have a highly symmetrical structure in which 60 carbon atoms are arranged in a closed net with 20 hexagonal faces and 12 pentagonal faces. The pattern in exactly like the design on the surface of a soccer ball. C_{60} has been found to form in sooting flames when hydrocarbons are burned.

All the fullerenes have even number of atoms, with formulae ranging upto C_{400} and higher. These materials offer exacting prospects for technical application. For example, because C_{60} readily accepts and donates electrons, it has possible application in batteries.

(ii) Uses of Fullerenes : It is hoped fullerenes or their compounds may find used as -

(A) superconductors

(B) semiconductors

(C) lubricants

(D) catalysts

(E) as highly tensile fibers for construction industry.

(F) inhibiting agents in the activity of the AIDS virus.

12.3 (d) Explaining Conduction in Carbon :

In diamond, all four electrons in the outer shell of each carbon atom are used to make covalent bonds. This means that there are no free electrons and so diamond is an insulator. In graphite, only three of the outer shell electrons are used in bonding to other carbon atoms. This leaves on electrons per atom free to move, so graphite acts as an electrical conductor.

12.3 (e) Difference Between Properties of Diamond and Graphite :

Property	Diamond	Graphite
Hardness	Hardest natural substance	Very Soft
Density	3.5 g/cm^3	2.4 g/cm^3
Tendency to cunduct electric current	Bad conductor	Good conductor
Colour	Pure diamond is colourless	Black
Transparency	Transparent	Opaque
Occurrence	Rare	Abundant

DAILY PRACTICE PROBLEMS # 12

OBJECTIVE DPP - 12.1

1. Which of the following is an allotropic form of carbon ?
(A) Diamond (B) Graphite (C) Fullerene (D) All of these

2. Diamond is not a good conductor of electricity because -
(A) it is very hard.
(B) its structure is very compact.
(C) it is not water soluble.
(D) is has no free electrons to conduct electric current.

3. In a double covalent bond number of electron pairs shared are -
(A) 2 (B) 3 (C) 4 (D) 6

4. Which of the following compound contain single covalent bond ?
(A) Oxygen (B) Nitrogen (C) Methane (D) Carbon dioxide

5. Carbon dioxide molecule contains -
(A) single covalent bond (B) double covalent bond
(C) triple covalent bond (D) ionic bond

6. Covalent bond between atoms is formed by -
(A) loss of electrons (B) gain of electrons
(C) sharing of electrons (D) loss and gain of electrons both

7. Covalent compounds can be dissolved in -
(A) benzene (B) ether (C) alcohol (D) all of these

8. Covalent compounds are -

(A) good conductors of electricity.

(B) bad conductors of electricity.

(C) semiconductors of electricity.

(D) none of these.

9. Which of the following allotrope of carbon is used in making crucibles ?
(A) Diamond (B) Graphite (C) Fullerene (D) Coke

10. Structure of diamond is -
(A) linear (B) tetrahedral (C) trigonal (D) hexagonal

SUBJECTIVE DPP - 12.2

1. Why do atoms take part in bond formation ?

2. Write the Lewis dot structure of PH_3.

3. Name one electrovalent and one covalent compound containing chlorine.

4. An element 'X' has four valence electrons, while an element 'Y' has sis valence electrons. What type of bond is expected to be formed between the two? Draw the structure of the compound.

5. Name a carbon containing molecule in which two double bonds are present.

⮞⮞⮞ CARBON AND ITS COMPOUNDS ⮜⮜⮜

13.1 VERSATILE NATURE OF CARBON :

About 3 million organic compounds are known today. The main reasons for this huge number of organic compounds are =

(i) Catenation : The property of self linking of carbon atoms through covalent bonds to form long straight or branched chains and rings of different sizes is called catenation. Carbon shows maximum catenation in the periodic table due to its small size, electronic configuration and unique strength of carbon - carbon bonds.

(ii) Tetravalency of carbon : Carbon belongs to group 14 of periodic table. Since the atomic number of carbon is 6. The electronic configuration of carbon atom is 2,4. It has four electrons in the outermost shell. Therefore, its valency is four. Thus carbon forms four covalent bonds in its compounds. A methane molecule (CH_4) is formed when four electrons of carbon are shared with four hydrogen atoms are shown below.

$$\begin{array}{c} x \\ {}_{x}C_{x} \\ x \end{array} + \ 4H \qquad \begin{array}{c} H \\ \overset{x}{\bullet} \\ H \underset{x}{\overset{\bullet}{}}C\underset{}{\overset{\bullet}{x}}H \\ \underset{\bullet}{x} \\ H \end{array} \qquad or \qquad CH_4$$

Carbon atom | Hydrogen atom | Methane

(iii) Tendency to form multiple bond : Due to small size of carbon it has a strong tendency to form multiple bond (double & triple bonds) by sharing more than one electron pair. As a result, it can form a variety of compound. For example -

$$\begin{array}{c} H\quad H \\ |\quad\ | \\ H-C-C-h \\ |\quad\ | \\ H\quad H \end{array} \qquad \begin{array}{c} H\quad H \\ |\quad\ | \\ H-C=C-H \end{array} \qquad H-C\equiv C-H$$

Ethane | Ethene | Ethyne

13.2 VITAL FORCE THEORY OF BERZELIUS HYPOTHESIS :

Organic compounds cannot by synthesized in the laboratory because they require the presence of a mysterious force (called vital force) which exists only in living organisms.

13.3 WOHLER'S SYNTHESIS :

In 1828, Friedrich Wohler synthesized urea (a well known organic compound) in the laboratory by heating ammonium cyanate. Urea is the first organic compound synthesized in the laboratory.

$$\underset{\text{Ammonium sulphate}}{(NH_4)_2SO_4} + \underset{\text{Potassium cyanate}}{2\,KCNO} \longrightarrow \underset{\text{Ammonium cyanate}}{NH_4CNO} + \underset{\text{Potassium sulphate}}{K_2SO_4}$$

$$\underset{\text{Ammonium Cyanate}}{NH_4CNO} \xrightarrow[\text{Re arrangement}]{\text{Heat}} \underset{\text{Urea}}{NH_2-\overset{\overset{\displaystyle O}{\|}}{C}-NH_2}$$

13.4 HYDROCARBONS :

13.4 (a) Introduction :

The organic compounds containing only carbon and hydrogen are called hydrocarbons. These are the simplest organic compounds an are regarded as parent organic compounds. All other compounds are considered to be derived form them by the replacement of one or more hydrogen atoms by other atoms or groups of atoms. The major source of hydrocarbons is petroleum.

13.4 (b) Types of Hydrocarbons:

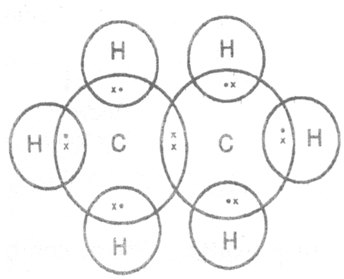
The hydrocarbons can be classified as :

(I) Saturated hydrocarbons.

(A) Alkanes : Alkanes are saturated hydrocarbons containing only carbon - carbon and carbon - hydrogen single covalent bonds.

For e.g. : CH_4 (Methane)

C_4H_6 (Ethane)



Electron dot structure of ethane

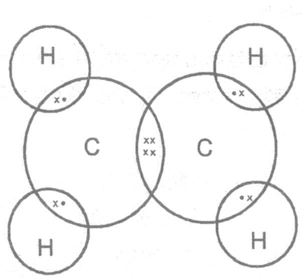
(ii) Unsaturated hydrocarbons :

(A) Alkenes : These are unsaturated hydrocarbons which contain carbon - carbon double bond. They contain two hydrogen less than the corresponding alkanes.

General formula: C_nH_{2n+2}

For e.g. : C_2H_4 (Ethane)

C_3H_6 (Propane)

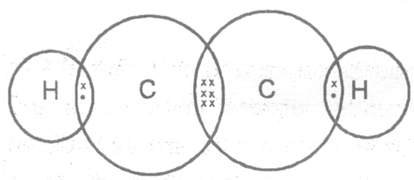


Electron dot structrure of etherne

(B) Alkynes : They are also unsaturated hydrocarbons which contain carbon - carbon triple bond. They contain four hydrogen atoms less than the corresponding alkanes.

General formula : C_nH_{2n}

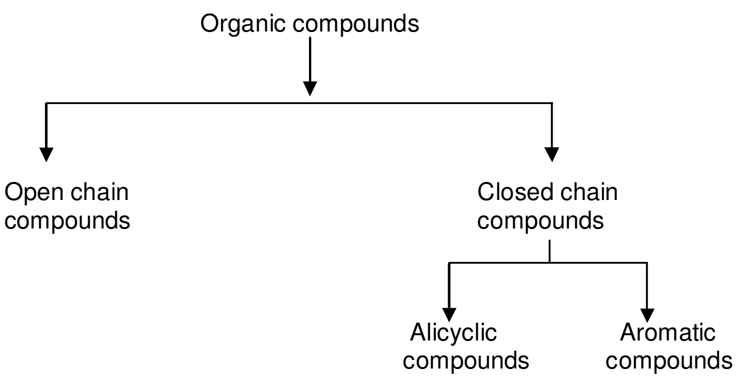
For e.g. : C_2H_2 (Ethane)
C_3H_4 (Propane)



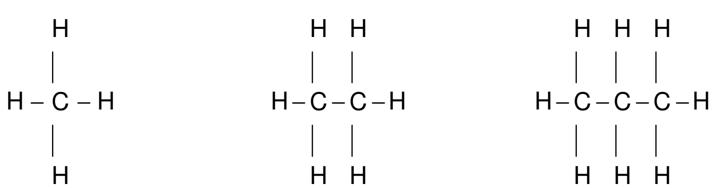
Electron dot structure of ethane

13.4 (c) Classifications of Organic Compounds:

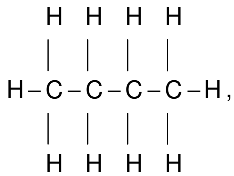
The organic compounds are very large in number on account of the self - linking property of carbon called catenation. These compounds have been further classified as open chain and cyclic compounds.



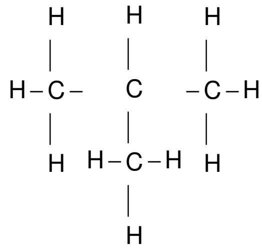
(i) Open chain compounds : These compounds contain an open chain of carbon atoms which my be either straight chain or branched chain in nature. Apart from that, they may also be saturated or unsaturated based upon the nature of bonding in the carbon atoms. For example.



Methane Ethane Propane



Butane



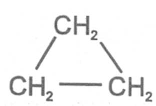
2-Methylpropane

Butane is a straight chain alkane while 2- Methylpropane is branched chain in nature.

(ii) Closed chain or Cyclic compounds : Apart form the open chains, the organic compounds can have cyclic or ring structures. A minimum of three atoms are needed to form a ring. These compounds have been further classified into following types.

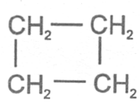
(A) Alicyclic compounds : Those carboxylic compounds which resemble aliphatic compounds in their properties are called alicyclic compounds.

For eg.

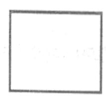


or

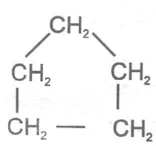
Cyclopropane



or

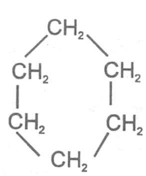


Cyclobutane



or

Cyclopentane



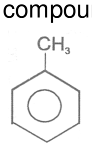
or

Cyclohexane

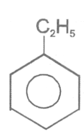
(B) Aromatic compounds : Organic compounds which contain one or more fused or isolated benzene rings are called aromatic compounds.

For eg.

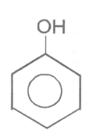
Benzene



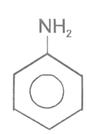
Toluene



Ethyl benzene



Phenol



Anilien

13.5 HOMOLOGOUS SERIES :

Homologous series may be defined as a series of similarly constituted compounds in which the members possess similar chemical characteristics and the two consecutive members differ in their molecular formula by - CH_2.

13.5 (a) Characteristics of Homologous Series :

(i) All the members of series can be represented by the same generally formula.

For eg. General formula for alkane series is C_nH_{2n+2}.

(ii) Any two consecutive members differ in their formula by a common difference of - CH_2 and differ in molecular mass by 14.

(iii) Different member in a series have a common functional group.

For eg. All the members of alcohol family have - OH group.

(iv) The members in any particular family have almost identical chemical properties. Their physical properties such as melting point, boiling point, density etc. show a regular gradation with the increase in the molecular mass.

(v) The members of a particular series can be prepared almost by the identical methods.

13.5 (b) Homologues :

The different members of a homologous series are known as homologues.

For example :

(i) Homologous series of alkanes

General formula : C_nH_{2n+2}.

