(Acids, Bases And Salts)

Q.1 What are acids? Give their general characteristics. (Properties)

Ans. According to Arrhenius theory of acids and bases, Acids may be defined as the substances containing hydrogen which upon dissolving in water give hydrogen ions (H^+).

Some Important acids are sulphuric acid (H_2SO_4), Nitric acid (HNO_3), Hydrochloric acid (HCl), acetic acid, lactic acid, carbonic acid etc.

General characteristics of acids:-

1. Acids are sour in taste.
2. All acids contain ionisable hydrogen.
3. Acids turn blue litmus into red, methyl orange into red and decolourize phenolphthalein.
4. Most of the acids are corrosive in nature. They produce a burning sensation on skin and holes on the clothes on which they fall.
5. Most of the acids are soluble in water.
6. Acids in the form of aqueous solutions conduct electricity.

(Chemical properties)

(1) Action of Acids with Metals

Acids react with metals such as magnesium (Mg), zinc (Zn), sodium (Na), or potassium (K) to form a salt and liberate hydrogen gas.

$$Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$$

Magnesium — Sulphuric acid — Magnesium sulphate — Hydrogen

$$2Na + 2HCl \longrightarrow 2NaCl + H_2$$

Sodium — Hydrochloric acid — Sodium chloride — Hydrogen

However, some metals such as copper (Cu), silver (Ag), gold (Au) or mercury (Hg) do not react with acids to give hydrogen gas.

(2) Action of acids with metal carbonates and bicarbonates:-

Acids react with metal carbonates and bicarbonates such as potassium carbonate, sodium bicarbonate or calcium carbonate to liberate carbon dioxide gas, with a brisk effervescence, leaving behind a salt solution.

This property of acids is widely used in soda-acid type fire extinguisher.

Metal carbonate + Acid → salt +Water + Carbon dioxide

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$$

Calcium Carbonate — Hydrochloric acid — Calcium chloride — Water — Carbon dioxide

Take a hard-glass test tube having a two holed rubber cork. Through one hole insert a thistle funnel and through the other insert a glass delivery tube. Put small amount of calcium carbonate in the glass tube. Add a little amount of dil. HCl through the thistle funnel. A brisk effervescence is produced. Pass this gas into a test tube containing lime water through the delivery tube. The lime water turns milky showing that the gas which comes through the delivery tube is carbon dioxide.

Similarly metal bicarbonates when treated with acids, they produce salt and water with the liberation of carbon dioxide gas. For example with sodium bicarbonate when treated with nitric acid produces sodium nitrate, water and carbon dioxide.

$2NaHCO_3$	+	$2HNO_3$	$2\ Na_2\ NO_3$	+ $2H_2O$	+ $2CO_2$
Sodium Bicarbonate		Nitric acid	Sodium nitrate	Water	Carbon dioxide

(3) Acids react with bases to form salt and water

Acid + Base ⟶ salt + water

The reaction of acid and a base to form salt and water is called neutralization reaction e.g.

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

(4) Acid react with metal oxides to form salt and water e.g

$$CuO + 2HCl \longrightarrow CuCl_2 + H_2O$$

Q.2 Give the classification of acids.

Ans. Acids can be classified in a number of ways. The major classes of acids are described as follows:

A. Classification based on Source:-

1. Organic acids

Acids which are obtained usually from plants and animals are known as organic acids e.g. oxalic acid, lactic acid, acetic acid etc.

2. **Inorganic acids:--**

These are the acids which are generally obtained from minerals. These are also called as mineral acids. e.g. Hydrochloric acid, Nitric acid, sulphuric acid etc.

B. Classification based on Strength:-

1. Strong acids:-

These are the acids which almost completely dissociate and produce a high conc. of H^+ ions in aqueous solution e.g. HCl, HNO_3, $H_2\ SO_4$ etc.

2. Weak acids:-

These are the acids which dissociate partially and produce a low conc. of H^+ ions in aqueous solution e.g. acetic acid (CH_3 COOH) phosphoric acid ($H_3\ PO_4$), carbonic acid (H_2CO_3) etc.

C. Classification based on Concentration:-

1. Concentrated Acids:-

These are the aqueous solutions of acids having a relatively high percentage of acid.

2 Dilute acids:-

These are the aqueous solutions of acids having relatively low percentage of acid.

Q.3 Give some uses of acids.

Ans. Some of the uses of acids are as follows:-

1 Sulphuric acid has wide use in industries e.g. it is used in the manufacture of fertilizers like ammonium sulphate, in petroleum refining, in paints, in synthetic fibers and is used in storage batteries.

2 Nitric acid is used in the manufacture of fertilizers like ammonium nitrate, dyes, plastics etc.

3 Hydrochloric acid is used in textile, leather and dye industries. It is also used in cleaning the metal surfaces.

4 Boric acid is used as antiseptic (eye wash)

5 Oxalic acid is used to remove ink stains.

6 Carbonic acid is used in soft drinks.

7 Phosphoric acid is used in manufacture of fertilizers.

Q.4 What do all acids have in common?

Ans. When an acid is dissolved in water, it always produces hydrogen ions (H^+). Thus an acid is a substance which upon dissolving in water produces (H^+) ion.
e.g. HCl is an acid because it dissolves in water to produce hydrogen ions.

$$HCl + H_2O \longrightarrow H^+(aq) + Cl^-(aq)$$

Similarly,

$$HNO_3 + H_2O \longrightarrow H^+(aq) + NO_3^-(aq)$$
$$H_2SO_4 + H_2O \longrightarrow 2H^+(aq) + SO_4^{-2}(aq)$$

From the above examples it is evident that a common property of all the acids is that they all produce H^+ ions in water. Thus HCl, HNO_3, H_2SO_4 etc. are all acids because upon dissolving in water they produce H^+ ions .

Q.5 What are bases? Give their general characteristics.

Ans. According to Arrhenius theory of acids and bases, Bases may be defined as the substances containing Hydroxyl group which upon dissolving in water give hydroxide ions (OH^-).
Some important bases are sodium hydroxide (Na OH), potassium hydroxide (KOH) Calcium hydroxide [$Ca(OH)_2$] etc. Their dissociation can be represented as follows:

$$NaOH \xrightarrow{Water} Na^+ + \bar{O}H$$
$$KOH \xrightarrow{Water} K^+ + \bar{O}H$$
$$Ca(OH)_2 \xrightarrow{Water} Ca^{2+} + 2\,\bar{O}H$$

General characteristics of bases:-

1. Bases are bitter in taste and soapy in touch.
2. Bases contain ionisable hydroxide ion.
3. Bases turn red litmus into blue, methyl orange into yellow and phenolphthalein into pink.
4. Some bases like caustic sods (NaOH) are corrosive in nature.
5. Bases react with metals to produce salts and hydrogen gas. e.g.

$$2NaOH + 2Al + 2H_2O \xrightarrow{\Delta} \underset{\text{Sodium aluminate}}{2NaAlO_2} + 3H_2$$

$$2\,NaOH + Zn \xrightarrow{\Delta} \underset{\text{Sodiumzincate}}{Na_2ZnO_2} + H_2$$

6. Bases when heated with ammonium salt, ammonia gas is produced e.g.

$$NH_4Cl + NaOH \xrightarrow{\Delta} NaCl + H_2O + NH_3\uparrow$$

7. Bases When treated with acids, result in the formation of salts and water e.g.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$
$$KOH + HNO_3 \longrightarrow KNO_3 + H_2O$$

8. Bases react with non-metal oxides to form salt and water. e.g.

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

9. They act as electrolytes .i.e. They produce ions in solutions and hence their aqueous solutions conduct electric current.

Q.6 What are alkalies? Give examples.

Ans. The bases which are soluble in water and give hydroxide ions ($\overline{OH}$) in their aqueous solution are called alkalies. e.g.

NaOH, KOH, NH_4 OH etc. They are soapy to touch, bitter in taste and corrosive in nature. All the bases do not dissolve in water but have basic characteristics. Thus, all alkalies are bases but all bases are not alkalies.

Q.7 What do all bases have in common?

Ans. When a base is dissolved in water, it always produces hydroxide ions ($\overline{OH}$ ions). Thus a base is substance which upon dissolving in water produces hydroxide ions e.g. sodium hydroxide is a base because it dissolves in water to produce hydroxide ions.

$$NaOH + H_2O \longrightarrow Na^+ (aq) + \overline{OH} (aq)$$

Similarly,

$$KOH + H_2O \longrightarrow K^+ (aq) + \overline{OH} (aq)$$

$$Mg(OH)_2 + H_2O \longrightarrow Mg^{2+} (aq^-) + 2\overline{OH} (aq)$$

From the above examples it is evident that a common property of all the bases is that they all produce hydroxide ($\bar{O}H$) ion when dissolved in water. Thus, Na OH, KOH, - $Mg(OH)_2$, Ca $(OH)_2$, NH_4 OH etc are all bases because upon dissolving in water they produce hydroxide (OH) ions.

Q.8 Write Notes on.

a, Strong Base b, Weak Base

a. Strong Base:- A base which completely ionizes in water and thus produces a large amount of hydroxide ions ($\overline{OH}$) is known as a strong base. e.g. NaOH, KOH, Ba $(OH)_2$ are strong bases because they completely ionise in aqueous soln.

b. Weak Base:- A base which partially ionizes in water and thus produces a small amount of hydroxide ions ($\overline{OH}$) is known as a weak base. e.g. NH_4OH, Ca $(OH)_2$, Mg $(OH)_2$ are weak bases because they ionize partially in their aqueous solns.

Q.9 Write a note on pH scale and pH value.

Ans. In 1909, Sorenson devised a scale known as pH scale on which the strength of acid solutions as well as basic solutions could be represented by making use of hydrogen ion concentration. Sorenson linked the hydrogen ion concentrations of acid and base solutions to the simple numbers 0 to 14 on the pH scale. The term pH is derived from the Danish word Potenz de hydrogen (power of HT ion).

pH of a solution is defined as the negative logarithm of the hydrogen ion concentration in moles per litre.

Mathematically; $pH = -\log [H^+]$ = or $H^+ = {}^1/_{\log[H^+]}$

Thus pH of a solution may be also be defined as the logarithm of the reciprocal of hydrogen ion concentration.

pH of Neutral solution.

In pure water $[H^+] = 1.0 \times 10^{-7}$

pH of pure (neutral) water = $- \log (10^{-7}) = -7 \times -\log 10 = -7 \times -1 = 7$

Thus, the pH value of pure water is equal to 7.

pH of Acid Solutions

We know that all acidic solutions have H^+ ion concentration greater than 1.0×10^{-7}. The H^+ ion concentration in an acidic solution may be 10^{-5}, 10^{-6}, 10^{-4}, etc.