Value of n	Molecular formula	IUPAC name
n = 1	CH_4	Methane
n = 2	C_2H_6	Ethane
n = 3	C_3H_8	Propane

(ii) Homologous series of alkenes

Value of n	Molecular formula	IUPAC name	Common name
n = 1	C_2H_4	Ethane	Ethylene
n = 3	C_3H_6	Propane	Propylene
n = 4	C_4H_8	But - 1 – ene	α - Butylenes ($H_3C - CH_2 - HC = CH_2$)

(iii) Homologous series of alkynes
General formula : C_nH_{2n-2}

Value of n	Molecular formula	IUPAC name	Common name
n = 2	C_2H_2	Ethyne	Acetylene
n = 3	C_3H_4	Propyne	Methyl acetylene
n = 4	C_4H_6	But - 1 - yne	Ethyl acetylene ($CH_3 - CH_2 - C \equiv CH$)

DAILY PRACTIVE PROBLESM # 13

OBJECTIVE DPP - 13.1

1. The general formula for saturated hydrocarbon is -
(A) C_nH_{2n+2} (B) C_nH_{2n} (C) C_nH_{2n-2} (D) C_nH_{2n-n}

2. Select the alkyne form the following -
(A) C_4H_8 (B) C_5H_8 (C) C_7H_{19} (D) None of these

3. The first compound to be prepared in the laboratory was -
(A) methane (B) ethyl alcohol (C) acetic acid (D) urea

4. In order to form branching, an organic compound must have a minimum of -
(A) four carbon atoms (B) three carbon atoms
(C) five carbon atoms (D) any number of carbon atoms

5. The number of C - H bonds in ethane (C_2H_6) molecule is -
(A) four (B) six (C) eight (D) ten

6. The main reason for this huge number of organic compounds are -
(A) catenation (B) tetravalency of carbon
(C) tendency to form multiple bonds (D) all of these

7. Which of the following is a saturated hydrocarbon ?
(A) C_2H_6 (B) C_2H_4 (C) C_2H_5 (D) All of these

8. Whish of the following is not an open chain compound ?
(A) methane (B) ethane (C) Toluene (D) Butyne

9. Which of the following is an aromatic compound?
(A) Cyclohexane (B) Ethyne (C) Phenol (D) All of these

10. Which of the following does not belong to alkane ?
(A) C_2H_4 (B) CH_4 (C) C_2H_6 (D) C_4H_{10}

SUBJECTIVT DPP = 13.2

1. What is the common difference in two consecutive members in a homologous series ?

2. What is catenation? Why does carbon show maximum tendency to catenate ?

3. What are saturated hydrocarbons? Give one example.

CARBON AND ITS COMPOUNDS

14.1 NOMENCLATURE OF ORGANIC COMPOUNDS :

Nomenclature means the assignment of names to organic compounds. There are two main systems of nomenclature of organic compounds –

- Trivial system
- IUPAC system (International Union of Pure and Applied Chemistry)

14.1 (a) Basic Rules of Nomenclature or Compounds in IUPAC System :

For naming simple aliphatic compounds, the normal saturated hydrocarbons have been considered as the parent compounds and the other compounds as their derivatives obtained by the replacement of one or more hydrogen atoms with various functional groups.
Each systematic name has first two or all three of the following parts :

(i) Word root : The basic unit is a series of word rot which indicate linear or continuous number of carbon atoms.

(ii) Secondary suffix : Suffixes added after the primary suffix to indicate the presence of a particular functional group in the carbon chain are known as secondary suffixes.

14.1 (b) Name of Straight Chain Hydrocarbons

The name of straight chain hydrocarbon may be divided into two parts
(i) Word root (ii) Primary suffix

(i) Word roots for carbon chain lengths :

Chain length	Word root	Chain length	Word root
C_1	Meth-	C_8	Hex –
C_2	Eth –	C_7	Hept –
C_3	Prop –	C_8	Oct –
C_4	But –	C_9	Non –
C_5	Pent -	C_{10}	Dec -

(ii) Primary suffix :

Class of Cmpounds	Primary suffix	General name
$>C-C<$ **Saturated**	**- ane**	**Alkane**
$>C=C<$ **Unsaturated**	**- ene**	**Alkene**
$(-C\equiv C-)$ **Unsaturated**	**- yne**	**Alkyne**

Examples :

Molecular formular	Word root	Primary suffix	IUPAC Name
CH_4	Meth –	- ane	Methane
CH_3-CH_3	Eth –	- ane	Ethane
$CH_3CH_2CH_3$	Prop –	- ane	Propane
$CH_3CH_2CH_2CH_3$	But –	- ane	Butane
$CH_2=CH_2$	Eth –	- ane	Ethene
$CH_3-CH=CH_2$	Prop –	- ane	Propene
CH_3-$C\equiv CH$	Prop -	- yne	Propyne

14.1 (c) Names of Branched Chain Hydrocarbon :

The carbon atoms in branched chain hydrocarbons are present as side chain. These side chain carbon atoms constitute the alkyl group or alkyl radicals. An alkyl group is obtained from an alkane by removal of a hydrogen. General formula of an alkyl group = C_nH_{2n+1}
An Alkyl group is represented by R.

For eg.

(i)

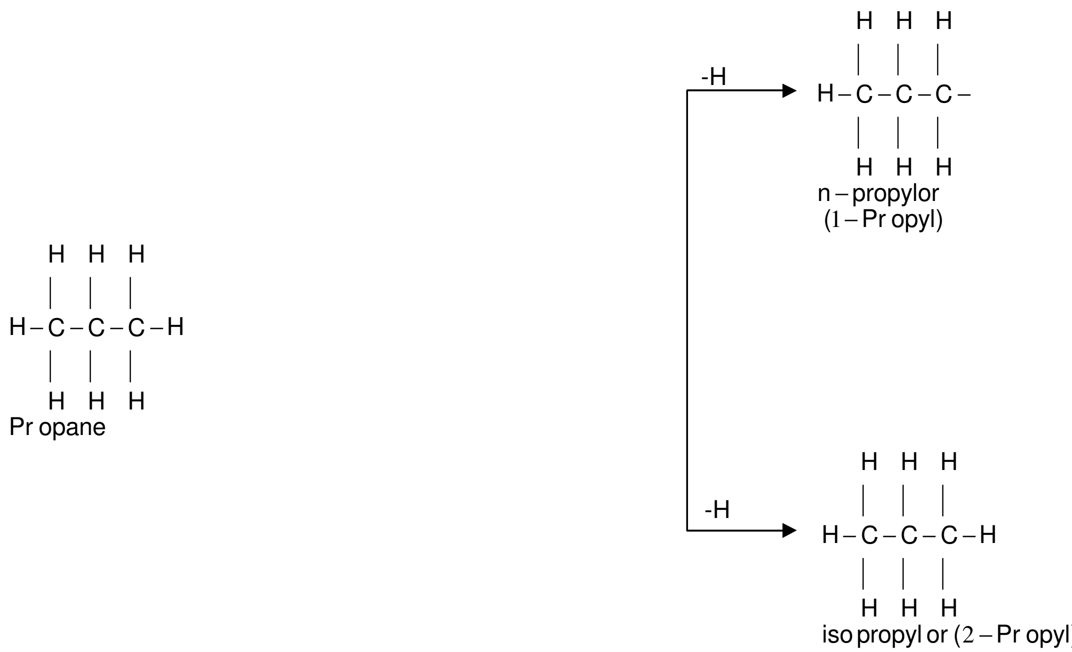
$$\begin{array}{c} H \\ | \\ H-C-H \\ | \\ H \end{array} \xrightarrow{-H} \begin{array}{c} H \\ | \\ H-C- \\ | \\ H \end{array}$$

Methane → Methyl

(ii)

$$\begin{array}{c} H\quad H \\ |\quad\ | \\ H-C-C-H \\ |\quad\ | \\ H\quad H \end{array} \xrightarrow{-H} \begin{array}{c} H\quad H \\ |\quad\ | \\ H-C-C- \\ |\quad\ | \\ H\quad H \end{array}$$

Ethane → Ethyl

(ii) 

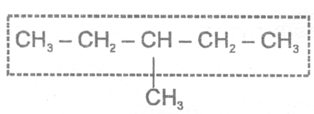
14.1 (d) A Branched Chain Hydrocarbon is Named Using the Following General IUPAC Rules :

Rule 1 : Longest chain rule : Select the longest possible continuous chain of carbon atoms. If some multiple bond is present, the chain selected must contain the multiple bond.

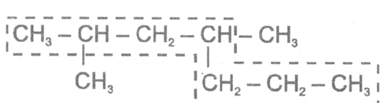
(i) The number of carbon atoms in the selected chain determines the **word root.**

(ii) Saturation or unsaturation determines the primary suffix (P. suffix(.

(iii) Alkyl substituents are indicated by prefixes .

e.g. 

च्तमपिग रू डमजीलस ूवतक
तववज रू चमदज च्
ेर्निपिग रू ंदम

eg. 

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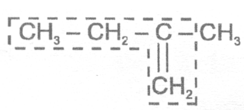
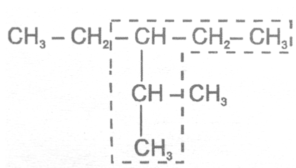
eg. 

च्तमपिग रू डमजीलस ॅवतक
तववज रू ठनज च्ै र्निपिग
रू मदम

eg. 

च्तमपिगमे रू म्जीलसए डमजीलस ूवतक
तववज रू च्मदज च्ै र्निपिग रू ंदम

Rule 2 : Lowest number Rule : The chain selected in numbered in terms of arabic numerals and the position of the alkyl groups are indicated by the number of the carbon atom to which alkyl group is attached.

(i) The numbering is done in such a way that the substituents carbon atom has the lowest possible number.

(ii) If some multiple bond is present in the chain, the carbon atoms involved in the multiple bond should get lowest possible numbers.

eg.

$$\overset{1}{CH_3}-\underset{\underset{CH_3}{|}}{\overset{2}{CH}}-\overset{3}{CH_2}-\overset{4}{CH_3}$$

2 – Methyl butane
(Correct)

$$\overset{4}{CH_3}-\underset{\underset{CH_3}{|}}{\overset{3}{CH}}-\overset{2}{CH_2}-\overset{1}{CH_3}$$

3 – Methyl butane
(Wrong)

eg.

$$\overset{1}{CH_3}-\underset{\underset{CH_3}{|}}{\overset{2}{CH}}-\overset{3}{CH_2}-\overset{4}{CH_2}-\overset{5}{CH_3}$$

2- Methylpentane
(Correct)

$$\overset{5}{CH_3}-\underset{\underset{CH_3}{|}}{\overset{4}{CH}}-\overset{3}{CH_2}-\overset{2}{CH_2}-\overset{1}{CH_3}$$

4- Methylpentane
(Wrong)

eg.

$$\overset{4}{CH_3}-\underset{\underset{CH_3}{|}}{\overset{3}{CH}}-\overset{2}{CH}=\overset{1}{CH_2}$$

3 – Methylbut – 1 – yne
(Correct)

$$\overset{1}{CH_3}-\underset{\underset{CH_3}{|}}{\overset{2}{CH}}-\overset{3}{CH}=\overset{4}{CH_2}$$

2 – Methylbut – 3 – ene
(Wrong)

e.g.

$$\overset{4}{CH_3}-{}^{3}\overset{\overset{CH_3}{|}}{CH}-{}^{2}C\equiv{}^{1}CH$$

3 – Methylbut – 1 – yne
(Corract)

$$\overset{4}{CH_3}-{}^{2}\overset{\overset{CH_3}{|}}{CH}-{}^{3}C\equiv{}^{4}CH$$

2 – Metylbut - 3 - yne
(Wrong)

The name of the compound, in general, is written in the following sequence. (Position of substituents) - (prefixes) (word root) (p - suffix)

Rule : 3 Use of prefixed di, tri etc. : If the compound contains more than one similar alkyl groups, their positions are indicated separately and an appropriate numerical prefix, di, tri, etc., is attached to the name of the substituents. The positions of the subsistent are separated by commas.

eg.

$$\overset{1}{CH_3}-\overset{\overset{CH_3}{|}}{\overset{2}{CH}}-\overset{\overset{CH_3}{|}}{\overset{3}{CH}}-\overset{4}{CH_2}-\overset{5}{CH_3}$$

1, 3 – Dimethylpentane

$$\overset{5}{CH_3}-\overset{4}{CH_2}-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{\overset{3}{C}}}-\underset{\underset{CH_3}{|}}{\overset{2}{CH}}-\overset{1}{CH_3}$$

2,3,3 – Trimethylpentane

eg.

$$\overset{1}{CH_3}-\underset{\underset{CH_3}{|}}{\overset{2}{CH}}-\underset{\underset{CH_3}{|}}{\overset{3}{CH}}-\overset{4}{CH_2}-\underset{\underset{CH_3}{|}}{\overset{5}{CH}}-\overset{6}{CH_3}$$

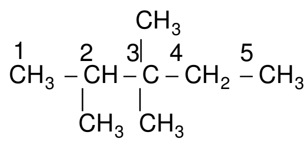
2, 3, 5 Trimethylhexane

$$\overset{1}{CH_3}-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{\overset{2}{C}}}-\overset{3}{CH_2}-\overset{\overset{CH_3}{|}}{\overset{4}{CH}}-\overset{5}{CH_3}$$

2, 2, 4 Trimethylpentane

Rule 4 : Alphabetical arrangement of prefixes : If there are different alkyl substituents present in the compound their names are written in the alphabetical order. However, the numerical prefixes such as di, tri etc. are not considered for the alphabetical order.

For eg :

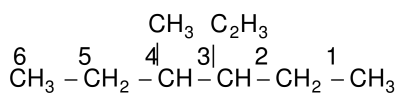


3 – Ethyl – 2, 3 - dimethylpentane

Rule 5 : Naming of different alkyl substituents at the equivalent positions :

If two alkly substituents are present at the equivalent position then numbering of the chain is done is such a way that the alkyl group which comes first in alphabetical order gets the lower position.

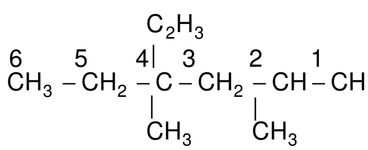
eg.



3 – Ethyl – 4 – methylhexane

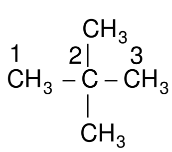
14.1 (e) Some More Example :

(i)



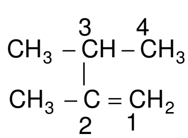
Word root :	Hex
Primary suffix :	ane
Substituents :	two methyl & one ethyl groups
IUPAC name :	4- Ethyl - 2,4 - dimethylhexane

(ii)



Word root :	Prop
P. Suffix :	ane
Substituents :	to methyl groups
IUPAC name :	2,2- Dimethylpropane

(iii)



Word root :	But
P. Suffix :	ene
Substituents :	two methyl groups
IUPAC name :	2, 3 – Dimethylbut - 1 - ene

(iv)

$$\begin{array}{cccccccccccc} \overset{6}{CH_3} & - & \overset{5}{CH_2} & - & \overset{4}{CH} & - & \overset{3}{C} & \equiv & \overset{2}{C} & - & \overset{1}{CH_3} \\ & & & & | & & & & & & \\ & & & & CH_3 & & & & & & \end{array}$$

4 – Methylhex – 2 - yne

14.2 FUNCTIONAL GROUP :

14.2 (a) Introduction :

An atom or group of atoms in an organic compound or molecule that is responsible for the compound's characteristic reactions and determines its properties is known as **functional group.** An organic compound generally consists of two parts -

(i) Hydrocarbon radical (ii) Functional group

For eg.

$$\begin{array}{ccccccc} & & H & & H & & \\ & & | & & | & & \\ H & - & C & - & C & - & OH \\ & & | & & | & & \\ & & H & & H & & \end{array}$$

Hydrocarbon radical **Functional group**

- Functional group is the most reactive part of the molecule.
- Functional group determines the chemical properties of an organic compound.
- Hydrocarbon radical determines the physical properties of the organic compound.

14.2 (b) Main Functional Groups :

(i) Hydroxyl group (-OH) : All organic compounds containing - OH group are known as alcohols.
For e.g. Methanol (CH_3OH), Ethanol (CH_3 - CH_2 - OH) etc.

(ii) Aldehyde group (-CHO) : All organic compounds containing CHO group are known as aldehydes.
For e.g. Methanol (HCHO), Ethanol (CH_3CHO) etc.

(iii) Ketone group (-CO-) : All organic compounds containing -CO- group are known as ketones.
For e.g. 2- Propanone (CH_3COH_3), 2-Butanone ($CH_3COCH_2CH_3$) etc.

(iv) Carboxyl group (-COOH) : All organic acids contain carboxyl group. Hence they are also called carboxylic acids.

For e.g. CH_3COOH (Ethanoic acid)
CH_3CH_2COOH (Propanoic acid)

(v) Halogen group (x= F, Cl, Br, I) : All organic compounds containing - X(F, Cl, Br or I) group are known as halides.

For e.g. Chloromethane (CH_3Cl), Bromomethane (CH_3Br) etc.

14.2 (c) Nomenclature of Compounds Containing Functional Group :

In case come functional group (other than $C=C$ and $C \equiv C$) is present, it is indicated by adding secondary suffix after the primary suffix. The terminal 'e' of the primary suffix is removed if it is followed by a suffix beginning with 'a', 'e', 'i', 'o', 'u'. Some groups like - F, - Cl, - Br and - I are considered as substituents and are indicated by the prefixes.

Some groups like – CHO, $-\overset{O}{\overset{\|}{C}}-$ - COOH, and - OH are considered as functional groups and are indicated by suffixes.

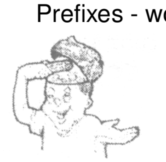
Class	Functional Group	General Formular	Prefix	Suffix	IUPAC Name
Carboxylic acid	$-\overset{O}{\overset{\|}{C}}-OH$	$R-\overset{O}{\overset{\|}{C}}-OH$ $(R=C_nH_{2n+1})$	Carboxy	- oic acid	Alkanoic acid
Ester	$-\overset{O}{\overset{\|}{C}}-OR$	$R-\overset{O}{\overset{\|}{C}}-O-R'$ $(R \neq R')$	Carbalkoxy	Alkyl (r;) – oate	Alkyl alkanoate
Aldehyde	- CHO	R - CHO	Formyl or oxo	- al	Alkanal
Ketone	$-\underset{O}{\underset{\|}{C}}-$	$R-\underset{O}{\underset{\|}{C}}-R$	oxo	- one	Alkanal
Alcohol	-OH	R – OH	Hydroxy	- ol	Alkanol
Alkenes	C =C	C_nH_{2n}	-	- ene	Alkene
Alkynes	$C\equiv C$	C_nH_{2n-2}	-	- yne	Alkene
Halides	-X (X = F, Cl, Br, I)	R – X	Halo	-	Haloalkane

14.2 (d) Naming of an Organic Compound Containing Functional Group :

Step 1 : Select the longest continuous chain of the carbon atoms as parent chain. The selected chain must include the carbon atom involved in the functional groups like - COOH, - CHO etc., or those which carry the functional groups like - OH, - Cl etc.
Step 2 : The presence of carbon - carbon multiple bond decides the primary suffix.
Step 3 : The secondary suffix is decided by the functional group.

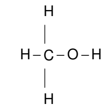
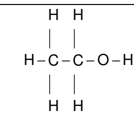
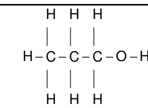
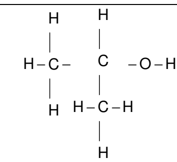
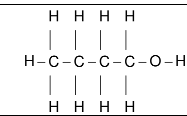
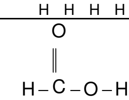
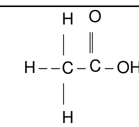
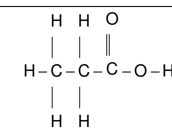
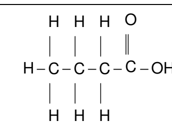
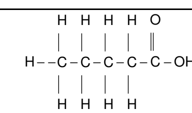
Step 4 : The carbon atoms of the parent chain are numbered in such a way so that the carbon atom of the functional group gets the lowest possible number. In case the functional group does not have the carbon atom, then the carbon atom of the parent chain attached to the functional group should get the lowest possible number.

Step 5 : The name of the compound is written as -
Prefixes - word root - primary suffix - secondary suffix

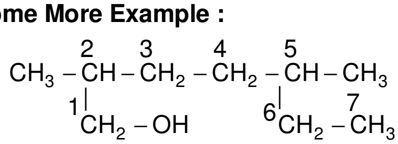


Store in your memory

The number of carbon atoms in the parent chain decides the word root.

S.No.	Compound	Common name	Derived name	IUPAC	Strucutre
1	$CH_3 - OH$	Methyl alcohol or Wood spirit	Carbiinol	Methanol	
2	$CH_3 - CH_2 - OH$	Ethyl alcohol	Methyl carbinol	Ethanol	
3	$CH_3 - CH_2 - CH_2 - OH$	n-Propyl alcohol	Ethyl carbinol	1-Propanol	
4	$CH_3 - \underset{\substack{\vert \\ CH_3}}{CH} - OH$	Isopropyl alcohol	Dimethyl carbinol	2-Propanol	
5	$CH_3 - CH_2 - CH_2 - CH_2 - OH$	n-Butyl alcohol	n-Propyl carbinol	1-Butanol	
6	HCOOH	Formic acid	-	Methanoic acid	
7	$CH_3\ COOH$	Acetic acid	-	Ethanoic acid	
8	$CH_3 - CH_2 - COOH$	Propionic acid	-	Propanoic acid	
9	$CH_3 - CH_2 - CH_2 - COOH$	Butryic acid	-	Butanoic acid	
10	$CH_3 - CH_2 - CH_2 - CH_2 - COOH$	Valeric acid	-	Petanoic acid	

14.2 (e) Some More Example :

(i) 

Longest chain contains carbon : 7
Word root : Hept
primary suffix : ane
Functional group : - OH
Secondary suffix : - ol
IUPAC Name : 2,5 - Dimethylheptan -1 - ol

(ii) $\overset{5}{CH_3}-\overset{4}{CH_2}-\overset{3}{CH}=\overset{2}{CH}-\overset{1}{\overset{\overset{O}{\|}}{C}}-OH$

Word root :	Pent
Primary suffix :	ene
Secondary suffix :	-oic acid
Position of double bond :	2^{nd}
IUPAC name :	Pent - 2 - en - 1 - oic acid

(iii) $\overset{1}{CH_3}-\underset{\underset{Cl}{|}}{\overset{2}{CH}}-\overset{3}{CH_2}-\overset{4}{CH_3}$

Word root :	But
Primary suffix :	ane
Prefix :	chloro
IUPAC name :	2 - Chlorobutane

14.3 ISOMERS & ISOMERSISM :

14.3 (a) Introduction :

Such compounds which have same molecular formula but different in some physical or chemical properties are known as isomers and the phenomenon is known as isomerism.

ISOMERSIM

- Structural Isomerism
  - Chain
  - Position group
  - Functional
  - Metamerism
  - Tautomerism
- Stereoisomerism
  - Geometrical
  - Optical

14.3 (b) Structural Isomerism:

Such compounds which have same molecular formula but different structural arrangement of atoms in their molecules are known as structural isomers and the phenomenon is known as structural isomerism.

(i) Chain isomerism : The isomerism in which the isomers differ from each other due to the presence of different carbon chain skeletons in known as chain isomerism.

For eg:

(A) C_4H_{10}

$CH_3 - CH_2 - CH_2 - CH_3$, $\qquad$ $\begin{array}{c} CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_3 \end{array}$

n - Butane $\qquad$ 2- Methylpropane (Isobutane)

(B) C_5H_{12}

$CH_3 - CH_2 - CH_2 - CH_2 - CH_3$ $\qquad$ $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2 - CH_3$

n - Pentane $\qquad$ 2- Methylbutane (isopentance)

$$CH_3 - \overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C}}}} - CH_3$$

2,2 - Dimethylpropane (neo - pentane)

(C) C_4H_8

$CH_3 - CH_2 - CH = CH_2$, $\qquad$ $CH_3 - \overset{\displaystyle CH_3}{\overset{|}{C}} = CH_2$

But - 1 - ene $\qquad$ 2 - Methylpropene

(ii) Position isomerism: In this type of isomerism, isomers differ in the structure due to difference in the position of the multiple bond or functional group.

For eg.

(A) C_4H_8

$CH_2 - CH_2 - CH = CH_2$, $\qquad$ $CH_3 - CH = CH - CH_3$

But - 1 - ene $\qquad$ But-2-ene

(B) C_3H_8O

$CH_3\text{-}CH_2\text{-}CH_2\text{-}OH$ $\qquad$ $CH_3 - \underset{\displaystyle OH}{\underset{|}{CH}} - CH_3$

Propane - 1 - ol $\qquad$ Propane - 2 - ol

(iii) Functional group isomerism : In this type of isomerism, isomers differ in the structure due to the presence of different functional groups.

For eg.