Consider an acidic solution whose H^+ ion concentration = 10^{-6}

Its pH = $- \log (H^+) = - \log(10^{-6}) = -6 \times -\log 10 = -6 \times -1 = 6$ [$\because \log 10 = 1$]

Thus. pH values of all acidic solutions will be less than 7.

pH of Basic Solutions

All basic solutions have H^+ ion concentration less than 10^{-7}. Consider a basic solution whose H^+ ion concentration is 10^{-8}

Its PH= $- \log [H^+] = - \log [10^{-8}] = -8 \times -\log 10 = -8 \times -1 = 8$

Thus, pH valves of all basic solutions will be more than 7.

It may be noted that

(1) Solutions having pH between 0 to 2 are strongly acidic.
(2) Solutions having pH between 2 to 4 are moderately acidic and
(3) Solutions having pH between 4 to 7 are weakly acidic.
(4)Solutions having pH equal to 7 are neutral
(5) Solutions having pH between 7 and 10 are weakly basic;
(6) Solutions having pH between 10 and 12 are moderately basic, and
(7) Solutions having pH between 12 and 14 are strongly basic.

Q.10 Describe the importance of pH in every day life.

Ans. pH plays a very important role in our every day life as described below:

1. **Biological Importance:-** Biochemical reactions take place at definite pH values. Our body works within a pH range of 7.0 to 7.8. If there occurs any change in this pH, there occurs disturbance in the normal functioning of our body.
2. **pH in our digestive system:-** Our stomach produces hydrochloric acid which helps in the digestion of food. But during indigestion, the stomach produces too much acid, which causes pain and irritation. To relieve this pain, antacids such as magnesium hydroxide (milk of magnesia) which is a mild base is used to bring the pH in stomach in the normal range.
3. **pH Changes as the cause of tooth decay :-**
   Tooth enamel, made up of calcium phosphate is the hardest substance in our body. It does not dissolve in water, but is corroded when the pH in the mouth is below 5.5. Thus tooth decay starts when the pH of the mouth is lower than 5.5. Normally the pH of mouth is 7.0. Bacteria present in the mouth produce acids by degradation of sugary food materials remaining in the mouth after eating. Due to production of acids, pH of the mouth becomes less than 5.5 and corrosion of tooth enamel takes place. To prevent this, clean mouth after eating food and use tooth pastes, which are generally basic for neutralizing the excess acids present in the mouth.
4. **Importance of pH of the soil in agriculture:-** Plants require a specific pH range for their healthy growth. In order to find out whether a particular soil is fit for a particular crop, we have to check the pH of that soil and then compare its pH range in which its growth is healthy. And also to determine whether acidic or basic fertilizers are required for a particular crop.
   Acid rain:- Rain is the purest form of water having pH equal to 7. If oxides of nonmetals like SO_2 and CO_2 present in the atmosphere get dissolved in rain water then the pH of rainwater becomes less than 5.6, it is called acid rain. When this acid rain flows into rivers, it lowers the pH of the river water and therefore the survival of aquatic life in such rivers become difficult.

Q.11 What are salts? Give different methods of their preparation.

Ans. A salt is an ionic compound formed by the partial or complete displacement of the ionisable hydrogen atoms of an acid by a metal ion or ammonium ion. e.g.

NaCl, Na_2SO_4, Na_2CO_3, KCl, NH_4 Cl etc.

The most common methods used for the preparation of salts are as follows:-

1. **By neutralization reaction of acids and bases:-** In neutralization reaction an acid reacts with a base to form salt and water e.g.

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

Sod. Hydroxide — Hydrogen Acid — Sodium Chloride — Water

$$NH_4OH + HCl \longrightarrow NH_4Cl + H_2O$$

Ammonium Hydroxide — hydrochloric acid — ammonium chloride

2. **By the action of metals on acids:-** Active metals react with acids to form salts with the evolution hydrogen gas. e.g.

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2\uparrow$$

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

3. **By the action of acids on metal carbonates and bicarbonates:-** Metal carbonates and bicarbonates when treated with acids result in the formation of salt and water with the evolution of carbon dioxide gas. e.g.

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$$

$$NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$$

Q.12 Name some families of salts. Give examples of each family.

Ans. Salts are classified into different families either on the basis of the acid or on the basis of the base from which they have been obtained. The different families are as follows:-

1. **Chlorides:-** The salts which are formed by the reaction of hydrochloric acid (HCl) with any base are called as chlorides e.g. Sodium Chloride (NaCl), Potassium Chloride (KCl), Ammonium Chloride (NH_4Cl), Barium Chloride ($BaCl_2$) etc.
2. **Nitrates:-** The salts which are formed by the reaction of nitric acid (HNO_3) with any base are called as nitrates. e.g. sodium nitrate ($NaNO_3$), Potassium nitrate (KNO_3), calcium nitrate Ca $(NO_3)_2$
3. **Sulphates:-** The salts which are formed by the reaction of sulphuric acid (H_2SO_4) with any base are called sulphates e.g. Sodium sulphate (Na_2SO_4), Potassium sulphate (K_2SO_4) magnesium sulphate (Mg SO_4), Copper sulphate ($CuSO_4$) etc.
4. **Carbonates:-** The salts which are formed by the reaction of carbonic acid (H_2CO_3) with any base are known as carbonates e.g.
   Sodium carbonate (Na_2CO_3), Potassium carbonate (K_2CO_3), Calcium carbonate ($CaCO_3$) etc.
   Some other families are phosphates, oxalates, acetates etc. These families are derived from phosphoric acid, oxalic acid, acetic acid respectively.

Q.13 pH Values of Salt Solutions:-

The interaction of salts with water to give acidic, basic or neutral solutions is called as salt hydrolysis. The pH of the solution obtained after the salt hydrolysis depends upon the type of salt dissolved. On the basis of nature of the acid or base from which salts are derived, salts are of following four types:

a. **Salts of a strong acid and a strong base:-** The solution of salts, derived from strong acid and strong base have neutral pH i.e. '7' this is because the acid and base produced, neutralize each other completely. e.g.

NaCl, Na NO_3, Na_2 SO_4, KCl, KNO_3, K_2SO_4.

$NaCl + H_2O \longrightarrow NaOH + HCl$

Sodium Chloride — Sodium Hydroxide (Strong Base) — Hydrochloric acid (Strong acid)

b. Salts of strong acid and weak base:- The solution of salts, derived from strong acid and weak base have acidic pH i.e. less than 7. this is because the strong acid produced is not completely neutralized by weak base produced.

e.g. NH_4 Cl, Cu SO_4, Al Cl_3, Zn SO_4 etc.

$NH_4Cl + H_2O \longrightarrow NH_4OH + HCl$

Ammonium Chloride Salt — (W.B) (S.A)

C. Salts of weak acid and strong base:- The solution of salts, which are obtained from weak acid and strong base have basic pH i.e. greater than 7. This is because the strong base produced is not completely neutralized by weak acid. e.g.

Na_2CO_3, Na HCO_3, CH_3COONa etc.

$Na_2CO_3 + 2H_2O \longrightarrow H_2CO_3 + 2NaOH$

Sodium Carbonate — (W.A) (S.B)

d. Salts of weak acid and weak base:- The soln. of the salts derived from weak acid and weak base is almost neutral i.e. pH nearly equal to 7,. e.g. CH_3COONH_4

$CH_3COONH_4 + H_2O \longrightarrow CH_3COOH + NH_4OH$

Ammonium Acetate. — (W.A) (W.B)

Q.14 Give a detailed account of common salt (sodium chloride).

Ans. Chemical Nature of common salt:- Common salt is chemically called as sodium chloride. Its chemical formula is NaCl. It is used as an essential constituent of food materials. Hence is also called as table salt.

Occurrence:- Common salt occurs naturally in sea- water and as rock salt.

1. **Common salt from sea water:-** Common salt is obtained from sea water by the process of evaporation. In this process, water is trapped in large shallow pools called as lagoons for evaporation. The sun's heat evaporates the water slowly and common salt is left behind. How ever, the common salt so obtained is still impure as it contains many other salts mixed with it.
2. **Common salt from underground deposits:-** Common salt is also found in the form of solid deposits in several parts of the world under the earth's crust. These underground deposits are called rock salt. Rock salt is usually brown due to presence of impurities in it. Rock Salt is mined from the underground deposits just like coal.

Use of common salt:-

1. It is an essential constituent of our food materials.
2. it is used as preservative for a number of food materials e.g. in packed meat and fish.
3. It is used to prepare freezing mixtures (like ice-creams)
4. It is used in the preparation of soaps, pottery glaze etc.
5. It is used as a raw material for the preparation of other chemicals.

Q.15 What is caustic soda?
How is it manufactured? Give its uses.

Ans. Caustic soda is chemically called as sodium hydroxide. Its chemical formula is NaOH. It is basic in nature and acts as a strong base. Sodium hydroxide is prepared by chloro alkali process. The process involves the passage of electric current through an aqueous solution of sodium chloride called brine. It produces hydrogen gas at cathode and chlorine gas at anode. The solution obtained in the cathodic compartment contains sodium hydroxide. This solution is taken out and is concentrated to get solid sodium hydroxide. The reactions taking place are:-

$$2NaCl\ (S) \xrightarrow{Water} 2Na^{+}\ (aq.) + 2\ \overline{Cl}\ (aq).$$

$$2H_2O \rightleftharpoons 2H^{+} + 2OH^{-}$$

At cathode:-

$$2H^{+}\ (aq) + \overline{2e} \longrightarrow H_2\uparrow$$

At anode:- $2\overline{Cl}\ (aq) - 2\overline{e} \longrightarrow Cl_2\uparrow$

The over all reaction can be represented as:-

$$2NaCl\ (aq) + 2H_2O\ (l) \longrightarrow \underset{\text{Sodium Hydroxide}}{2NaOH} + H_2\uparrow + Cl_2\ (g)\uparrow$$

Use of caustic soda:-

1. It is used as an effective cleansing agent.
2. It is used in the manufacture of soaps and detergents.
3. It is used in the refining of petroleum.
4. It is used in textile industries for mercerizing.
5. It is also used in paper industries.
6. It is used in making artificial fibers like rayon etc.

Q.16 Give preparation, properties and uses of bleaching powder .

Ans. The chemical formula of bleaching powder is $Ca\ OCl_2$, called as calcium oxychloride.

Preparation:-

Bleaching powder is prepared by the action of chlorine on dry slaked lime $Ca\ (OH)_2$, at a temp. of 40—50^{o}C,

$$\underset{\text{Dry Slaked lime}}{2Ca\ (OH)_2} + 2Cl_2 \xrightarrow{40\text{-}50^{0}C} \underset{\text{Bleaching Powder}}{2Ca\ OCl_2} + 2H_2$$

Bleaching powder is mostly manufactured by a process called as Hasenclever process.

Properties:-

1. It is a yellowish white powder having smell of chlorine.
2. It gradually loses its chlorine when left exposed to the air. This is because CO_2 present in the air reacts with bleaching powder liberating chlorine.

$$\underset{\text{bleaching Powder}}{CaOCl_2} + CO_2 \longrightarrow \underset{\text{Calcium Carbonate}}{Ca\ CO_3} + Cl_2$$

3. It is soluble in cold water.
4. It reacts with dilute hydrochloric acid or dilute sulphuric acid liberating

chlorine gas.

$$Ca\,OCl_2 + 2HCl \longrightarrow CaCl_2 + H_2O + Cl_2$$
$$CaOCl_2 + H_2SO_4 \longrightarrow Ca\,SO_4 + H_2O + Cl_2$$

Uses:-

1. It is used for bleaching textiles in textile industries.
2. It is used for bleaching wood pulp in paper industries.
3. It is used for disinfecting water to make it free from germs.
4. It is used as an oxidizing agent in many chemical industries.