(A) C_3H_8O

$CH_3 - CH_2 - O - CH_3$ and $CH_3 - CH_2 - CH_2 - OH$

Methoxy ethane — Propane - 1 - ol

(B) C_4H_6

CH_3-$CH_2C \equiv CH$ and $CH_2 = CH - CH = CH_2$

But-1-yne — Buta - 1, 3-diene [or 1, 3 - Butadiene]

DAILY PRACTIVE PROBLEMS # 14

OBJECTIVE DPP - 14.1

1. The general formula fo an ester (where R represents an alkyl group) is -
(A) ROH (B) R-COOH (C) R-COOR (D) RH

2. The functional group, present in $CH_3COOC_2H_5$ is-
(A) ketonnic (B) aldehydic (C) ester (D) carboxylic

3. IUPAC name of CH_3CH_2OOH is -
(A) wood spirit (B) methyl carbinol (C) ethanol (D) ethyl alcohol

4. The IUPAC name of the compound having the formula $(CH_3)_3$ CCH = CH_2 is -
(A) 3,3,-trimethyl -1-propane (B) 1,1,1- trimethyl-1-butene
(C) 3,3-dimethyl-1-butene (D) 1,1-dimethyl-1,3-butene

5. The IUPAC name of $(CH_3CHCH_3$ is -
(A) 2-methylpropane (B) 2,2-dimethylethane
(C) trimethylmethan (D) none of these

6. The IUPAC name of the following compound is -
CH_2 - CH - CH $(CH_3)_2$
(A) 1,1-dimethyl -2 propane (B) 3- methyl -1-butene
(C) 2- vinyl propane (D) 1-isoproply ethylene

7. IUPAC name of second member of homologous series of carboxylic acids is -
(A) methanoic acid (B) ethanoic acid (C) propanic acid (D) butanoic acid

8. The IUPAC name of cH_3 - $C(CH_3)$ (OH) CH_2 - $CH(CH_3)$ CH_3 is -
(A) 2,4-dimethyl pentan -2-ol (B) 2,4- dimethyl pentan -4-ol
(C) 2,2- dimethyl butane (D) butanol -2-one

9. The IUPAC name of $(CH_3)_2\,CHCH_2CH_2Br$ is
(A) 1-bromopentance
(B) 2- methyl-4-bromo pentane
(C) 1- bromo -3- methyl butane
(D) 2-methyl -3- bromo pentane

10. The functional group in an alcohol is -

(A) $-\overset{\overset{\displaystyle O}{\|}}{C}-O-$ (B) $-\overset{\overset{\displaystyle O}{\|}}{C}-OH$ (C)-OH (D) $-\overset{\overset{\displaystyle O}{\|}}{C}-H$

SUBJECTIVE DPP - 14.2

1. In an organic compound, which part largely determines its physical & chemical properties ?

2. Give IUPAC name of the following compounds -

(a) $CH_3 - CH_2 - CH_2 - OH$

(b) $CH_3-\underset{\underset{\displaystyle OH}{|}}{CH}-CH_3$

(C) How are these two compounds related to each other ?

3. Draw the structures of the following compounds -
(a) simplest ketone
(b) next higher homologue of butanoic acid
(c) acetic acid
(d) n-butly alcohol

4. Name a functional group which can never occupy terminal position.

5. Give the IUPAC names of -
(a) $CH_3 - CH_2 - Br$
(b) $CH_3 - CH_2 - CH_2 - CH_2 - C \equiv CH$

6. How many structural isomers are possible for pentane? Draw these.

7. Name the isomerism exhibited by the following pairs of compounds -
(a) Proponal & Propanone
(b) 1- Propanol & 2- Propanol

Teko CLASSES ....the support

CARBON AND ITS COMPOUNDS

CL - 15

15.1 CHEMICAL PROPERTIES OF CARBON COMPOUNDS :

The important chemical properties of organic compounds are discussed below :

15.1 (a) Combustion:

Carbon in all its allotropic forms burns in air or oxygen to give carbon dioxide and releases energy in the form of heat and light.
Most carbon compound also release a large amount of heat and light on burning.

C Carbon	+	O_2 Oxygen	$\longrightarrow$	CO_2 Carbon dioxide	+	Hear and light		
CH_4 Methane	+	$2O_2$ Oxygen	$\longrightarrow$	CO_2 dioxide	+	$2H_2O$ Carbon	+	Heat and light Water
C_2H_4 Ethane	+	$3O_2$ Oxygen	$\longrightarrow$	$2CO_2$ dioxide	+	$2H_2O$ Carbon	+	Heat and light Water
$2C_2H_2$ Ethyne	+	$5O_2$ Oxygen	$\longrightarrow$	$4CO_2$ dioxide	+	$2H_2O$ Carbon	+	Heat and light Water
CH_2CH_2OH Ethanol	+	$3O_2$ Oxygen	$\longrightarrow$	$2CO_2$ Carbon dioxide	+	$3H_2O$ Water	+	Heat and light

Saturated hydrocarbons will generally give a clean flame while unsaturated carbon compounds will give a yellow flame with lots of black smoke. This results in a sooty deposit on the metal plate. However, limiting the supply of air results in incomplete combustion of even saturated hydrocarbons giving a sooty flame.

15.1 (b) Oxidation :

Oxidation is a process in which oxygen is added to a substance. The substances which add oxygen to other substances are called oxidising agents. There are many oxidising agents such as alkaline potassium permanganate (alk. $KMnO_4$), acidified potassium dichromate ($K_2Cr_2O_7$), nitric acid (HNO_3) etc. which are commonly used in organic chemistry. Some common reactions of oxidation are -

(i) $CH_2 = CH_2 + H_2O + (O) \xrightarrow{\text{Alkaline } KMnO_4} \begin{array}{l} CH_2 - CH_2 \\ | \quad\quad | \\ OH \quad OH \end{array}$

Ethylene glycol

Ethane

(ii) $CH \equiv CH + 4(O) \xrightarrow{\text{Alkaline } KMnO_4} \begin{array}{l} COOH \\ | \\ COOH \end{array}$

Oxalic acid

(iii) $CH_3CH_2OH \xrightarrow[\text{Acidified } K_2Cr_2O_7 + \text{Heat}]{\text{Alkaline } KMnO_4} CH_3COOH$

Ethanol Ethanoic acid

(iv) $CH_3CHO \xrightarrow[\text{Acidified } K_2Cr_2O_7]{\text{Alkaline } KMnO_4 \text{ Or}} CH_3COOH$

Ethanol Ethanoic acid

15.1 (c) Substitution Reaction:

The reaction in which an atom or group of atoms in a molecule is replaced or substituted by different atoms or group of atoms are called substitution reactions. Saturated hydrocarbons are fairly uncreative. For example, chlorine does not react with methane at room temperature. However, in the presence of sunlight the reaction of chlorine and hydrocarbons is fairly fast reaction. It gives a variety of products.

$CH_4 + Cl_2 \xrightarrow{\text{Sulight}} CH_3Cl + HCl$

Methane Chlorine Chloromethane Hydrogen chloride

In this reaction H - atom of methane has been replaced by a - Cl atom converting CH_4 to CH_3Cl. However, if Cl_2 is used in excess, all the hydrogen atoms are replaced by chlorine atom one by one.

$CH_3Cl + Cl_2 \xrightarrow{\text{Sulight}} CH_2Cl_2 + HCl$

Chloromethane Chlorine Dichloromethane Hydrogen chloride

$CH_2Cl_2 + Cl_2 \xrightarrow{\text{Sulight}} CHCl_2 + HCl$

Dichloromethane Chlorine Trichloromethane (Chloroform) Hydrogen chloride

$CHCl_3 + Cl_2 \xrightarrow{\text{Sulight}} CCl_4 + HCl$

Trichloromethane Chlorine Tetrachloromethane (Carbon tetrachloride) Hydrogen chloride

15.1 (d) Addition Reaction:

The reactions in which two molecules react to form a single product having all the atoms of the combining molecules are called addition reactions. Unsaturated compounds such as alkenes contain double bond between carbon atoms. Because of the presence of double bond, they undergo addition reaction.

(i) Addition of halogen to alkenes:

$$CH_2 = CH_2 + cl_2 \xrightarrow{CCl_4} \begin{array}{cc} CH_2- & CH_2 \\ | & | \\ Cl & Cl \end{array}$$

Ethane Chlorine 1,2-Dicloroethane

$$CH_2 = CH_2 + Br_2 \xrightarrow{CCl_4} \begin{array}{cc} CH_2- & CH_2 \\ | & | \\ Br & Br \end{array}$$

Ethene Bromine 1,2- Dibromoethane

(ii) Addition of hydrogen :

$$CH_2 = CH_2 + H_2 \xrightarrow[573K]{Ni} CH_2 - CH_3$$

Ethene Hydrogen Ethane

This reaction is called hydrogenation. Hydrogenation reaction is used in the manufacture of vanaspati ghee from vegetable oils. The vegetable oil such as ground nut oil, cotton speed oil and mustard oil contain bonds (C = C) in their molecules. When reacted with hydrogen in the presence of nickel as catalyst, they are converted into vanaspati ghee which is solid at room temperature like butter or ghee.

Vegetable oil + H_2 $\xrightarrow[\text{Catalyst}]{Ni}$ Vegetable ghee or Vanaspati ghee

(Unsaturated hydrocarbons) (Saturated hydrocarbons)

15.2 BURNING OF SUBSTANCES WITH OR WITHOUT SMOKY FLAME :

When coal or charcoal burns n an 'angithi', sometimes it just glows red and gives out heat without a flame. This is because a flame is only produced when gaseous substances burn. When wood or charcoal is ignited, the volatile substances present vapourise and burn with a flame in the beginning.
A luminous flame is also observed when the atoms of the gaseous substances are heated and start to glow. The colour of the flame is characteristic of that element. For example, when a copper wire is heated in the flame of the a gas stove, a bluish green colour is obtained.

The incomplete combustion gives soot or smoke which is due to carbon. Saturated hydrocarbons burn with blue non-sooty flame. This is because the percentage of carbon in these compounds is low which gets oxidised completely by the oxygen present in the air.
On the other hand, unsaturated hydrocarbons burn with yellow sooty flame. This is because the percentage of carbon in these compounds is comparatively higher (than saturated compounds). Therefore, all the carbon does not get oxidised completely in the oxygen of the air. Due to incomplete combustion, the flame is sooty due to the presence of unburnt carbon particles.

The fuels such as coal, petroleum have some amount of nitrogen and sulphur in them. On heating, they are burnt to oxides of nitrogen and sulphur, which are released in the atmosphere. These are the major pollutants in the environment.

15.3 FORMATION OF COAL AND PETROLEUM:

Coal and petroleum are the fossil fuels. These are believed to be formed from biomass which has been subjected to various biological and geological processes inside the earth. Coal is formed from the remains of plants and animals (fossils) which died about millions of years ago. These remains gradually got buried deep in the earth during earthquakes, volcanoes etc. These remains were covered with sand, clay and water. Due to high temperature and high pressure and the absence of air inside the earth, the fossils got converted into coal. This process of conversion of plants and animals buried inside the earth under high temperature and pressure to coal is called **carbonisation.** It is a very slow process and may have taken thousands of years.

Petroleum is formed form the bacterial decomposition of the remains of animals and plants which got buried under the sea millions of years ago. When these organisms died, they sank to the bottom and got covered by sand and clay. Over a period of millions of years, these remains got converted into hydrocarbons by heat, pressure and catalytic action. The hydrocarbons formed rose though porous rocks and got trapped between two layers of impervious rock forming an oil trap.

15.4 SOME IMPORTANT CARBON COMPOUNDS :

15.4 (a) Ethanol or (Ethyl alcohol):

- Ethanol is the second member of the homologous alcoholic series.
- It is also known as methyl carbinol.
- Structural formula.

$$\begin{array}{ccccccccc} & & H & & H & & & & \\ & & | & & | & & & & \\ H & - & C & - & C & - & O & - & H \\ & & | & & | & & & & \\ & & H & & H & & & & \end{array}$$

(i) Properties of Ethanol:

(A) Physical properties.

- Ethanol is colourless liquid having a pleasant smell.
- Ethanol boils at 351 K.
- It is miscible with water in all proportions.
- It is a nonconductor of electricity (it does not contain ions)
- It is neutral to litmus.

(B) Chemical properties :

- **Combustion :** Ethanol burns in air with a blue flame to form CO_2 & H_2O.

$$C_2H_5OH + 3O_2 \longrightarrow 2O_2 + 3H_2O$$

- **Oxidation**

(i) By mild oxidizing agent CrO_3 (Chromic anhydride).

$$CH_3CH_2OH \xrightarrow[\text{In glacial acetic acid}]{CrO_3} CH_2CHO$$

(ii) By strong oxidizing agent ($K_2Cr_2O_7 + H_2SO_4$ or alkaline $KMnO_4$).

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[\text{or } K_2Cr_2O_7 + H_2SO_4]{\text{Alkaline } KMnO_4} \underset{\text{Ethanoic acid}}{CH_3COOH}$$

(C) Reaction with sodium: Ethanol reacts with sodium to produce hydrogen gas and sodium ethoxide.

$$2\,C_2H_5OH + 2Na \longrightarrow 2C_2H_5ONa \quad + \quad H_2(\uparrow)$$

(iv) Reaction with carboxylic acids : [ESTERIFICATION] The process of formation of an ester by the combination of an alcohol with carboxylic acid is known as etherification/

$$\underset{\text{Carboxylic acid}}{R-\overset{\overset{\large O}{\|}}{C}-OH} + \underset{\text{Alcohol}}{HO-R'} \xrightarrow{Conc.H_2SO_4} \underset{\text{Alkyl Alkanoate (Ester)}}{R-\overset{\overset{\large O}{\|}}{C}-OR'} + H_2O$$

When ethanol reacts with ethanoic acid in presence of concentrated sulphuric acid ethyl ethanoate and water are formed.

$$\underset{\text{Ethanoic acid}}{CH_3COOH} + \underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow{\text{Conc. } H_2SO_4} \underset{\text{Ethyl Ethanoate}}{CH_3COOC_2H_5} + H_2O$$

Esters are sweet smelling substances and thus are used in making perfumes.

(v) Acton with concentrated sulphuric acid : Ethanol reacts with concentrated sulphuric acid at 443 K to produce ethylene. This reaction is known as acidic dehydration of ethanol because in this reaction, water molecule is removed from ethanol.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[443K]{Conc.H_2SO_4} CH_2 = CH_2 + H_2O$$

The concentrated sulphuric acid may be regarded as a dehydrating agent because it removes water from ethanol.

15.4 (b) Some Important Terms :

(i) Denatured alcohol : To prevent the misuse for drinking purpose, the alcohol supplied for industrial purpose is rendered unfit by mixing it with some poisonous substances like methanol, pyridine, copper sulphate etc. It is known as denatured alcohol.

(ii) Rectified spirit : Ethanol cottoning 5 percent water is known as rectified spirit.

(iii) Absolute alcohol : Rectified spirit is heated under reflux over quicklime for about 5 to 6 hours and then allowed to stand for 12 hours. One distillation, pure alcohol (C_2H_5OH = 100%) is obtained. This is called absolute alcohol.

(iv) Power alcohol : Alcohol, which is used for generating power is called power alcohol. It consists of a mixture of absolute alcohol petrol roughly in the ratio 20 : 80. Since alcohol itself, does not mix with petrol, therefore, a third solvent such as benzene, ether etc. is added as a co-solvent.

15.4 (c) Uses of Ethanol:

(I) Ethanol is a constituent of beverages like beer, wine, whisky and other liquors.

Beer	=	3 - 6% Ethanol
Whisky	=	50% Ethanol
Wine	=	10 - 20% Ethanol

(ii) Ethanol is used to sterilize wounds and syringes.

(iii) Antifreeze : It is a mixture of ethanol and water which has a much lower freezing point than that of water. It is used in radiators of vehicles in cold countries.

(iv) It is used in manufacture of paints, des, medicines, soaps and synthetic rubber. Solution of ethanol prepared in pharmaceutical industry are known as **tinctures.**

15.4 (d) Harmful effects of drinking alcohol :

(i) If ethanol is mixed with CH_3OH and consumed, it may cause serious poisoning and loss of eyesight.

(ii) It causes addiction (habit forming) and mixes with blood. It damages liver if taken regularly.

(iii) Higher amount of consumption of ethanol leads to loss of body control & consciousness. It may even cause death.

DAILY PRACTICE PROBLEMS # 15

OBJECTIVE DPP - 15.1

1. Sometimes during cooking the bottom of the vessel becomes black from outside. This means that -
(A) food is not cooked properly. (B) fuel is not burning completely.
(C) fuel is burring completely. (D) fuel is dry.

2. Rectified spirit is -
(A) 50% ethanol (B) 80% ethanol (C) 95% ethanol (D) 100 % ethanol

3. Which of following gives ethane when heated with cons. sulphuric acid ?
(A) CH_3CHO (B) CH_3COOH (C) CH_3OH (D) CH_3CH_2OH

4. Which of the following will react with sodium metal ?
(A) Ethanol (B) Ethanol (C) Ethane (D) Ethane

5. Ethanol on complete oxidation gives -
(A) CO_2 and water (B) acetaldehyde (C) acetic acid (D) acetone

6. When ethyl alcohol is heated with conc. H_2SO_4 the product formed is -
(A) C_4H_8 (B) C_2H_4 (C) C_3H_4 (D) C_2H_2

7. When alcohol reacts with sodium metal the gas evolved is-
(A) O_2 (B) CH_2 (C) CO (D) CO_2

8. Power alcohol contains -
(A) 50% petrol and 50% ethanol
(B) 80% petrol and 20% ethanol
(C) 25% petrol and 75% ethanol
(D) 70% petrol and 30% ethanol

SUBJECTIVE DPP -15.2

1. What is denatured alcohol ? How is it prepared ?

2. What are the harmful effects of drinking alcohol ?

3. What is an antifreeze ?

4. Do alcohols give litmus test ?

5. Give the important uses of ethyl alcohols.

CARBON AND ITS COMPOUNDS

16.1 ETHANOIC ACID (OR ACETIC ACID) :

(i) Molecular formula : CH_3COOH

(ii) Structural formula :

$$\begin{array}{ccccccc} & & H & & O & & \\ & & | & & \| & & \\ H & - & C & - & C & - & O - H \\ & & | & & & & \\ & & H & & & & \end{array}$$

(iii) It dissolves in water, alcohol and ether. Its dissolution in water takes place with the evolution of heat and decrease in volume of the solution.

(iv) The melting point of ethanoic acid in 290 K and hence it often freezes during winter in cold climates. Therefore, it is names as **glacial acetic acid.**

16.1 (b) Chemical properties :

(i) Acidic character : Ethanoic acid is a monobasic acid. It has a replaceable hydrogen atom in its - COOH group. Therefore, it neutralizes alkalies.

(A) It reacts with a solution of sodium hydroxide to form sodium ethanoate and water.

$$CH_3COOH + NaOH \rightleftharpoons \underset{\text{Sodium Ethanoate}}{CH_3COONa} + H_2O$$

Sodium ethanoate is an ionic compound which dissolves in polar solvents such as water, but does not dissolves in non polar solvents such as alcohol, propanone etc.

The aqueous solution of sodium ethanoate is alkaline due to hydrolysis.

$$\underset{}{CH_3COONa} \overset{H_2O}{\rightleftharpoons} \underset{\text{Weak acid}}{CH_3COOH} + \underset{\text{Strong base}}{NaOH}$$

(B) It reacts with sodium carbonate and sodium bicarbonate with the evolution of CO_2 gas.

$$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2 \uparrow$$

$$CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2 \uparrow$$

(C) It reacts with metals like sodium, zinc and magnesium to liberate hydrogen gas.

$$2CH_3COOh + 2Na \rightarrow 2CH_3COONHa + H_2 \uparrow$$

$$2CH_3COOH + Zn \rightarrow (CH_3COO)_2Zn + H_2 \uparrow$$

(ii) Ester formation : When ethanoic acid in heated with ethanol in presence of small quantity of conc. H_2CO_4 ethyl ethanoate, a sweet smelling ester, is formed.

$$CH_3COOH + HOC_2H_5 \xrightleftharpoons{H+} \underset{\text{Ethel ethanoate}}{CH_3COOC_2H} + H_2O$$

This process of Easter formation is called **etherification.**

(iii) Decarboxylation :
When sodium ethanoate is heated with soda lime, methane is formed.

$$\underset{\text{Sodium ethanoate}}{CH_3COONa + NaOH} \xrightarrow{CaO} \underset{\text{Methane}}{CH_4} + Na_2CO_3$$

The term' decarboxylation ' is used when the elements of carbon dioxide are removed from a molecule.

16.1 (c) Uses :

(i) Dilute aqueous solution (5-8%) of ethanoic acid is called vinegar, which is used to preserve food (sausage, pickles, etc.)

(ii) Pure ethanoic acid is used as a solvent and chemical reagent.

(iii) As cellulose ethanoate, it is used in making photographic films and rayon.

(iv) Ethanoic acid finds application in the preparation of propanone, choroethanoic acid, ethanoates of metals etc.

(v) It is widely used in the manufacture of textiles.

(vi) It is used in the preparation of white lead.

16.1 (d) Tests for Ethanoic Acid :

(i) Litmus test : Add small amount of blue litmus solution to the given compound. If the blue litmus solution turns red, it indicates that the organic compound is ethanoic acid.

(ii) Sodium bicarbonate test: Take a small portion of the organic compound in a test tube and add a pinch of solid sodium bicarbonate. Evolution of carbon dioxide with brisk effervescence shows the presence of carboxylic acid.

(iii) Ester formation : When a mixture of ethanoic acid and ethanol is heated in the presence of concentrated sulphuric acid, a fruity smelling ester, ethyl ethanoate, is produced.

16.2 SOAPS AND DETERGENT :

The word **'detergent'** means' **cleansing agent** and so the detergents are substances which **remove dirt** and have cleansing action in water. According to this definition of detergents, soap is also a detergent and has been used for more than two thousand years. There are two types of detergents :

(a) Soapy detergents or soaps

(b) Non - soapy detergents or soapless soaps.

16.3 (a) Soap:

A soap is a **sodium or potassium salt** of some **long chain carboxylic acids** (fatty acid). Sodium salts of fatty acids are known as hard soaps and potassium salts of fatty acid are known as soft soaps. A soap has a large non-ionic hydrocarbon group and an ionic $COO^{-}Na^{+}$ group. The structure of soap can be represented as:

where  represents the hydrocarbon group and Θ represents negatively charged carboxyl group. Some example so soaps are sodium stearate, $C_{17}H_{35}COO^{-}\ Na^{+}$, sodium palmitate, $C_{15}H_{31}COO^{-}\ Na^{+}$ and sodium oleate, $C_{17}H_{33}COO^{-}\ Na^{+}$.

Hard water, which contains salts of magnesium and calcium, reacts with soap to form magnesium and calcium salts of fatty acid.

(i) Preparation of soap : Soap is prepared by heating oil or fat of vegetable or animal origin with concentrated sodium hydroxide solution (caustic soda solution). Hydrolysis of fat takes place and a mixture of sodium salt of fatty acids and glycerol is formed. Since the salt of fatty acids thus formed are used as soap so alkaline hydrolysis of oils and fats is commonly known as saponification.

$$\begin{array}{l} CH_2O.COC_{15}H_{31} \\ | \\ CHO.COC_{15}H_{31} + 3NaOH \\ | \\ CH_2O.COC_{15}H_{31} \end{array} \longrightarrow \begin{array}{l} CH_2OH \\ | \\ CHOH + 3C_{16}H_{31}COONa \\ | \\ CH_2OH \end{array}$$

fat or oil
(Tripalmitin)

Soap
(sodium palmitate)

(ii) Limitation of soaps : Soap is not suitable for washing clothes with hard water because of the following reasons.

(A) Hard water contains salts of calcium and magnesium. When soap is added to hard water, calcium and magnesium ions of hard water react with soap forming insoluble calcium and magnesium salts of fatty acids.

$$2C_{17}H_{35}COONa + MgCl_2 \longrightarrow (C_{17}H_{35}COO)_2Mg \downarrow + 2NaCl$$

Soap (Hardness of water) White ppt.

$$2C_{17}H_{35}COONa + CaCl_2 \longrightarrow (C_{17}H_{35}COO)_2Ca \downarrow + 2NaCl$$

(Hardness of water White ppt.

Therefore, a lot of soap is wasted if water is hard.

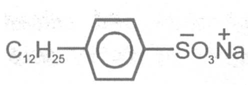
(B) When hard water is used, soap forms insoluble precipitates of calcium and magnesium salts, which stick to the cloth being washed. Therefore, it interferes with the cleaning ability of the soap and makes the cleaning process difficult.

These calcium and magnesium salts of fatty acid are insoluble in water and separate as cruddy white precipitate.

16.3 (b) Detergents:

These are also called synthetic detergents or soapless soaps. A synthetic detergent is the **sodium salt of a long chain benzene sulphonic acid or the sodium salt of a long chain alkyl hydrogen sulphate.**

(i) Preparation of Synthetic Detergents : Synthetic detergents are prepared by **reacting hydrocarbons** from petroleum with **conc. sulphuric acid** and converting the product into its **sodium salt.**
Example :



Sodium p-dodecyl benzenesulphonate

$$C_{12}H_{25} - O - SO_2 - \overset{-}{O}\overset{+}{Na}$$

Sodium lauryl sulphate

Washing powders available in the market contain about 15 to 30 percent detergents by weight.

Alkaline hydrolysis of oils and fats is commonly known as saponification.

16.3 (c) Comparison Between Properties of Soaps and Detergents :

S.No	Soaps	Synthetic detergents
1	Soaps are sodium salts of higher fatty acids	Synthetic detergents are sodium alkyl sulphates or sodium alkyl benzene sulphonates with alkyl group having more than ten carbon atoms.
2	Soaps are prepared form natural oils and fats.	Synthetic detergents are prepared form the hydrocarbons of petroleum.
3	Soaps form insulable salts (curdy white ppt.) with calcium and magnesium which are present in hard water and hence, cannot be used in hard water/	Calcium and magnesium salts of detergents are soluble in water and, therefore, no curdy white precipitates are obtained in hard water and hece, can be used even in hard water.
4	Soad cannot be used in acidic medium and they are decomposed into carboxylic acids in a cidic medium.	They cay be used in acidic medium as they are the salt of strong acids and are not decomposed in acidic medium.
5	Soaps are biodegradable.	Some of the synthetic detergents are not biodegradable.

16.3 (d) Advantages of Synthetic Detergents Over Soap :

Synthetic detergents are widely used as cleaning agents these days. Some of their advantages over soaps are :

(i) Synthetic detergents can be used for washing even in hard water. On the other, soaps are not suitable for use with hard water.