Q.17 Give preparation properties and uses of plaster of paris.

Ans . The chemical name of plaster of paris is calcium sulphate hemihydrate. Its chemical formula is $Ca\,SO_4 \frac{1}{2} H_2O$.

Preparation:- It is prepared from gypsum which is calcium sulphate dihydrate ($CaSO_4.2H_2O$). Gypsum is heated in a kiln to a temperature of 100^OC. At this temperature, it loses three –fourth of its water of crystallization resulting in the formation of plaster of paris.

$$Ca\,SO_4\,2H_2O \xrightarrow{100^OC} Ca\,SO_4 . \frac{1}{2} H_2O + 1\frac{1}{2} H_2O$$
Gypsum — Plaster of Paris

Properties:-

1. It is a white powder.
2. When mixed with water, it forms a paste which sets into a hard mass. This is called setting of plaster of paris.

$$CaSO_4\ \frac{1}{2} H_2O + 1\frac{1}{2} H_2O \longrightarrow CaSO_4\ 2H_2O$$
P.O.P — Gypsum

Uses:-

1. It is used for producing moulds for toys, pottery, ceramics etc.
2. It is used for making statues, models and other decorative materials.
3. It is used in medical applications for setting broken and fractured bones in right position and in dentistry.
4. It is used for making smooth surfaces, decoratives designs on ceilings, walls, pillars etc.
5. It is used as a fire proof material.
6. It is used in laboratories for sealing the air gaps in apparatus to make them air tight.

Q.18 Give preparation properties and uses of:-

a. Baking soda

b. Washing Soda.

a. Baking soda:-Baking soda is chemically known as sodium hydrogen carbonate or sodium bicarbonate. Its chemical formula is $NaHCO_3$.

Preparation:-

Baking soda is manufactured by solvay's process using sodium chloride as one of the raw materials. In this method ammonia is added to sodium chloride soln. (brine) followed by the reaction with carbon dioxide, which results in the production of sodium bicarbonate. The reaction can be represented as follows:-

$$NaCl + H_2O + CO_2 + NH_3 \longrightarrow NH_4Cl + NaHCO_3$$
Sodium bicarbonate

Properties:-

1. It is white crystalline solid.
2. It is sparingly soluble in water and forms alkaline solution.
3. Up on heating decomposes into sodium carbonate, water and carbon dioxide.
4. It reacts with acids to give out carbon dioxide.

Uses:-

1. It is used as an ingredient of antacids.
2. It is used as an additive in food and drinks.
3. It is used in soda acid fire extinguisher.

Washing Soda:-

Chemically washing soda is sodium carbonate containing ten molecules of water as water of crystallization. So it is called sodium carbonate decahydrate .

($Na_2\ CO_3\ 10H_2O$). However, dehydration of water of crystallization results in the formation of anhydrous sodium carbonate which is called as soda ash ($Na_2\ CO_3$).

Preparation :- In the manufacture of sodium carbonate, carbon dioxide is passed through ammonical brine and produces insoluble sodium bicarbonate.

$$\underset{\text{Ammoniacal brine solution}}{NaCl + NH_3 + H_2O} + CO_2 \longrightarrow \underset{\text{Sodium bicarbonate}}{NaHCO_3} + NH_4Cl$$

The precipitate, sodium bicarbonate is separated by filtration and is heated strongly to get sodium carbonate.

$$2NaHCO_3 \xrightarrow{\Delta} Na_2\ CO_3 + H_2O + CO_2$$

Sodium carbonate so obtained is re-crystallized from water to get sodium carbonate having molecular formula $Na_2\ CO_3.\ 10H_2O$

Properties:-

1. Washing soda is a transparent crystalline solid.
2. A molecule of washing soda contains 10 molecules of water of crystallization.
3. Washing soda loses nine molecules of water of crystallization when kept open in air This process is called efflorescence. Thus washing soda is efflorescent in nature.
4. It is readily soluble in water. It dissolves in water to form an alkaline solution.
5. On heating washing soda does not decompose, but loses all the molecules of water and becomes dry.
6. It reacts with acids to give out carbon dioxide.

Uses:-

1. It is used in laundry.
2. It is used for softening hard water.
3. It is used in the manufacture of glass, soaps, paper etc.
4. It is used as cleansing agent for domestic purposes.
5. It is used as laboratory reagent.

Q.19 Write a short note on water of crystallization.

Ans. Water of crystallization is the fixed number of water molecules present in one formula unit of a salt.

Examples

a. copper sulphate crystals contain five water molecules as water of crystallization. Chemical formula of crystalline copper sulphate is $CuSO_4\ 5H_2O$. copper sulphate is blue in colour due to presence of five molecules of water as water of crystallization.

b. Gypsum:- Its chemical formula is $CaSO_4\ 2H_2O$. It has two molecules of water as water of crystallization.

Textual Questions:

Q. 1. You have been provided with three test tubes. One of them contains distilled water and the other two contain an acidic solution and a basic solution respectively. If you are given only red litmus paper, how will you identify the contents of each test tube?

Ans. The contents of each test tube would be identified by change in colour of red litmus paper. For example, when we wet the red litmus paper with the basic solution, it changes into blue colour. Put the changed blue litmus paper in the solution which turns the blue colour of litmus paper to red, the solution will be the acidic solution. The solution, which has no effect on red or blue litmus paper, will be neutral and hence it will be distilled water.

Q.2 Why should curd and sour substances not be kept in brass and copper vessels?

Ans. Curd and other sour foodstuffs contain acids, which can react with the metal of the vessel to form poisonous metal compounds which can cause food poisoning and damage our health. Therefore it is advised not to store food stuffs which contain acidic substances in brass or copper containers.

Q.3 Which gas is usually liberated when an acid reacts with a metal?

Ans. When acids reacts with metals, salts are produced with the libration of hydrogen gas

(Metal + Acid t ⟶ Salt +Hydrogen gas.

e.g. $2HCl + Zn \longrightarrow Zn Cl_2 + H_2$

Q 4. Metal compound A reacts with dilute hydrochloric acid to produce effervescence. The gas evolved extinguishes a burning candle. Write a balanced chemical equation for the reaction if one of the compounds formed is calcium chloride.

Ans. The gas that extinguishes a burning candle is carbon dioxide, which is formed by the action of dilute hydrochloric acid on a metal carbonate and produces effervescence. Since one of the compounds formed is calcium chloride, it shows that the metal compound is calcium carbonate. Thus, the metal compound A is calcium carbonate ($CaCO_3$). Calcium carbonate reacts with dilute hydrochloric acid to form calcium chloride, carbon dioxide and water. This can be written as:

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

Q. 5. Why do HCl, HNO_3, etc. show acidic characters in aqueous solutions while solutions of compounds like alcohol and glucose do not show acidic character?

Ans. An acid is a substance, which dissociates on dissolving in water to produce hydrogen ions [H+(aq) ions]. The substance like HCl, H_2SO_4, show acidic character because they dissociate in aqueous solutions to produce hydrogen ions, (H+(aq) ions).

On the other hand, substances like alcohol (C_2H_5OH) and glucose ($C_6H_{12}O_6$) do not ionize to liberate H^+ ions in their aqueous solutions, hence are not acidic in nature.

Q 6. Why does an aqueous solution of acid conduct electricity?

Ans. An acid upon dissolving in water. dissociates into ions (cations and anions). When electrodes of different potential are introduced in such an aqueous solution, the ions of acid get migrated towards opposite terminals (electrodes). This migration of ions of acidic solution is responsible for conduction of electricity.

Q. 7. Why does dry HCl gas not change the colour of the dry litmus paper?
Ans. HCl gas shows its acidic character only in aqueous solution. this is because in aqueous solution it completely ionizes to liberate H^+ ions. Hence changes the colour of litmus paper.
However, when HCl gas is in dry form, it does not ionize to liberate H^+ ions.
Since dry HCl gas does not contain any hydrogen ions in it, so it does not show acidic behaviour. That is why there is no change observed on litmus paper.

Q. 8. While diluting an acid, why is it recommended that the acid should be added to water and not water to the acid?
Ans. Dilution of concentrated acid with water is a highly exothermic process. Thus diluting an acid should be done by adding concentrated acid to water gradually with stirring.
Because the heat is evolved gradually and is easily absorbed by the large amount of water
If, however, water is added to concentrated acid to dilute it, a large amount of heat is evolved at once. The heat generated may cause the mixture to splash the acid on our face or clothes and cause acid burns.

Q. 9. How is the concentration of hydronium ions (H_3O^+) affected when a solution of an acid is diluted?
Ans. When the concentrated solution of an acid is diluted by mixing water, the concentration of hydronium (H_3O^+ ions) per unit volume decreases.

Q. 10. How is the concentration of hydroxide ions (OH-) affected when excess base is dissolved in a solution of sodiumhydroxide?
Ans. concentration of OH^- ions increases per unit volume on dissolving exess base in the solution of sodiumhydroxide.

Q. 11. You have two solutions A and B. The pH of solution A is 6 and pH of solution B is 8.
i. Which solution has more hydrogen ion concentration?
ii. Which of this is acidic and which one is basic?
Ans. i. The pH of a solution is inversely proportional to its hydrogen ion concentration. This means that the solution having lower pH will have more hydrogen ion concentration. In this case, solution A(having a lower pH of 6) will have more hydrogen ion concentration that solution B.
ii. We know solution with pH < 7 are acidic and the solution with pH > 7 are basic. Therefore solution A with pH = 6 is acidic and solution B with pH = 8 is basic in nature.

Q. 12. What effect does the concentration of H^+(aq) ions have on the nature of the solution?
Ans. Acids produce hydrogen ions in water. So, when an acid is added to an aqueous solution, the concentration of hydrogen ions in aqueous solution increases. The solution thus formed will have more of hydrogen ions and therefore its acidic character increases.

Q. 13. Under what soil condition do you think a farmer would treat the soil of his fields with quick lime (calcium oxide) or slaked lime (calcium hydroxide) or chalk (calcium carbonate)?
Ans. Quick lime, slaked lime or chalk are alkaline in nature. These chemicals should be added to the soil, when it is acidic in nature so as to neutralize it. This is because for healthy growth of crop plants, the soil should be neutral in nature.

Q. 14. What is the common name of the compound $CaOCl_2$?
Ans. The common name of the compound $CaOCl_2$ is bleaching powder.

Q. 15. Name the substance that on treatment with chlorine yields bleaching powder.
Ans. Dry slaked lime (Calcium hydroxide) $Ca(OH)_2$ is the substance that on treatment with chlorine yields bleaching powder.

Q. 16. Name the sodium compound, which is used, for softening hard water.
Ans. Sodium carbonate (washing soda) is used for softening hard water.

Q. 17. What will happen if a solution of sodium hydrogen carbonate is heated? Give the equation of the reaction involved.
Ans. Sodium hydrogen carbonate upon heating decomposes into sodium carbonate, carbon dioxide and water. The equation for the reaction involved is as follows.

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$$

Sodium bicarbonate → sodium carbonate

Q.18 What happens when water is added to plaster of Paris?
Write an equation to show the reaction between Plaster of Paris and water?
Ans. Plaster of Paris has a very remarkable property of setting into a hard mass on wetting with water. So, when water is added to plaster of Paris, it sets into a hard mass in about half an hour. The setting of plaster of Paris is due to the hydration. The hydrated crystals of plaster of Paris is called gypsum, which sets to form a hard, solid mass.

$$CaSO_4 . \tfrac{1}{2} H_2O + 1\tfrac{1}{2} H_2O \longrightarrow CaSO_4 . 2H_2O$$

Plaster of Paris → Gypsum

Q. 19. Why does distilled water not conduct electricity, whereas rainwater does?
Ans. Distilled water does not conduct electricity because it does not contain any ionic compound (like acids, bases or salts) dissolved in it. On the other hand, rain water, while falling to the earth through the atmosphere, dissolves an acidic gas, carbon dioxide from the air and forms carbonic acid (H_2CO_3). Carbonic acid provides hydrogen ions, H+(aq), and carbonate ions, CO_3^{2-} (aq), to rain water. So, due to the presence of carbonic acid (which provides ions to rain water), the rain water conducts electricity.

Q.20 Write word equations and then balanced equation for the reactions taking place when
Dilute sulphuric acid reacts with zinc granules.
Ans. The word equation is:-

Zinc + Sulphuric acid ⟶ Zinc sulphate + Hydrogen.

9 balanced chemical equation

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2\uparrow$$

Q. 21. Why do acids not show acidic behaviour in the absence of water?
Ans. The acidic behaviour of an acid is due to the presence of hydrogen ions. An acid produce H^+ ions on dissociation in presence of water. In absence of water H^+ ions are not produced. Hence acids do not show acidic character in absence of water.

Q. 22. Five solutions A, B, C, D and E when tested with universal indicator showed pH as 4, 1, 11, 7 and 9 respectively. Which solution is?
(i) Neutral?
(ii) Strongly alkaline?
(iii) Strongly acidic?
(iv) Weakly acidic?
(v) Weakly alkaline?

Ans. Arrange the pH in increasing order of hydrogen-ion concentration.

	Solution	Ph	Nature
1.	D	7	Neutral
2.	C	11	Strongly alkaline
3.	B	1	Strongly acidic
4.	A	4	Weakly acidic
5.	E	9	Weakly alkaline

Arrangement of pH in the increasing order of hydrogen ion concentration is as follows:

pH (11) pH (9) pH (7) pH (4) pH (1)

C E D A B

pH in the increasing order of hydrogen ion concentration

Q.23. Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid (HCl) is added to test-tube A while acetic acid (CH_3COOH) is added to test-tube B. In which test-tube will fizzing occur more vigorously and why?
Ans. Acetic acid (CH_3COOH) is a weak acid whereas hydrochloric acid (HCl) is a strong acid. Fizzing occurs in the test tube due to the evolution of hydrogen gas by the action of acid on magnesium ribbon. Since hydrochloric acid is a strong acid a large amount of hydrogen gas is liberated in the test tube A. So fizzing occurs more vigorously in test tube A.

Q.24. Fresh milk has a pH of 6. How do you think the pH will change as it turns into curd? Explain.
Ans. When milk changes into curd, its pH will decrease. This is because lactic acid is formed when milk turns into curd, which is more acidic than milk. We know more acidic is a substance, lesser is its pH.
The pH will change to below 6, as lactic acid is formed when milk turns into curd.

Q.25. A milkman adds a very small amount of baking soda to fresh milk.
a. Why does he shift the pH of the fresh milk from 6 to slightly alkaline?
Ans. Fresh milk is acidic and it turns sour easily to become more acidic. In presence of baking soda, milk becomes alkaline and does not turn sour easily because the alkali does not allow the milk to become more acidic easily.
b. Why does this milk take a long time to set as curd?
Ans. When the milk sets to curd, the pH decreases i.e. it becomes more acidic the presence of alkali does not allow it to become more acidic easily. Hence it will take a long time to set as curd.

Q. 26. Plaster of Paris should be stored in a moisture-proof container. Why?
Ans:- Plaster of paris is $CaSO_4$ ½ H_2O. It absorbs moisture to become gypsum with formula $CaSO_4$ $2H_2O$, and sets to a hard mass. This will make the plaster of paris useless after some time. Hence it should be stored in a moisture proof container**.**

Q. 27. What is a neutralization reaction? Give two examples.
Ans. The reaction of an acid with a base, giving rise to the corresponding salt and water is called neutralization reaction.
Examples:
$NaOH + HCl \longrightarrow NaCl + H_2O$
(Base) (Acid) Sodium

$$\underset{\text{(Base)}}{Mg(OH)_2} + \underset{\text{(Acid)}}{H_2CO_3} \longrightarrow \underset{\text{Magnesium Carbonate (Salt)}}{MgCO_3} + \underset{\text{Chloride (Salt)}}{2H_2O}$$

Q.28 Write short note on Indicators.
An indicator is a substance that changes colour when brought in contact with an acid or a base. Many natural substances such as black carrot juice and red cabbage juice are good indicators. But a commonly used indicator is litmus. It is a purple dye, which comes from lichens. A paper soaked in litmus solution and dried is called litmus paper. A blue litmus paper turns red in acids and red litmus paper turns blue in bases. There are also other indicators that are commonly used to test acids and bases, e.g. methyl orange and phenolphthalein. Methyl orange has red colour in acids and yellow colour in bases phenolphthalein has pink colour in bases and turns colourless in acids.

Q.29 What is atmosphere of Venus (planet) made up of?
Ans) The atmosphere of Venus is made up of thick white and yellow clouds of sulphuric acid. Because of this, life can not exist on this planet.

Q.30 Give an example where nature provides neutralization options?
Ans) Nettle is a herbaceous plant which grows in the wild. Its leaves have stinging hair, which cause painful stings due to secretion of methanoic acid (formic acid), when touched accidentally. A traditional remedy is rubbing the area with leaf of dock plant. The dock plant secretions are alkaline in nature. The dock plant grows besides the nettle plant. This is the best example where nature provides neutralization.

Q.31 What do you understand by 'Available chlorine" as used in case of bleaching powder?
Ans) Chlorine liberated when bleaching powder ($CaOCl_2$) is treated with excess of diluted H_2SO_4 is called as available chlorine.

Q.32 What do you mean by hydroscopic nature of common salt?
Ans) Hydroscopic nature of common salt means that it catches moisture from air and becomes wet. Hydroscopic nature of common salt is because of the presence of some impurities in the form of magnesium chloride ($MgCl_2$).

Q.33 What is meant by deliquescence and deliquescent?
Ans) Certain anhydrous or partially hydrated salts can absorb moisture from air and become moist. This property of salts is called deliquescence. The salts showing deliquescence property are called deliquescent salts. The salts like $MgCl_2$, $CaCl_2$ are deliquescent salts.

Carbon & its compounds Chapter: (5

Q.1 How does carbon occur in nature?
Ans. Carbon is one of the most widely distributed element, found in earth's crust. It occurs both, in free state as well as in combined state.
In free state, carbon occurs as diamond, graphite and coal. Diamond and graphite are pure forms of carbon. Coal is an impure form of carbon in which percentage of carbon varies. In combined state carbon occurs as:-
(i) Oxides such as carbon dioxide , and carbon monoxide.
(ii). In the form of natural gas, petroleum products, marsh gas.
(iii) Carbonates in the form of metal carbonagbtes such as.

Magnesium carbonate, ($MgCO_3$), Calcium carbonate, ($CaCO_3$), Zinc carbonate, ($Zn\ CO_3$).

iv. In the form of bio-molecules like proteins, fats, carbohydrates etc.

Q.2 Describe the position of carbon in periodic table.

Ans. Carbon is a non-metallic element having symbol 'C'. It has an atomic number of 6 and mass number of 12u. It occurs in three isotopic forms such as $^{12}_{6}C$, $^{13}_{6}C$ and $^{14}_{6}C$ Its electronic configuration is K , L
2 4

Where K & L are 1st and 2nd shells of carbon respectively.

It belongs to group 14 and is the first member of the group. The other members of the group are Si, Ge, Sn and Pb. Since it occurs at the top of the group 14, this group is also known as carbon family.

Q.3 Discuss unique nature of carbon.

Ans. The unique nature of carbon can be explained in the following points.:-

i. Carbon has the self linking property to form chains of varying lengths and shapes (straight, branched, closed). This property of carbon is known as catenation.

ii. Carbon differs from the next of the elements of its group because of its smaller size and higher electro-negativity.

iii. Carbon shows unique ability to form multiple bonds such as C=C, C≡C, C = O, C ≡ N etc.

iv. Carbon can bind to almost every elements in periodic table especially O, H, S etc.

v. Carbon forms complex molecules, therefore the no. of isomers increases.

Q.4 State the reason, why carbon always forms covalent bonds?

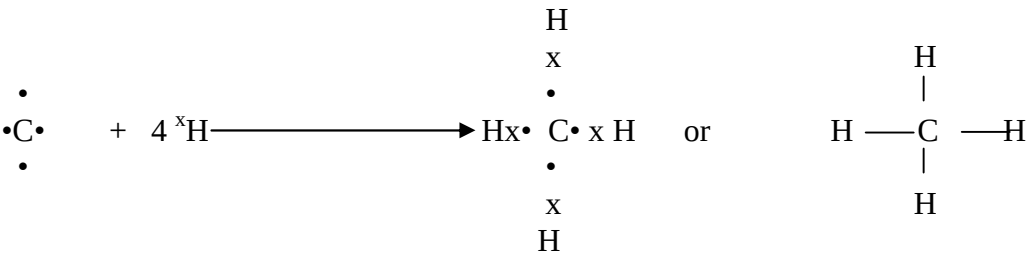
Ans. Carbon has six electrons and its electronic configuration is: K , L
2 4

Thus, an atom of carbon contains four electrons in its outer shell (L-Shell). From the electronic configuration of carbon, it seems that carbon can form compounds in three different ways:

1. By losing all four outer most electrons to form C^{4+}ion .
2. By gaining four electrons to form $C^{-4.}$ ion.
3. By sharing all the four outer most electrons present in L – Shell and forming four covalent bonds.

Since carbon atom is small in size, so its outer most electrons are strongly bound to the nucleus and therefore large amount of energy is needed to remove electrons from a carbon atom.

As a result carbon atom shows no tendency to lose its valence electrons. On the other hand, due to low nuclear charge, carbon is moderately electronegative, so it does not show any tendency to gain electrons. Therefore, the option left for carbon to form compounds is only by sharing its four electrons forming four covalent bonds to complete its octet.