(ii) Synthetic detergents can be used even in acidic solutions because they are not readily decomposed in acidic medium. On the other hard, soaps cannot be used in acidic medium because they are decomposed into carboxylic acids in acidic medium.

(iii) Synthetic detergents are more soluble in water than soaps.

(iv) Synthetic detergents have a stronger cleaning action than soaps.

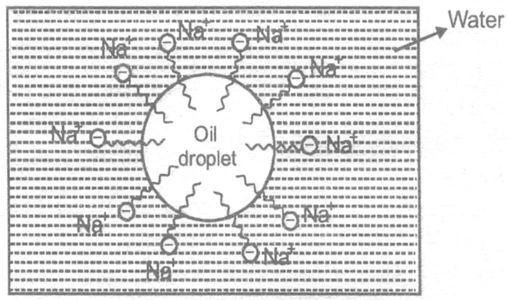
16.3 (e) Cleaning Action of Soaps and Detergents :

A molecule of soap is made up of two parts : a non polar part consisting of a long chain 12 - 18 carbon atoms and a polar part, $COO^- Na^+$. The polar end in water soluble and is thus hydrophilic whereas hydrocarbon part is insoluble in water and is thus hydrophobic. In a soap solution, the hydrocarbon portions of several soap molecules huddle together to form aggregates of molecules (or ions) called micelles. The soap micelles are negatively charged due to the presence of carboxylate ions at the surface. Repulsion between similarly charged micelles keeps them dispersed in the solution.


Store in your memory

The hydrocarbon part is however soluble in non-polar solvents and is sometimes called lipophilic.

(i) Cleansing action of soap : Mostly the dirt is held to any surface such as cloth by the oil or grease which is present there. Now since the oil and grease are not soluble in water, the dirt particles cannot be removed by simply washing the cloth with water. However, when soap is applied, the non polar hydrocarbon part of the soap molecules dissolves in oil droplets while the polar - COO^- NA^+ groups remain attached to water molecules. In this way, each oil droplet gets surrounded by negative charge.



These negatively charged oil droplets cannot coalesce and continue breaking into small droplets. These oil droplets (containing dirt particles) can be washed away with water along with dirt particles. So, the action of soap or detergents in to emulsify oil or grease, this loosens the soil particles of dirt and they are removed.

In a soap molecule hydrophilic polar end in water soluble and hydrophobic hydrocarbon part is insoluble in water.

Soap or detergent helps in cleansing in another way. Not only it emulsifies oil or grease but it also lowers the surface tension of water. As a result of this water wets things more effectively.

When water is added on to the surface of the cloth then water molecules tend to stay as close to each other as possible because of the strong forces of attraction (hydrogen bonding) for each other and do not wet the cloth properly. If some soap solution is added to this away then polar end of soap dissolves in water and non polar hydrocarbon end remains away from the water. Thus, soap molecules arrange themselves between the water molecules on the surface of water and decrease the forces of attraction between the water molecules. Water can now spread on the surface of cloth and can make it wet effectively.

16.3 (f) Synthetic Detergent : A Serious Problem :

It may be noted that in the past, the widespread use of detergents caused pollution of rivers and other water bodies. Earlier the synthetic detergents were made from long chain of hydrocarbons having a lot of branched chains in them. These branched chain detergent molecules were degraded very slowly by the micro organisms present in water bodies like lakes or rivers.

Therefore, they tend to remain in water bodies for a long time and make water unfit for aquatic life. For example, detergents containing phosphates can cause rapid growth of algae and therefore, deplete the dissolved oxygen present in the water of lakes and rives. As a result of lack of oxygen, fish and other aquatic animals may die. To solve these problems, now-a-days, the detergents are prepared from hydrocarbons which have minimum branching. These are degraded more easily than branched chain detergents. Therefore, these are biodegradable and create less problems.

DAILY PRACTICE PROBLEMS # 16

OBJECTIVE DPP - 16.1

1. Vinegar is -
(A) 5% aqueous solution of acetic acid
(B) 20% alcoholic solution of acetic acid
(C) 100% acetic acid
(D) none of these

2. Glacial acetic acid is -
(A) 100% acetic acid free of water.
(B) solidified acetic acid.
(C) gaseous acetic acid.
(D) frozen acetic acid.

3. When ethanoic acid is heated with $NaHCO_3$ the gas evolved is -
(A) H_2 (B) CO_2 (C) CH_4 (D) CO

4. Which of the following will give a pleasant smell heated with ethyl alcohol, in presence of sulphuric acid -
(A) CH_3COOH (B) CH_3CH_2OH (C) CH_3OH (D) CH_3CHO

5. During decarboxylation of ethanoic acid with soda lime (NaOH + CaO), CO_2 is removed as -
(A) CO_2 (B) CO (C) NA_2CO_3 (D) $CaCO_3$

6. A by product of soap industry is -
(A) sodium hydroxide
(B) sodium palmitate
(C) glycerol
(D) Both B & C

7. Which one of the following statements is incorrect about soaps :

(A) Soaps are biodegradable.

(B) Soaps are sodium salts of higher fatty acids.

(C) Soaps are prepared from natural oils & fats.

(D) Soaps can be used in acidic solutions.

8. Which of the following is not correctly matched ?

(A) Hard soaps - sodium salts of fatty acids.

(B) Soft soaps - potassium salts of fatty acids.

(C) Hydrophilic - water insoluble

(D) None of these

9. Cleansing action of soaps includes :

(A) formation of micelles.

(B) emulsification of oil or grease.

(C) lowering of surface tension of water.

(D) all of the above.

10. Washing powders contain detergent in the following range -
(A) 10 - 15 % (B) 15 - 30% (C) 50 - 60 % (D) 40 - 50 %

SUBJECTIVE DPP - 16.2

1. Although both acid and base are obtained from the salt of ethanoic acid, yet the overall aqueous solution of sodium ethanoate is alkaline. Give reason.

2. Complete the following reactions -

(a) $CH_3COOH + NAaHCO_3 \longrightarrow$

(b) $HCOOH + CH_3OH \xrightarrow[H_2SO_4]{Conc.}$

3. Describe the following
(i) power alcohol (ii) denatured spirit

4. Why are detergents preferred over soaps ?

5. Give the chemical reaction involved in the preparation of soaps.

ANSWERS

OBJECTIVE DPP - 12.1

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

SUBJECTIVE DPP - 12.1

Sol.1 To achieve the configuration of nearest noble gas element.

Sol.2 $\underset{\textstyle H}{H \overset{\cdot}{_x} \overset{\cdot\cdot}{P} \overset{\cdot}{_x} H}$

Sol.3 Sodium chloride (NaCl) & Chlorine gas (Cl_2)

Sol.4 Covalent, Y = X = Y

Sol.4 O = C= O (CO_2)

OBJECTIVE DPP - 13.1

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

SUBJECTIVE DPP - 13.2

Sol.1 (a) Functional group isomerism (b) Position isomerism

Sol.2 The common difference is $-CH_2$.

OBJECTIVE DPP - 14.1

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

SUBJECTIVE DPP - 13.2

Sol.1 Functional group

Sol.2 (a) Propan-1-ol (b) propan-2-ol (c) Position isomers

Sol.3 (a) CH_3COCH_3 (b) $CH_3CH_2CH_2CH_2COOH$
(c) CH_3COOH (d) $CH_3CH_2CH_2CH_2OH$

Sol.4 Ketone group (- CO -)

Sol.5 (a) 1- Bromoethane (b) 1- Hexyne

OBJECTIVE DPP - 15.1

Ques	1	2	3	4	5	6	7	8
Ans.	B	C	D	A	C	B	B	B

SUBJECTIVE DPP - 15.2

Sol.3 It is a mixture of ethanol and water which has a much lower freezing point that than of water. It is used in radiators of vehicles in cold countries.

Sol.4 No, because they are neutral in nature.

OBJECTIVE DPP - 16.1

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

SUBJECTIVE DPP - 16.2

Sol.1 Sodium ethanoate is a salt of strong base and weak acid.

Sol.2 (a) CH_3COONa, CO_2, H_2O

(b) $HCOOCH_3$, H_2O

PERIODIC TABLE & PERIODICITY IN PROPERTIES

17.1 DEFINITION :

A periodic table may be defined as the table giving the arrangement of all the known elements according to their properties so that elements with similar properties fall with the same vertical column and elements with dissimilar properties are separated.

17.2 EARLY ATTAMPTS TO CLASSIFY ELEMENTS :

17.2 (a) Metals and Non - Metals :

Among the earlier classification, **Lavoisier** classified the elements as metals and non-metals. However, this classification proved to be inadequate. In 1803, **John Dalton** published a table of relative atomic weights (now called atomic masses). This formed an important basis of classification of elements.

17.2 (b) Dobereiner's Triads :

(i) In 1817, **J.W.Dobereiner** a German Chemist gave this arrangement of elements.

(A) He arranged **elements with similar properties** in the groups of **three** called **triads.**

(B) According to **Dobereiner** the atomic mass of the central element was merely the arithmetic mean of atomic masses of the other two elements.

For e.g.

Elements of the triad	Symbol	Atomic mass
Lithium	Li	7
Sodium	Na	23
Potassium	K	39

$$\text{Atomic mass of sodium} = \frac{\text{Atomicmass of lithium} + \text{Atomic mass of potassium}}{2}$$

$$= \frac{7+39}{2} = 23$$

Some examples of triads are given in the table :

S.No.	**Triads**	**Relative atomic masses**	**Average of atomic masses of the first and the third element**
1	S, Se, Te	32, 79, 128	$\frac{32+128}{2}=80$
2	Cl, Br, I	35.5, 80, 127	$\frac{35.5+127}{2}=81.25$
3	Ca, Sr, Ba	40, 88, 137	$\frac{40+137}{2}=88.5$

(ii) Limitations of Dobereiner's Classification :

(A) Atomic mass of the three elements of some triads are almost same.

e.g. Fe, Co, ni and Ru, Rh, Pd

(B) It was restricted to few elements, therefore discarded.

17.2 (c) Newlands' Law of Octaves :

In 1866, an English chemist, **John Newlands,** Proposed a new system of grouping elements with similar properties. He tried to correlate the properties of elements with their atomic masses. he arranged the then known elements in the order of **increasing atomic masses.** He started with the element having the lowest atomic mass (hydrogen) and ended at **thorium** which was the 56th element. He observed that every eight element had properties similar to that of the first.
Thus, Newlands suggested that when the elements are arranged in the order of increasing atomic masses, the properties of every eight element are a repetition of that of the first element.

Newland called this relation as a law of octaves due to the similarity with the musical scale.

(i) Newlands' arrangement of elements into 'Octaves':

Notes of Music	**sa (do)**	**re (re)**	**ga (mi)**	**ma (fa)**	**pa (so)**	**da (la)**	**ni (ti)**
	H	Li	Be	B	C	N	O
	F	Na	Mg	Al	SI	P	S
Elements	Cl	K	Ca	Cr	Ti	Mn	Fe
	Co and Ni	Cu	Zn	Y	In	As	Se
	Br	Rb	Sr	Ce and La	Zr	-	-

(ii) Limitations of law of octaves : The law of octaves has the following limitations :

(A) The law of octaves was found to be **applicable only upto calcium.** It was not applicable to elements of higher atomic masses.

(B) Position of hydrogen along with fluorine and chlorine was not justified on the basis of chemical properties.

(C) Newlands **placed two elements in the same slot** to fit elements in the table. He also **placed some unlike elements** under the same slot. For example, cobalt and nickel are placed in the same slot and in the column of fluorine, chlorine and bromine. But cobalt and nickel have properties quite different from fluorine, chlorine and bromine. Similarly, iron which has resemblances with cobalt and nickel in its properties has been placed for away from these elements.

Thus, it was realized that Newlands' law of octaves **worked well only with lighter elements.** Therefore, this classification was rejected.

17.2 (d) Mendeleev's Periodic Table :

The major credit for a systematic classification of elements goes to **Mandeleev.** He has been trying to group the elements on the basis of some fundamental property of the atoms. When Mendeleev started his work, **only 63 elements** were known. He examined the relationship between atomic masses of the elements and their physical and chemical properties.
Among chemical properties, Mendeleev concentrated mainly on the compound formed by elements with oxygen and hydrogen. he selected these two elements because these are very reactive and formed compound with most of the elements known at that time. The formulae of the compounds formed with these elements (i.e. oxides and hydrides) were regarded as one the basic properties of an element for its classification.

(i) Mendeleev's periodic law : This law states that the physical and chemical properties of the elements are the periodic function of their atomic masses. This means that when the elements are arranged in the order of their increasing atomic masses, the elements with similar properties recur at regular intervals. Such orderly recurring properties in a cyclic fashion are said to be occurring periodically. This is responsible for the name periodic law or periodic table.

(ii) Merits of Mendeleev's periodic table : Mendeleev's periodic table was one of the greatest achievements in the development of chemistry. Some of the important contributions of his periodic table are given below :

(A) Systematic study of elements : He arranged known elements in order of their increasing atomic masses considering the fact that elements with similar properties should fall in the same vertical column.