Q.5 What is allotropy? Give the allotropic forms of carbon.

Ans. The phenomenon of existence of an element in two or more different forms having different physical properties but similar chemical properties is known as allotropy and the various forms as allotropes or allotropic forms. Carbon, sulphur and phosphorus are some of the non-metals that show allotropy. Carbon exists in two allotropic forms:
(1) Crystalline (2) Amorphous

1. **Crystalline forms of carbon:-** crystalline forms of carbon are:
a) Graphite b) Diamond c) Fullerenes
2. **Amorphous forms of carbon:-** The various amorphous forms of carbon are coal, coke, charcoal, bone or animal charcoal, carbon black etc.
Among all the known forms of carbon, diamond, graphite and fullerenes are the purest forms.

Q.6 Give a detailed account of Diamond. (occurrence, structure, properties and uses)

Ans. Diamond is the purest form of carbon. The word diamond comes from the two Greek words diaphones means transparent and adamas means extremely hard. Diamond is found in all shapes and sizes. Diamond is found in ancient valcano pipes where it is generally embedded in a soft dark coloured rock called blue ground or Kimberlite rocks.

Diamond can also be prepared artificially by subjecting carbon to very high pressure and temperature. These synthetic diamonds are small but are otherwise indistinguishable from natural diamonds.

Occurrence: Diamond deposits have been found in South Africa, Ghana, Angola, India, Brazil and Eastern Siberia.

In India, diamond are found in Panna (Madhya Pradesh), Wajrakarur (Andrapradesh) and Golconda (Karnataka). The famous Kohinoor diamond was found is Wajrakarar.

Structure:- In diamond each carbon atom is linked to four other carbon atoms directed towards the corners of a regular tetrahedron through covalent bonds. The arrangement gives rise to a closely packed, hard, three dimensional structure which makes the diamond hardest natural substance. All the four valence electrons are engaged in forming carbon- carbon bonds, leaving no free electron. This makes diamond poor conductor of electricity.

Properties of Diamond:-

1) Diamond is a transparent solid having extra ordinary brilliance.
2) It is usually colourless, but we can impart colour to diamond by adding small amount of impurities in the form of metal salts.
3) It is a poor conductor of heat and electricity.
4) It has a high density of $3.5 g/cm^3$.
5) It has a high refractive index of 2.5.
6) It is the hardest natural substance. One can cut a diamond with only diamond.

Use of Diamond:-

1) It is used in Jewellery because the property cut and polished diamond sparkles brightly.
2) It is used to cut glasses.
3) It is used for cutting and drilling of rocks.
4) It is used to make radiation proof windows in space satellites because it has ability to keep out harmful radiations.
5) Due to its extra-ordinary sensitivity to heat rays diamonds are used for making high precision thermometers.

Q.7 Give occurrence structure properties and uses of graphite.

Ans. Graphite is a crystalline form of carbon. It finds its name from the Greek word "grapheine" means to write. It is also called black lead because it marks paper black like lead. The chemical symbol of graphite is C.

Occurrence:- Graphite occurs free in nature and is widely distributed throughout the world. Major producers of graphite are USSR, Mexico, India, China, Canada and Srilanka. In India graphite is found in Orissa, Rajasthan, J&K State , Bihar, Karnataka, Tamilnadu etc. Graphite can also be prepared artificially by heating coke to a high temperature.

Structure of Graphite:- The structure of Graphite is altogether different from that of diamond. A graphite crystal actually consists of sheets or layers of Carbon atoms. In a graphite layer, each carbon atom is bonded to three other carbon atoms in the same plane forming hexagonal rings. To satisfy the fourth valency of carbon, each hexagonal ring has three alternate single and double bonds. The various layers are held together by weak Vander – walls forces of attraction. The distance between any two successive layers is 340 pm.

Properties:-

1) Graphite is an opaque, grayish-black in colour, with hexagonal crystals.
2) It is soft and greasy to touch.
3) It is a good conductor of heat and electricity.
4) Its density is 2.2 g/cm^3.
5) It is stable to heat and possesses a high melting point of around 3700^OC.
6) It has a metallic lustre.

Uses:-

1) It is used as a lubricant in fast moving machinery as graphite is soft and slippery.
2) It is used to make electrodes in batteries and electric furnaces.
3) It is used to make the core of lead pencils as it is soft and can mark paper.
4) It is used to make black paints and in printer inks.

Q.8 Comparison of properties of Diamond and Graphite.

Ans. The difference between the properties of diamond and graphite is summarized as below:-

Diamond	**Graphite**
1. Diamond is the hardest substance known.	1. Graphite is soft and soapy to touch
2. Diamond has a density of 3.5 g/m^3.	2. Graphite has a density of 2.3 g/m^3.
3. Diamond is transparent and has a high refractive index.	3. Graphite is black and is opaque.
4. Diamond is a non-conductor of heat and electricity.	4. Graphite is a good conductor of heat and electricity.
5. Diamond occurs as octahedral crystals.	5. Graphite occurs as hexagonal rings.

Q. 9 Write a short note on Fullerenes.

Ans. Fullerenes are a class of carbon allotropes. They are spherical in shape and contain even no. of carbon atoms ranging from 60 to 350. The C_{60} fullerene is the most stable and was first to be identified. It contains 60 carbon atoms which are arranged in the shape of a foot ball, therefore it is also called as bucky ball.

These allotropes look like geodesic domes designed by the US Architect Buckminster Fuller, they are called as Buckminster fullerenes. Buckminster fullerene is dark solid at room temp. The properties of fullerene lie between diamond and graphite.

Compounds of Carbon.

The compounds of carbon can be classified into two categories.

1, Inorganic compounds 2, Organic Compounds

1, Inorganic Compounds:- These are the compounds of carbon with metals and non-metals (other than hydrogen). These do not have carbon- carbon bonds in them., these compounds are generally obtained from mineral sources. e.g. Salt from Sea, metal oxides from soils etc.

2. Organic compounds:- These are the compounds of carbon and hydrogen and their derivatives. These contain carbon – carbon bonds. Organic compounds are mostly derived from living organisms e.g. sugar from sugarcane, oils from vegetables, proteins from eggs etc.

Q.10. What are Hydrocarbons? Give the types of hydrocarbons.

Ans. The compounds containing only carbon and Hydrogen are called hydrocarbons i.e.

Carbon + Hydrogen ⟶ Hydrocarbon

e.g. methane (CH_4), ethane (C_2H_6), Ethene (C_2H_4), . The natural source of hydrocarbons is petroleum and natural gas. Both petroleum and natural gas occurs deep inside the earth. Hydrocarbons are regarded as parent organic compounds and all other organic compounds are considered the derivatives of hydrocarbons.

There are two main types of hydrocarbons.

1. Saturated Hydrocarbons.
2. Unsaturated Hydrocarbons.

1) **Saturated Hydrocarbons:-** The hydrocarbons in which all carbon atoms are bonded to each other by single covalent bonds are called as saturated hydrocarbons. Saturated hydrocarbons are also called as alkanes or paraffins. The general formula of alkanes is $C_n H_{2n+2}$ where n= 1,2,3…....

e.g. If n = 1, the alkane is $C_1H_{2(1)+2} = CH_4$ (methane)

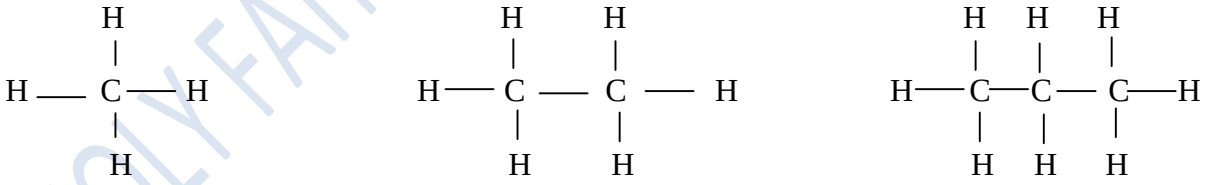
if n = 2, $C_2H_{2x2+2} = C_2H_6$ (ethane)

If n = 3 , $C_3H_{2x3+2} = C_3H_8$ (Propane)

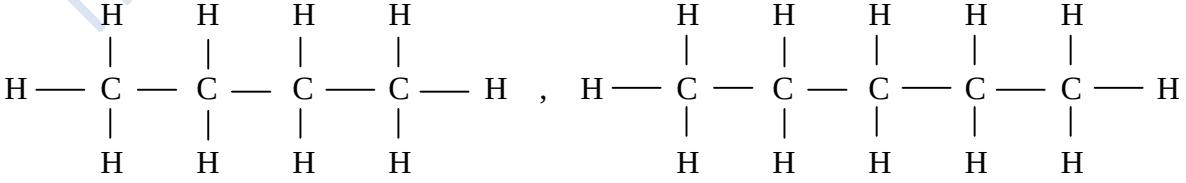
If n = 4, C_4H_{10} (Butane)

If n = 5, C_5H_{12} (Pentane)

Their structural formulae are as follows:-



(Methane) **(Ethane)** **(Propane)**



Butane **Pentane**

Any successive members of alkane differ by CH_2 unit. CH_2 unit is called methylene group.

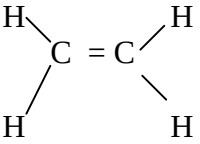
Unsaturated Hydrocarbons:-

The hydrocarbons which contains double (=) or triple (≡) bonds between carbon atoms are called unsaturated hydrocarbons. Unsaturated hydrocarbons are of two types.

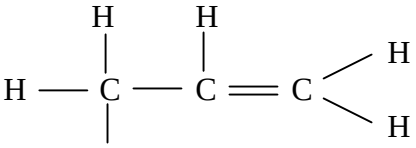
(i) Alkenes:- Unsaturated hydrocarbons containing double bond between carbon atoms are called as alkenes. Alkenes are also called as olefins. The general formula of alkenes is $C_n H_{2n}$, where n = 2,3, 4……. e.g.

If n = 2 , $C_2 H_{2x2}$ = C_2H_4 Ethene
If n = 3 , $C_3 H_{2 x 3}$ = $C_3 H_6$ Propene
If n = 4 , $C_4 H_{2 x 4}$ = $C_4 H_8$ Butene

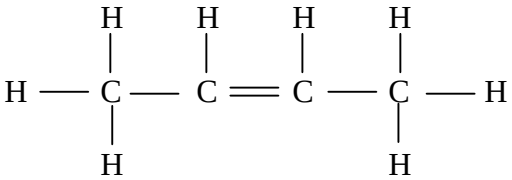
Their structural formulae are:



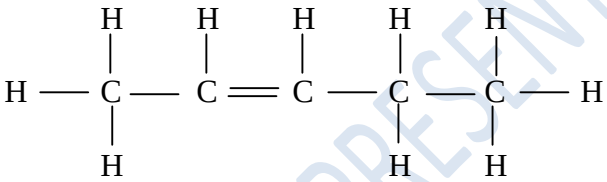
Ethene



Propene



Butene



Pentene

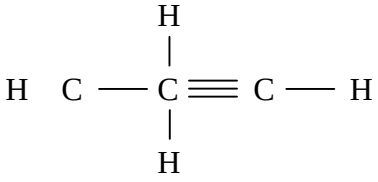
(ii) Alkynes: Unsaturated hydrocarbons containing triple bonds between carbon atoms are called as alkynes. The general formula of alkynes is CnH_{2n-2} . Where n = 2, 3, 4, 5…….

If n = 2, $C_2H_{2x2} - 2 = C_2H_2$ ethyne
If n = 3, $C_3H_{2x3} - 2 = C_3H_4$ propyne
If n = 4, $C_4H_{2x4} - 2 = C_4H_6$ butyne
If n = 5, $C_5H_{2x5} - 2 = C_5H_8$ Pentyne

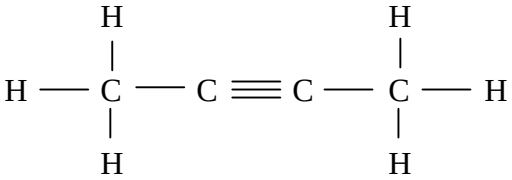
There structure formulae are as follows :

(I)

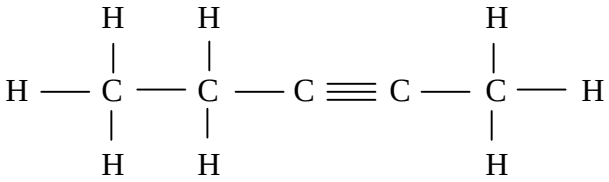
Ethyne



Propyne



Butyne



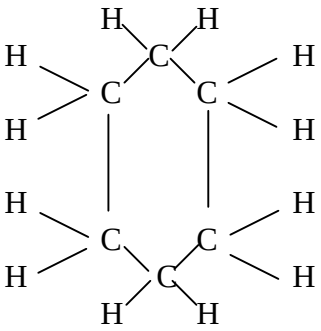
Pentyne

Cyclic Hydrocarbons:-

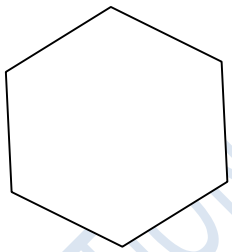
The hydrocarbons in which carbon atoms are arranged in a ring are called as cyclic hydrocarbons. The cyclic hydrocarbons can be saturated or unsaturated.

a) Saturated cyclic hydrocarbons :- Cyclohexane with molecular formula C_6H_{12} is a saturated cyclic hydrocarbon.

Its structural formula is

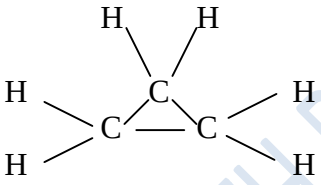


OR

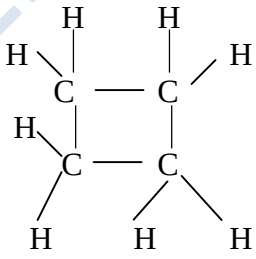


Cyclohexane

Similarly other cyclic hydrocarbons are,

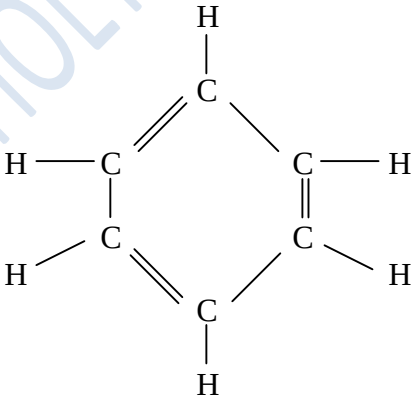


Cyclo Propane

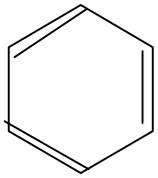


Cyclo butane

b) Unsaturated cyclic hydrocarbons:-Benzene is a well known unsaturated cyclic hydrocarbon its molecular formula is C_6H_6. Its structural formula is:-



Or



cyclo hexene or benzene

Q) What is covalent bond? Give different types of covalent bond?

Covalent bond:- The chemical bond formed by mutual sharing of electrons between two atoms in order to acquire stable nearest noble gas electronic configuration is called covalent

bond. The two combining atoms may be similar or dissimilar atoms. The difference between the electro negativities of the combining atoms should be either zero or very small. The compounds which contain covalent bonds are called covalent compounds. The covalent bond is generally formed between two non-metallic elements. The shared pair of electrons becomes the property of both the bonded atoms. For example,

$H\bullet + \bullet H \longrightarrow H \bullet\bullet H$. Or $H — H$

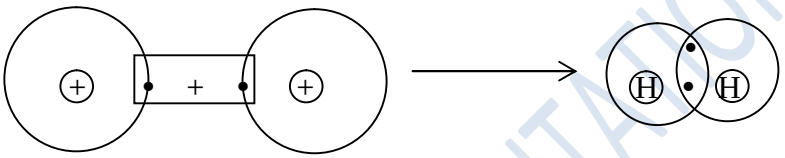
Depending upon the number of electron pairs shared between the two bonded atoms, covalent bond is of three types:-

1. Single covalent bond
2. Double covalent bond
3. Triple covalent bond.

1. **Single Covalent Bond:-** Single covalent bond is formed by sharing of one electron pair between the two atoms. Example.

Formation of Hydrogen. (H_2) molecule:

Hydrogen atom has one electron in its shell. In order to attain electronic configuration of He, it shares its electron with another hydrogen atom. Thus there is a single covalent bond between two hydrogen atoms

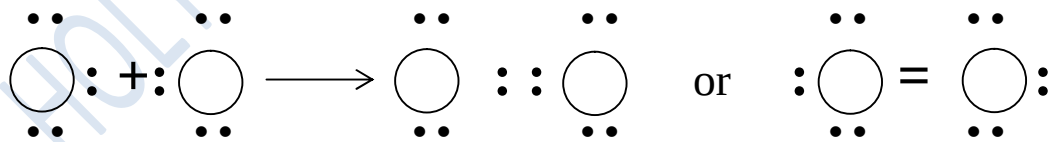


$H\bullet + \bullet H \longrightarrow H{:}H$ Or $H — H$

2) Double covalent bond:- Double covalent bond is formed by sharing of two electron pairs between two atoms in which each atom contributes two electrons. It is represented by putting two short (=) lines between two atoms. e.g.

Formation of oxygen (O_2) molecule:

Oxygen atom has six electrons in its outer most shell. It needs two electrons to complete its octet and attain configuration of neon. Hence, two oxygen atoms combine by sharing two pairs of electrons between them.



2,6 2,6 2,8 2,8

.

3) **Triple covalent bond:-** Triple covalent bond is formed by sharing of three electron pairs between two atoms in which each atom contributes three electrons. It is represented by three short lines between two atoms, e.g.

Formation of nitrogen (N_2) molecule:

Nitrogen atom has five electrons in its outer most shell. It needs three electrons to complete its octet and attain the configuration of the inert gas neon. Hence, two nitrogen atoms combine by sharing of three pairs of electrons between them and form N_2 having triple covalent bond between two nitrogen atoms.

:N⋮ ⋮N: ⟶ :N⋮⋮N: or N ≡ N

2,5 2,5 2,8 2,8

Q. Define Homologous series. Give its characteristics.

Ans. A Homologous series may be defined as a family of organic compounds having similar functional group and same chemical properties. Homologous series of alkanes is given below.

Alkane	**Molecular formula**
Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}
Pentane	C_5H_{12}
Hexane	C_6H_4

Characteristics of homologous series.

1) All the members of Homologous series can be represented by a general formula e.g. alkanes by $C_n H_{2n+2}$.
2) Any two adjacent members of a homologous series differ from each other by one carbon and two hydrogen atoms i.e. CH_2 group, by a mass number of 14 units.
3) All the members of a homologous series show similar chemical properties.
4) All the members of a homologous series have the same functional group.
5) The members of a homologous series show a gradation in physical properties.

Q. Discuss the nomenclature of various classes of organic compounds.

Ans:- IUPAC system of Nomenclature:- According to IUPAC system, the name of an organic compound consists of three parts.

(i) Word root (ii) Suffix (iii) Prefix.

(i) **Word root** denotes the number of carbon atoms present in the principal chain, which is the longest chain of carbon atoms.

Chain Length	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Word Root	Meth	Eth	Prop	But (a)	Pent (a)	hex (a)	Hept (a)

C8	C_9	C_{10}	C_{11}	C_{12}
Oct (a)	Non (a)	Dec (a)	Undec (a)	Dodec (a)

Where $C_1, C_2, C_3, \ldots\ldots\ldots\ldots\ldots$ represents no. of carbon atoms in the chain.

Note:- Extra 'a' given the parenthesis is used only if the primary suffix to be added to the word root start with a consonant.

(ii) **Suffix** (a) **Primary Suffix**… indicates type of bonds. If carbon atoms are linked with single bonds, the primary suffix is 'ane'.
If by double bond the Primary suffix is 'ene'.
If in triple bond the Primary suffix is 'yne'

(a) Secondary suffix is used to represent the functional group and is attached to primary suffix while writing its IUPAC Name.

(Note:- While adding a secondary suffix to the primary suffix the terminal 'e' of the primary suffix. ane, ene, yne, is replaced by secondary suffix)

(iii) **Prefix:-** Certain characteristics group are not considered functional groups, these are regarded as substituents such as –F, -Cl, -Br, -I etc. Writing the IUPAC name of an aliphatic compound.

Primary prefix + Word root + Primary suffix + Sec. Sufix IUPAC Name

---

$CH_3 – CH_2 – CH_3$	X	prop	ane	X	Propane
$CH_3 – CH – CH_2$	X	prop	ene	X	propene
$CH \equiv CH$	X	eth	yne	X	ethyne
$Cl – CH_2 – CH_2 – CH_3$ chloropropane	chloro	prop	ane	X	
$Cl – CH_2 – CH = CH_3$ chloropropene	chloro	prop	ene	X	
$CH3 – CH_2 – CH_2 – OH$	X	prop	ane	01	propanol
$Cl\ CH_2 – CH – CH_2 – OH$ propanol	chloro	prop	ane	01	chloro
$Cl\ CH – CH – CH_2 – OH$ propenol	chloro	prop	ene	01	chloro

It is not necessary that all of them may be present in a particular compound.

Q Discuss the nomenclature of different classes of organic compounds.