(B) Correction of atomic masses : The mendeleev's periodic table could predict errors in the atomic masses of certain elements were corrected. For example, atomic mass of beryllium was corrected from 13.5 to 9. Similarly, with the help of this table, atomic masses of indium, gold, platinum etc. were corrected.

(C) Mendeleev **predicated** the properties of those **missing elements** from the known properties of the other elements in the same group. Eka-boron, eka – aluminum and eka - silicon names were given for scandium, gallium and germanium (not discovered at the time of Mandeleev).

Properties predicted by Mendeleev for missing elements and those found experimentally were almost same.

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(D) Position of noble gases : Noble gages like helium (He), neon (Ne) and argon (Ar) were mentioned in many studies. However, these gases were discovered very late because they are very inert and are present in extremely low concentrations. One of the achievements of Mendeleev's periodic table was that when these gases were discovered, they could be placed in a new group without disturbing the existing order.

(iii) Limitations of Mandeleev's periodic table : Inspite of many advantages, the Mendeleev's periodic table has certain defects also. Some of these are given below -

(A) Position of hydrogen : Position of hydrogen in the periodic table is **uncertain.** It has been placed in 1A group with alkali metals, but certain properties of hydrogen resemble those of halogens. So, it may be placed in the group for halogens as well/

(B) Position of isotopes : Isotopes are the atoms of the same element having different atomic masses. Therefore, according to Mendeleev's classification these should be placed at different places depending upon their atomic masses. For example, hydrogen isotopes with atomic masses 1,2 and 3 should be placed at three places. However, isotopes have not been given separate places in the periodic table because of their similar properties.

(C) Anomalous pairs of elements " In certain pair of elements, the increasing order of atomic masses was not obeyed. In these, Mendeleev placed elements according to similarities in their properties and not in increasing order of their atomic masses.

For example :

- The atomic mass of argon is 39.9 and that of potassium 39.1 But argon is placed before potassium in the periodic table.

- The positions of cobalt and nickel are not in proper order. Cobalt (at. mass = 58.9) is placed before nickel (at. mass = 58.7)

- Tellurium (at. mass = 127.6) is placed before iodine (at. mass = 126.9)/

(D) Some similar elements are separated, in the periodic table. For example copper (Cu) and mercury (Hg), barium (Ba) and lead (Pb). On the other hand some dissimilar elements have been placed together in the same group.

e.g. : Copper (Cu), silver (Ag) and gold (Au) have been placed in group 1 along with alkali metals. Similarly, manganese (Mn) is placed in the group of halogens.

(E) Cause of periodicity : Mendeleev could not explain the cause of periodicity among the elements.

DAILY PRACTIVE PROBLESM # 17

OBJECTIVE DPP - 17.1

1. The law of octaves was proposed by -
(A) Newlands (B) Dobereiner (C) Lavoisier (D) Mendeleev

2. The early attempt to classify elements as metals and non-metals was made by -
(A) Mendeleev (B) Newlands (C) Lavoisier (D) Henry Moseley

3. The early attempts to classify elements were based on-
(A) atomic number (B) atomic mass
(C) electronic configuration (D) none of these

4. Cl, Br, I, if this is Dobereiner's triad and the atomic masses of Cl and I are 35.5 and 127 respectively, then the atomic mass of Br is -
(A) 162.5 (B) 91.5 (C) 81.25 (D) 45.625

5. According to Newlands' law of octaves 3rd element will resemble in its properties to-
(A) ninth element (B) eight element (C) tenth element (D) eleventh element

6. New lands could classify elements only upto-
(A) copper (B) chlorine (C) calcium (D) chromium

7. According to Mendeleev's periodic law which properties of the elements are the periodic function of their atomic masses ?
(A) Physical properties only (B) Chemical properties only
(C) Physical and chemical properties both (D) none of these

8. Mendeleev classified elements in-
(A) increasing order of atomic number (B) increasing order of atomic masses.
(C) decreasing order of atomic masses. (D) decreasing order of atomic number.

9. Mendeleev's periodic table was divided into -
(A) seven periods and seven groups (B) eight periods and eight groups.
(C) seven periods and eight groups (D) eight periods and seven groups.

10. Noble gases were included in Mendeleev's periodic table in the -
(A) 1st group (B) 7th group (C) 8 th group (D) None of these

SUBJECTIVE DPP - 17.2

1. Why did Mendeleev leave the gaps in the periodic table ?

2. What were the major defects of Mendeleev's classification ?

3. Why in the law proposed by Newlands called the Law of Octaves ?

4. A,B,C are the elements of a Dobereiner's triad. It the atomic mass of 'A' is 9 and that of 'C' is 39, what is the atomic mass of elements 'B' ?

5. Among the halogens F, Cl, Br, and I which does not fit in the Dobereiner's triad ?

6. What does the word 'Period' signify in the periodic table ?

7. What is common in the musical notes and the elements arranged by newlands ?

8. How many elements were know when Mendeleev gave his periodic table ?

PERIODIC TABLE & PERIODICITY IN PROPERTIES

18.1 MODERN PERIODIC TABLE :

18.1 (a)Introduction :

In 1913, an English physicist, **Henry Moseley** showed that the physical and chemical properties of the atoms of the elements are determined by their **atomic number** and not by their atomic masses. Consequently, the periodic law was modified.

18.1 (b) Modern periodic Law (Moseley's Periodic Law):

"Physical and chemical properties of an element are the periodic function of its atomic number". The atomic number gives us the **number of protons** In the nucleus of an atom and this number **increases atomic number,** is called periodicity.

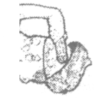
18.1 (d) Cause of Periodicity :

The periodic repetition of the properties of the elements is due to the recurrence of **similar valence shell** (outermost shell) electronic configuration (ns^1) and therefore, have similar properties.

Alkali Metals

Atomic number	Element	Symbol	Electronic configuration
3	Lithium	Li	2,1
11	Sodium	Na	2,8,1
19	Potassium	K	2,8,8,1
37	Rubidium	Rb	2,8,18,8,1
55	Caesium	Cs	2,8,18,18,8,1
87	Francium	Fr	2,8,18,32,18,8,1

Modern periodic table is based on atomic number, not an atomic mass.



PERIODIC TABLE OF THE ELEMENTS

Key: Group IUPAC 13 IIIA; Atomic number 5; Relative atomic mass 10.811; Symbol B; Element name Boron

s–Block Elements | Transition Metals (d –Block Elements) | p–Block Elements

Period	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 1.0079 H Hydrogen																	2 4.0026 He Helium
2	3 6.941 Li Lithium	4 9.0122 Be Beryllium											5 10.811 B Boron	6 12.011 C Carbon	7 14.007 N Nitrogen	8 15.999 O Oxygen	9 18.998 F Fluorine	10 20.180 Ne Neon
3	11 22.990 Na Sodium	12 24.305 Mg Magnesium											13 26.982 Al Aluminium	14 28.086 Si Silicon	15 30.974 P Phosphorus	16 32.065 S Sulphur	17 35.453 Cl Chlorine	18 39.948 Ar Argon
4	19 39.098 K Potassium	20 40.078 Ca Calcium	21 44.956 Sc Scandium	22 47.867 Ti Titanium	23 50.942 V Vanadium	24 51.996 Cr Chromium	25 54.938 Mn Manganese	26 55.845 Fe Iron	27 58.933 Co Cobalt	28 58.963 Ni Nickel	29 63.546 Cu Copper	30 65.39 Zn Zinc	31 69.723 Ga Gallium	32 72.64 Ge Germanium	33 74.922 As Arsenic	34 78.96 Se Selenium	35 79.904 Br Bromine	36 83.80 Kr Krypton
5	37 85.468 Rb Rubidium	38 87.62 Sr Strontium	39 88.906 Y Yttrium	40 91.224 Zr Zirconium	41 92.906 Nb Niobium	42 95.94 Mo Molybdenum	43 (98) Tc Technetium	44 101.07 Ru Ruthenium	45 102.91 Rh Rhodium	46 106.42 Pd Palladium	47 107.87 Ag Silver	48 112.41 Cd Cadmium	49 114.82 In Indium	50 118.71 Sn Tin	51 121.76 Sb Antimony	52 127.60 Te Tellurium	53 126.90 I Iodine	54 131.29 Xe Xenon
6	55 132.91 Cs Caesium	56 137.33 Ba Barium	57 138.91 La Lanthanum	72 178.49 Hf Hafnium	73 180.95 Ta Tantalum	74 183.84 W Tungsten	75 186.21 Re Rhenium	76 190.23 Os Osmium	77 192.22 Ir Iridium	78 195.08 Pt Platinum	79 196.97 Au Gold	80 200.59 Hg Mercury	81 204.38 Ti Thallium	82 207.2 Pb Lead	83 208.98 Bi Bismuth	84 (209) Po Polonium	85 (210) At Astatine	86 (222) Rn Radon
7	87 (223) Fr Francium	88 (226) Ra Radium	89 (227) Ac Actinium	104 (261) Rf Rutherfordium	105 (262) Db Dubnium	106 (266) Sg Seaborgium	107 (264) Bh Bohrium	108 (277) Hs Hassium	109 (268) Mt Meitnerium	110 (281) Ds Darmstadtium	111 (272) Rg Roentgenium							

Inner - Transition Metals (f-Block Elements)

LANTHANOIDES	58 140.12 Ce Cerium	59 140.91 Pr Praseodymium	60 144.24 Nd Neodymium	61 (145) Pm Promethium	62 150.36 Sm Samarium	63 151.96 Eu Europium	64 157.25 Gd Gadolinium	65 158.93 Tb Terbium	66 162.50 Dy Dysprosium	67 164.93 Ho Holmium	68 197.26 Er Erbium	69 168.93 Tm Thulium	70 173.04 Yb Ytterbium	71 174.97 Lu Lutetium
ACTINOIDES	90 232.04 Th Thorium	91 231.04 Pa Protactinium	92 238.03 U Uranium	93 (237) Np Neptunium	94 (244) Pu Plutonium	95 (243) Am Americium	96 (247) Cm Curium	97 (247) Bk Berkelium	98 (251) Cf Californium	99 (252) Es Einsteinium	100 (257) Fm Fermium	101 (258) Md Mendelevium	102 (259) No Nobelium	103 (262) Lr Lawrencium

18.1 (e) Long Form of Periodic Table :

(i) The long form of periodic table is based upon **Modern periodic law.** Long form of of periodic table is the contribution of **Range, Werner, Bohr and Bury.**

(ii) This table is also referred to as **Bohr's table** Since it follows Bohr's scheme of the arrangement of elements into four types based on **electronic configuration of elements.**

(iii) Long form of periodic table consists of **horizontal rows (periods)** and **vertical columns (groups).**

18.1 (f) Description of Periods :

(i) A **horizontal row** of a periodic table is called a **period .**

(ii) There are **seven periods** numbered as 1,2,3,4,5,6 and 7.

(iii) Each period starts with an **alkali metal** having outermost shell electronic configuration ns^1.

(v) Each period ends with a **noble gas** with outermost shell electronic configuration $ns^2\ np^6$ except helium having outermost electronic configuration $1s^2$.

(vi) Each period starts with the filling of **a new energy level.**

(A) 1st period : This period is called very short period because this period contains only 2elements H and He.

(B) 2nd and 3rd periods : These periods are called short periods because these periods contain 8 elements. 2nd periods starts from $_3$Li to $_{10}$Ne and 3rd period starts form $_{11}$Na to $_{18}$Ar.

(C) 4th and 5th periods : These periods are called long periods because these periods contain 18 elements. 4th period starts from $_{19}$K to $_{36}$Kr and 5th period start from $_{37}$Rb to $_{54}$Xe.

(D) 6th period : This period is called very long period. This period contains 32 elements. Out of the 32 elements 14 elements belong to **Lanthanoid series** ($_{58}$Ce to $_{71}$Lu). 6th period starts from $_{55}$Cs to $_{86}$Rn.

(E) 7th period : This period is called as incomplete period. It contains 25 elements. out of the 25 elements 14 elements belong to **Actinoid series** ($_{90}$Th to $_{103}$Lr.) 7th period starts from $_{87}$Fr to $_{111}$Rg.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Modern period table consists of seven periods and eighteen groups.

Period	No. Of Elements	Called as
(1*) n = 1	2	Very short period
(2^{nd}) n = 2	8	Short period
(3^{rd}) n = 3	8	Short period
(4^{th}) n = 4	18	Long period
(5^{th}) n = 5	18	Long period
(6^{th}) n = 6	32	Very long period
(7^{th}) n = 7	25	Incomplete period

Different elements belonging to a particular period have different electronic configurations and have different number of valence electrons. That is why elements belonging to a particular period have different properties.

18.1 (g) Description of Groups :

(i) A vertical column of elements in the periodic table is called a **group.**

(ii) There are **eighteen groups** numbered as 1,2,3,4,5,---------13,14,15,16,17,18.

(iii) A group consists of a series of elements having **similar valence shell electronic configuration** and hence exhibit **similar properties.**

e.g. : Li, Na, K belong to the same group and have 1 electron in their valence shell.

(iv) The group 18 is also known as **zero group** because the valency of the elements of this group is zero.

the elements of 18^{th} or zero group are called noble gases.

(v) The elements present in groups 1,2,13 to 17 are called **normal representative** elements.

(vi) Elements of group 1 and 2 are called **alkali metals** and alkaline **earth metals** respectively.

(vii) Elements present in group 17 are called **halogens.**

Elements present in a period have different properties, while elements present in a group have similar properties.

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18.1 (h) Merits of Long Form of Periodic Table L

(i) The long form of periodic table is based on **atomic number.** Atomic number is a more fundamental property of a element as compared to atomic mass.

Not two elements can have the same atomic number.

(ii) In the long form of periodic table, different isotopes can be placed at the same place because they have same atomic number. On the other hand, isobars such as Ar (40) and Ca (40) have to be placed at different places due to their different atomic numbers.

(iii) The long form of periodic table can explain why all the elements in a group have similar properties while the elements in a period have different properties.
The basis for periodicity of elements is the similar electronic configuration of the outermost shell of elements of the same group. The similar electronic configuration of the elements are repeated at regular intervals so the properties of the elements are also repeated at regular intervals.

(iv) It is easy to remember and reproduce the table.

18.1 (i) Limitations of Long Form of Periodic Table :

(i) Position of hydrogen is not accurate.

(ii) Inner transition elements (lanthaoids and actinoids(have been given separate positions below in the periodic table.

DAILY PRACTIVE PROBLEMS # 18

OBJECTIVE DPP - 18.1

1. Modern periodic law was proposed by-
(A) Mendeleev (B) Henry Mosley (C) Werner (D) Bohr and Bury

2. The long form of periodic table consists of -
(A) seven periods & either groups. (B) seven periods & eighteen groups.
(C) eight periods & eighteen groups. (D) eighteen periods & eight groups.

3. In the long form of periodic table lanthanides are placed in the -
(A) 2nd period (B) 5th period (C) 6th period (D) 7th period

4. All the members in a group of long form of periodic table have the same-
(A) valency (B) number of valence electrons
(C) chemical properties (D) all of these

5. Which of the following pairs of elements belong to the same period of the periodic table ?
(A) C, Mg (B) N, Ar (C) Ca, Cl (D) K, Cu

6. The number of elements in the 4th period of periodic table are -
(A) 8 (B) 18 (C) 10 (D) 32

7. One important merit of modern periodic table is -
(A) it explains why elements in the same group have the same chemical properties.
(B) hydrogen has been placed accurately.
(C) isobars have not been placed separately.
(D) it is based on classifying elements according to their atomic masses.

8. Which of the following properties does not match to the elements of halogen family ?
(A) They have seven electrons in their valence shells.
(B) They are diatomic in their molecular form.
(C) They are highly reactive chemically.
(D) They are metallic nature.

9. Which of the following sets does not belong to a group ?
(A) Li, Na, K (B) N, O, F, (C) Be, Mg, Ca (D) He, Ne, Ar

10. In the modern periodic table which one of the following does not have a appropriate position?
(A) Transition elements (B) Inert gases
(B) Inner transition elements (D) Halogens

SUBJECTIVE DPP - 18.2

1. What is a group and period in a periodic table ?

2. State the modern periodic law.

3. Why are 18th group elements called inert gases ?

4. Name three elements with single electron in their valence shell.

5. Name the metals among first ten elements in the modern periodic tale.

6. Give the name and the electronic configuration of the second alkali metal.

7. What is the similarity in the electronic configurations Mg, Ca and Sr ?

8. On the basis of the periodic classification, identify each set belonging to either a group or a period.
(a) Na, Mg, Al (b) K, RB, Cs (c) N, O, F (d) Ne, Ar, Kr

PERIODIC TABLE & PERIODICITY IN PROPERTIES

19.1 PERIODICITY IN PROPERTIES :

(i) The electronic configuration of the atoms display periodic variations with **increase in atomic number.**
(ii) The elements exhibit periodic variations of physical and chemical properties.
Following are some the important properties of the elements -
(a) Valency **(b)** Atomic size **(c)** Metallic and non - metallic character

19.1 (a) Valency :

(i) The **valency** of an element may be defined at the combining capacity of the element.
(ii) The electrons present in the outermost shell are called **valence electrons** and these electrons determine the valency of the atom.
Valiancy of an element is determined by the number of valence electrons in an atom of the element.

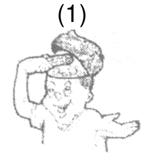
The valency of an element = number of valence electrons
(when number of valence electrons are from 1 to 4)
The valency of an element - 8 - number of valence electrons.
(when number of valence electrons are more than 4)

(iii) Variation of valency across a period : The number of valence electrons increases from 1 to 8 on moving across a period. They valency of the elements with respect to **hydrogen** and **chlorine** increases from **1 to 4** and then decreases from **4 to zero.** With respect to **oxygen** valency increases from **1 to 7.**

Variation of valency of elements of second and third periods :

Elements of second period

Li	Be	B	C	N	O	F
Valency with respect to H						
LiH	BeH_2	BH_3	CH_4	NH_3	H_2O	HF
(1)	(2)	(3)	(4)	(3)	(2)	(1)
Valency with respect to Cl						
LiCl	$BeCl_2$	BCl_3	CCl_4	NCl_3	Cl_2O	ClF
(1)	(2)	(3)	(4)	(3)	(2)	(1)



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Valency of elements changes in a period.

Elements of third period :

Na	Mg	Al	Si	P	S	Cl
Valency with respect to H						
NaH	MgH_2	AlH_3	SiH_4	PH_3	H_2S	HCl
(1)	(2)	(3)	(4)	(3)	(2)	(1)
Valency with respect to O						
Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	SI_2O_7
(1)	(2)	(3)	(4)	(5)	(6)	(7)

(iv) Variation of valency along a group : On moving down a group, the number of valence electrons remains the **same** and, therefore, all the elements in a group exhibit **the same valency.**
e.g. All the elements of group 1 have valency equal to 1 and those of group 2 have valency equal to 2.

Valency of elements remains same in a group.

19.1 (b) Atomic Size :

The term atomic size refers to the **radius** of an atom. In general atomic size may be considered as the distance between the centre of the nucleus and the outermost shell of an isolated atom.

(i) Variation of atomic size in a period : Within each period, the atomic radii decrease with increase in atomic number.
e.g. Atomic radii decrease from lithium to fluorine in the second period.
Reason : The decrease of atomic radii along a period can be explained on the basis of increase in **nuclear charge.** On moving from left to right across the period, the nuclear charge increases progressively by one unit but the additional electron goes to the **same shell.** As a result the electrons are pulled closer to the nucleus by the **increased nuclear charge.** This causes a **decrease** in atomic size.

Atomic Radii of Elements of Second period

Element	$_3Li$	$_4Be$	$_5B$	$_7N$	$_8O$	$_9F$	$_9F$	$_{10}Ne$
Nuclear Charge	+ 3	+ 4	+ 5	+ 6	+ 8	+9	+9	+ 10
Configuration	$2s^1$	$2s^2$	$2s^22p^1$	$2s^22p^2$	$2s^22p^3$	$2s^22p^4$	$2s^22p^5$	$2s^22p^6$
Atomic Radii (pm)	133	111	88	77	74	72	72	160

The values given in the table, show **abrupt increase** in the atomic size of Ne. This is due to the reason that the values for other elements are **covalent radii** whereas that for Ne it is **Vander Waals radius** because it does not form covalent bond due to its stable configuration.

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Covalent radii is taken when electrons are shared between two elements, while Vander Waals radii is taken in case of gases.

(ii) Variation of atomic radii within a group : The atomic radii increase from top to bottom within a group of the periodic table.

Atomic radii of alkali metals and halogens

Alkali		Halogens	
Element	Atomic Radius (pm)	Element	Atomic Radius (pm)
Li	133	F	64
Na	157	Cl	99
K	201	Br	114
Rb	216	I	133
Cs	235		

Reason :
In moving down a group, the **nuclear charge** increases with increase in atomic number, but at the same time there is a progressive increase in the number of **energy levels.** Since, the effect additional energy level is more pronounced than the effect of increased nuclear charge, the distance of the outermost electron from the nucleus increases on going down the group.

- **Atomic radii increase down the group.**
- **Atomic radii decrease across the period.**

19.2 METALLIC AND NON - METALLIC CHARACTER :

19.2 (a) Metals :

The metals are characterised by their nature of readily giving up the electrons.

(i) Metals comprise of more than 75% of all known elements and most of them appear on the left hand side of the periodic table.

(ii) Metals are usually **solid** at room temperature (except mercury).

(iii) They have **high melting and boiling points** and are **good conductors** of **heat** and **electricity.**

19.2 (b) Non - Metals :

(i) Non-metals do not lose electrons but take up electrons to form corresponding anions.
(ii) Non-metals are located at the top right hand side of the periodic table.
(iii) Non- metals are usually **solids or gases** (except bromine whish is liquid) at room temperature with **low melting and boiling points.**
(iv) They are **poor conductors** of heat and electricity.

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Carbon is an exception as one of its allotropic forms, graphite is a good conductors of electricity.

19.2 (c) Metalloids (Semimetals) :

(i) Some elements lying at the border of metallic and non- metallic behaviour possess the properties that are characteristics of **both metals and non - metals.** These elements are called semimetals or metalloids.

(ii) The metalloids comprise of the elements B, Si, Ge, As, Sb, Te and Po.

(iii) Variation of metallic character across a period :

Metallic character **decreases** along a period due to increase in ionisation energy.

Non - metallic character increases with increase in atomic number across a period.

(iv) Variation of metallic character along a group : Metallic character increases on going down a group from top to bottom. This can be explained in terms of decrease in lionisation energy on going down a group fro top to bottom.

NOTE : Metals generally form **cations** by losing electrons from their outermost shell, while non - metals generally form **anions** by accepting one or more electrons.
e.g. Alkali metals form M^+ ions by losing one electron, while alkaline earth metals form M^+ ions by losing two electrons from their outermost shell.


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Metallic character decreases and non-metallic character increases across a period from left to right, while metallic character increases and non-metallic character decrease down the group.

DAILY PRACTICE PROBLEMS # 19

OBJECTIVE DPP - 19.1

1. The difference between ions and atoms is of -
(A) relative size (B) configuration (C) presence of charge (D) All of these

2. Which of the following has the largest size ?
(A) Na (B) Na^+ (C) Mg (D) Mg^{+2}

3. An element M has a atomic number 9 and atomic mass 19. Its ion will be represented by -
(A) M (B) M^{+2} (C) M^- (D) M^{-2}

4. Which of the following has the maximum non-metallic character ?
(A) F (B) Cl (C) Br (D) I

5. Which of the following is the most reactive halogen ?
(A) F (B) Cl (C) Br (D) I

6. In the third period of the periodic table, the element having smallest size is -
(A) Na (B) Ar (C) Cl (D) Si

7. Which of the following elements has maximum metallic character ?
(A) Li (B) N (C) Na (D) P

8. On moving left to fight in a period, in the periodic table, metallic character -
(A) decrease (B) increases
(C) remains same (D) first increase, then decreases

9. On moving from top to bottom in a group, in the periodic table, size of an atom -
(A) increases (B) decreases
(C) remains same (D) first increases, then decreases

10. On moving from top to bottom in a group, in the periodic table, valency -
(A) increase (B) decreases
(C) remains same (D) first increases, then decreases

SUBJECTIVE DPP - 19.2

1. Why does the atomic size decreases from Na to Cl when we move in the third period of the periodic table ?

2. Show the variation of valency with respect to hydrogen in the 2nd period.

3. Which of the following species are isoelectronic in nature >
(i) Ca^{2+} (ii) K (iii) Mg^{2+} (iv) S^{2-} (v) Cl^{-}

4. What is the valency of the elements that are placed in group 18 ?

5. Name three elements which behave as metalloids.

ANSWERS

OBJECTIVE DPP 17.1

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

SUBJECTIVE DPP 17.2

Sol.4 Atomic mass of the B = 24 **Sol.5** Element F **Sol. 8** 63 elements

OBJECTIVE DPP 18.1

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

SUBJECTIVE DPP 18.2

Sol. 4 Li, Na, K **Sol.5** Li, Be

Sol.6 Second alkali metal = Sodium (Na), Electronic configuration = 2,8,1

Sol.7 All the elements have two electrons in their valence shell.

Sol.8 (a) Period (b) Group (c) Period (d) Group

OBJECTIVE DPP 19.1

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

SUBJECTIVE DPP 19.2

Sol.3 Ca^{+2}, S^{2-} & Cl^{-} ions are all isoelectronic in nature because they have 18 electrons.

Sol.4 Zero

Sol.5 B,Si, Ge, As, Sb, Te and Po are the elements which behave as metalloids.