Ans. The nomenclature of different classes of organic compounds is discussed below:-

1) Alkanes:- General formula C_nH_{2n+2} where n = 1,2,3……
suffix = ane, names word root = Alk, suffix = ane = alkane

2) Alkenes:-
General formula : $C_n\ H_{2n}$ Where n = 2,3,4 ……
Functional group : C = C (carbon- carbon double bond))
Suffix : ene
Names:- Replace the terminal "ane" of the corresponding alkane by suffix "ene".
The position of double bond is indicated by lowest possible integer. e.g.

n	Formula	Name
2	$CH_2 = CH_2$	ethene
3	$CH_3 – CH = CH_2$	propene
4	$CH_3 – CH = CH – CH_3$	2- butene
4	$CH_2 = CH – CH_2 – CH_3$	1- butene
4	$CH_3 – CH – CH_2 = CH_2$	1- butene

3. Alkynes:-

General formula = $C_n H_{2n-2}$ Where n = 2, 3, 4, …….

Functional group : - C ≡ C -(carbon – carbon triple bond.)

Suffix : yne.

Name : Replace the terminal "ane" of the corresponding alkane by suffix "eye"

Indicate the position of triple bond by lowest possible integer.

e.g.

n	Formula	Name
2	H-C≡ CH	ethyne
3	H C ≡ C – CH_3	propyne
4	CH ≡ C – CH_2 – CH_3	1 – butyne.
4.	CH_3- C ≡C – CH_3	2- butyne.
4	CH_3 – CH_2 – C ≡ CH	1- butyne

4. Halo alkanes or alkyl halides.

General formula = RX, when R=Cn H_{2n+1} with n = 1,2,3….. & X = F, Cl, Br, I)

Functional group : F, Cl, Br, I.

Prefix : Floro, chloro, Bromo, Iodo for F, Cl, Br, I respectively.

Name : - Add the prefix halo (Fluro, Chloro Bromo, Iodo,) to the parent alkane. Also indicate the position of functional group (F, Cl Br, I) by lowest integer.

e.g.

n	Formula	Name
1 (X=Cl)	CH_3 –Cl	Chloromethane
2 (X=Cl)	CH_3-CH_2- Cl	Chloro ethane
3 (X=F)	CH_3 – CH_2 – CH_2- F	1- Floro propane
	Br	
	|	
3 (X=Br)	CH_3 - CH - CH_3	2- Bromo propane.
4 (X=I)	I – CH_2 – CH_2 – CH_2 – CH_3	1 – Iodio butane
4 (X=F)	CH_3 – CH – CH_2 – CH_3	2 – Fluoro butane
	|	
	F	

5. Alcohols:-

General formula : R – OH (Where R= C_nH_{2n+1} & n = 1,2,3……)

Functional group : OH (Hydroxyl)

Suffix : ol

Name : Replace last 'e' of parent alkane by 'ol'

n	Formula	Name
1	CH_3 –OH	Methanol
2	CH_3-CH_2- OH	ethanol
3-	CH_3 – CH_2 – CH_2- OH	1-propanol
	OH	
	|	
3	CH_3 - CH - CH_3	2- Propanol .
4	CH_3 – CH_2 – CH_2 – CH_2 OH	1-butanol
	OH	
	|	
4	CH_3 – CH_2 – CH – CH_3	2- butanol

6. Aldehydes:-

General formula : RCHO

(where R : C_nH_{2n+1} and n = 0,1,2,3,4……)

Functional group : $-\overset{\overset{O}{\|}}{C}-H$ (aldehyde)

Suffix : al

Name : Replace last 'e' of 'parent alkane' by 'al'

n	formula	name
0	$H-\overset{\overset{O}{\|}}{C}-H$ / HCHO	methanal
1	$CH_3-\overset{\overset{O}{\|}}{C}-H$ / CH_3CHO	ethanal
2	$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-H$ O	propanal

7. Ketones:- $-\overset{\overset{O}{\|}}{C}-$

General formula : $R-\overset{\overset{O}{\|}}{C}-R'$ (Where R = Cn H_2n + 1 and

R′ = Cn′ H_2n′ +1 and n = 1,2,3, and

n′ = 1,2,3, also n & n′ may be same or different.)

Functional group : $\overset{\overset{O}{\|}}{C}$ (Ketone)

Suffix = one

Name = Replace last 'e' of 'ane' by 'one'

e.g.

n	n′	Formula	Name
1	1	$CH_3-\overset{\overset{O}{\|}}{C}-CH_3$	2 – Propanone
2	1	$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_3$ Or $CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$	2 – Butanone
2	2	$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$	3- Pentanone
3	1	$CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-CH_3$ Or $CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-CH_3$	2 – Pentanone

8. Carboxylic acids:

General formula : RCOOH where R=Cn H_2n + 1, Where n = 0,1,2 …….

Functional group : $-\overset{\overset{O}{\|}}{C}-OH$ (carboxyl)
Suffix : oic acid
Name = Replace last 'e' of alkane by 'oic acid'

n	Formula	Name
0	$H-\overset{\overset{O}{\|}}{C}-OH$	Methanoic acid
1	$CH_3-\overset{\overset{O}{\|}}{C}-OH$	Ethanoic acid
2	$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-OH$	Propanoic acid
3	$CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-OH$	Butanic acid

Q. Discuss some important chemical properties of carbon compounds.

Ans. Some of the important chemical properties of carbon compounds (Hydrocarbon) are discussed as follows:-

1. Combustion:- The process of burning of a carbon compound in air to give carbon dioxide, water, heat and light is known as combustion. Most of the carbon compounds burn in air to produce a lot of heat. e.g. alkanes burn in air to produce a lot of heat, hence are excellent fuels.

When methane burns in sufficient supply of air then carbon dioxide and water vapours are formed with the evolution of large amount of heat.

$$\underset{\text{Methane}}{CH_4} + \underset{\text{Oxygen}}{2O_2} \xrightarrow{\text{Combustion}} CO_2 + 2H_2O + \text{heat} + \text{Light}$$

Saturated hydrocarbons (alkanes) generally burn in air with blue (non- sooty flame.) This is because the percentage of carbon in alkanes is comparatively low- which gets completely oxidized.

Unsaturated hydrocarbons (alkenes and alkynes) burn in air with a yellow sooty flame. This is because the percentage of carbon in alkenes and alkynes is comparatively high.

2. Oxidation Reaction:- Addition of oxygen to any substance is called as oxidation and the substance which is capable of adding oxygen to other substances is called as oxidizing agent. Thus, the reaction in which oxygen is added to any substance is known as oxidation reaction.

e.g.

When alcohol is treated with acidified potassium dichromate or alkaline potassium permanganate, it gets oxidized to carboxylic acids.

$$\underset{\text{ethanol}}{CH_3-CH_2-OH} + 2[O] \xrightarrow[\text{acidified } K_2Cr_2O_7]{\text{alkaline } KMnO_4} \underset{\text{Ethanoic acid.}}{CH_3\overset{\overset{O}{\|}}{C}-OH} + H_2O$$

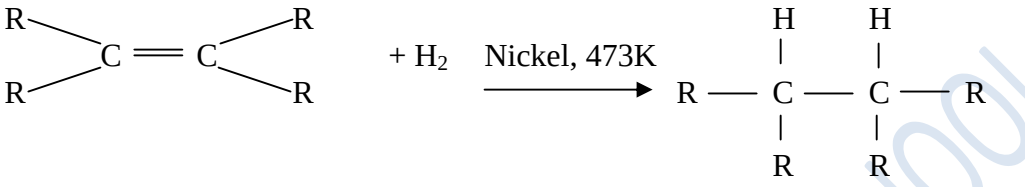
3. Addition Reactions:-

Reactions which involve addition of two reactants to form a single product are called addition reactions.

Due to presence of double and triple bonds , unsaturated hydrocarbons are more reactive and hence add hydrogen in presence of a catalyst such as nickel, platinum or palladium to form saturated hydrocarbons. This process is called as catalytic hydrogenation.

e.g. $CH_2 = CH_2 + H_2 \longrightarrow CH_3 - CH_3$

ethane ethane



Unsaturated hydrocarbon Saturated Hydrocarbon

Where R = CH_3, C_2H_5, C_3H_7 etc.

4. Substitution reaction:-

Reactions which involve the direct replacement (displacement) of an atom or a group of atoms in an organic molecule by another atom or group of atoms without any change in the rest of the molecule are called as substitution reactions. Substitution reaction is an important property of saturated hydrocarbons (alkanes) e.g. saturated Hydrocarbons in presence of heat and light react with chlorine to form substitution products. e.g.

$CH_4 + Cl_2 \xrightarrow[520 - 670k]{\text{Sun light}} CH_3Cl + HCl$

Methane Chlorine Chloro methane

$CH_3Cl + Cl_2 \longrightarrow CH_2Cl_2 + HCl$

Dichloromethane

Q. Give a detailed account of ethanol (C_2H_5OH).

Ans. Ethanol is the second member of the homologous series of alcohols. The chemical formula of ethanol is C_2H_5OH. The common name of ethanol is ethyl alcohol and is most common and most widely used.

Physical properties of alcohol.

Some of the physical properties of ethanol are described below.

1) Ethanol is a colourless liquid at room temp. its freezing point is 156K while its boiling point is 351K.
2) It has a distinct smell and a burning taste.
3) Ethanol is soluble in water.
4) It is lighter than water.
5) It has no effect on litmus paper.

Chemical properties of ethanol.

1) **Reaction with sodium:-**

Ethyl alcohol is weakly acidic in nature. It evolves hydrogen with active metals like sodium.

$2C_2H_5OH + 2Na \longrightarrow 2C_2H_5ONa + H_2$

Ethanol Sodium Sodium ethoxide

2) **Combustion reaction:-**

It burns in air to form CO_2 and water vapour.

$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O + \text{Energy}$

Ethanol

3) Oxidation reaction:-

Ethanol when heated with alkaline potassium permanganate solution or acidified potassium dichromate solution, it gets oxidized to ethanoic acid.

$$CH_3 - CH_2 - OH + 2\ [O] \xrightarrow[\text{or acidified}\ K_2 cr_2 O7]{\text{Alkaline KMnO}} CH_3COOH + H_2O$$

Ethanol nascent oxygen

4) Dehydration reaction:-

Ethanol when heated with concentrated sulphuric acid at 170^{o}C, it gets dehydrated to form ethane.

$$CH_3 - CH_2 - OH \xrightarrow[170\ oC]{\text{Conc. } H_2SO_4} CH_2 = CH_2 + H_2O$$

Ethanol (Dehydration) Ethene Water

5) Reaction with ethanoic acid:-

Ethanol reacts with ethanoic acid on warming in presence of H_2SO_4 to form ester.

$$CH_3COOH + C_2H_5OH \longrightarrow CH_3COOC_2H_5 + H_2O$$

Ethanoic acid Ethanol Ester

The reaction in which a carboxylic acid combines with an alcohol to form an ester is called as **esterfication reaction**. In this reaction concentrated H_2SO_4 acts as dehydrating agent.

Uses:-

1) Ethanol is used in the manufacture of paints, varnishes, medicines, perfumes, dyes, soaps and synthetic rubber.
2) Ethyle alcohol is used in alcoholic drinks like whiskey, beer etc.
3) It is used as an antiseptic to sterilize the wounds.
4) Ethyl alcohol is used as a fuel in cars and spirit lamps.
5) It is used in medicines such as tincture iodine, cough syrups, and many tonics.
6) Ethanol is used as a solvent for many organic compounds.

Q) What are harmful effects of drinking alcohol?

Ans.

1) Alcohol drinking leads to increased road accidents as it effects the nervous system and the person loses the judgment.
2) Alcohol drinking leads to quarrels and fights which increases the violence and crime in society. This is because alcohol drinking lowers the mental restrain.
3) Alcohol drinking leads to staggered movement, unclear speech, blurred vision, dizziness and vomiting.
4) Alcohol drinking makes a person financially bankrupt.
5) Alcohol drinking for longer periods damages the stomach, liver, heart, brain and ultimately causes death.
6) Adulterated alcohol drinking causes severe poisoning leading to blindness and even death.

Q) Write a short note on denatured alcohol.

Ans. A lot of alcohol is used in industries for manufacturing various products. This alcohol is much cheaper than the alcohol available in markets, as it is supplied to the industries tax free. To avoid its miss use, some poisonous substances such as methyle alcohol etc are added to it which make it unfit for drinking purposes. Such alcohol which has been made unfit for drinking is called denatured alcohol.

Q) Give a detailed account of ethanoic acid (or acetic acid)?

Ans) Ethanoic acid is the second member of the homologous series of carboxylic acids. The chemical formula of ethanic acid is CH_3COOH. The common name of ethanoic acid is acetic acid. A dilute solution of ethanoic acid in water is called vinegar.

Q) Preperation of acetic acid

Ans) A 10 – 12% solution of ethyle alcohol is fermented in presence of enzyme acetobacter and air at 30^0 to 35^0.

$$\underset{\text{Ethanol}}{CH_3 - CH_2 - OH} + O_2 \xrightarrow{\text{acetobacter}} \underset{\text{acetic acid}}{CH_3COOH} + H_2O$$

Physical properties of acetic acid:

1) It is colourles, pungent smelling corrosive liquid. It has a sour taste.
2) Its boiling point is 118^0C.
3) It is soluble in water.
4) Having low melting point (17^0C) it often freezes in winter in cold climates to form ice like solid, this gave rise to its name glacial acetic acid.

(1) Chemical properties:

1) Acetic acid being acidic in nature turns blue litmus into red in colour.

(2) Reaction with alcohols:

Ethanoic acid reacts with ethanol in presence of conc. H_2SO_4 as catalyst to form an ester.

$$\underset{\substack{\text{Ethanoic}\\\text{Acid}}}{CH_3COOH} + \underset{\text{ethanol}}{C_2H_5OH} \xrightarrow{\text{conc. } H_2SO_4} \underset{\substack{\\\text{ester}}}{CH_3 - \overset{\overset{O}{\|}}{C} - O - CH_2 - CH_3} + H_2O$$

(3) Reaction of ethanoic acid with a base

Ethanoic acid reacts with a base such as sodium hydroxide (NaOH) to give (sodium acetate) salt and water.

$$\underset{\text{Ethanoic acid}}{CH_3COOH} + NaOH \longrightarrow \underset{\text{sodium acetate}}{CH_3COONa} + H_2O$$

(4) Reaction with carbonates and bicarbonates

Ethanoic acid reacts with sodium carbonate and sodium bicarbonate to form sodium acetate, carbon dioxide and water.

$$2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + CO_2 + H_2O$$
$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + CO_2 + H_2O$$

Uses

1) Dilute ethanoic acid (vinegar) is used as a food preservative in the preparation of pickles and sauces.
2) Ethanoic acid is used for making cellulose acetate which is an important artificial fibre.
3) Ethanoic acid is used in the preparation of propanone and esters used in making perfumes and flavouring agents.
4) Ethanoic acids is used in the preparation of dyes, plastics and pharmaceuticals.
5)

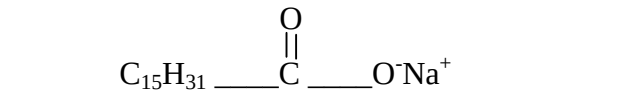
Q) What are soaps? Give their structure and preparation?

Ans) Soap is a cleansing agent. There are several cleansing agents but soaps are very popular cleansing agents which have been used for more than two thousand years.

Structure

Soaps consist of two parts:

1) A long hydrocarbon chain, which is hydrophobic (water repelling). It is called non-polar tail.
2) An ionic part which is hydrophilic (water attracting). It is called polar head.



Long hydrocarbon Chain (water repelling) — ionic part (water attracting)

sodium palmitate

Preparation

Soaps are made from animal fats or vegetable oils. Fats and oils are esters of higher fatty acids and glycerol.

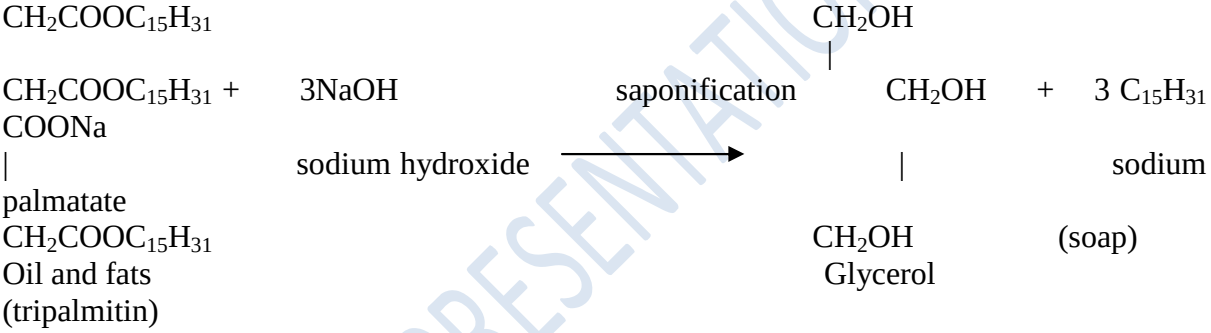
When fats and oils are heated with sodium hydroxide (NaOH) solution they split to form sodium salt of higher fatty acid called as soap and glycerol as byproduct.

Fats or oil (an ester) + sodium hydroxide (alkali) $\xrightarrow{\text{heat}}$ soaps (sodium salt of fatty acids) + glycerol (alcohol)

The process of making soap by the hydrolysis of fats and oils with alkalies is called saponification.

e.g. $CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$

ethyl ethanoate — sodium acutate

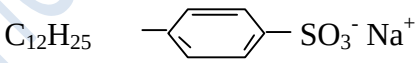


Oil and fats (tripalmitin) — Glycerol

Q) What are Synthetic detergents?

Ans) A synthetic detergent is the sodium salt of long chain benzene sulphonic acid which has cleansing properties in water. Synthetic detergents are called as soapless soaps because though they act like a soap in having the cleansing properties but they do not contain the usual soap molecule like sodium stearate etc. e.g. sodium n-dodecyle benzene sulphonate. Synthetic detergents are better cleansing agents than soaps because they do not form insoluble calcium and magnesium salts with hard water and therefore it can be used for washing even in hard water synthetic detergent have structures similar to that of soaps. e.g.

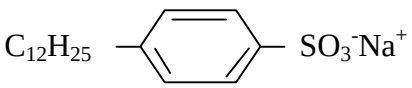
(i) Sodium n – dodecyl benzene sulphonate



It also consists of two parts.

(i) A long hydrocarbon chain, hydro phobic (water repelling) in nature called as non-polar tail.

(ii) An ionic part hydrophilic (water attracting) in nature called as polar head.



Non-polar tail (hydrophobic) — polar hard (hydrophilic)

Synthetic detergents are made from long chain hydrocarbons obtained from petroleum and these are made from by-products of oil refining and so are petroleum based.

The washing powders available in the markets contain about 15 – 30% detergents by weight. The remaining part of washing powders contain other chemicals which are added to impart it other desired properties, e.g. a mild bleaching agent such as sodium perborate is added to washing powders to produce whiteness in clothes.

Q. Write the advantages of synthetic detergents?

Some of the advantages of synthetic detergents over soaps are:

(i) Synthetic detergents can be used for washing even in hard water.

(ii) Synthetic detergents can be used even in acidic solutions.

(iii) Synthetic detergents have higher solubility than that of soaps.

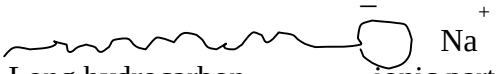
(iv) They have better cleansing action.

Q) Write a note on cleansing action of soaps and detergents?

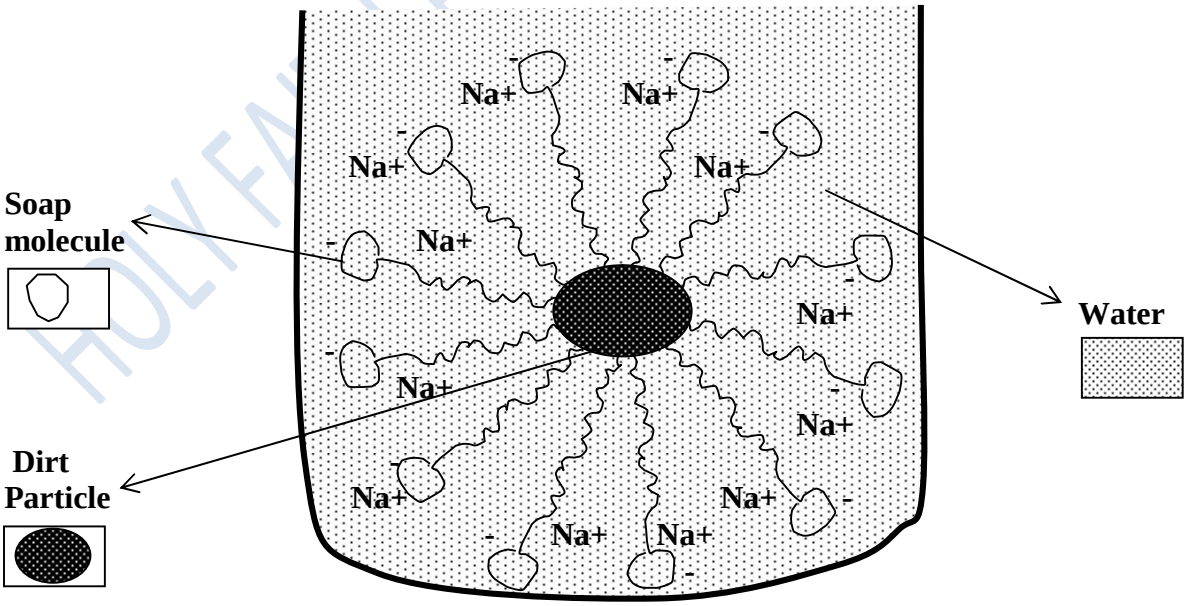
Ans) Soaps are sodium or potassium salts of higher fatty acids. e.g. sodium palmitate, $C_{15}H_{31}COO^{-}Na^{+}$. A soap molecule consist of two parts:-

i) A long chain hydrocarbon non-polar part ($C_{15}H_{31}$) which is soluble in oil or grease.

ii) Ionic part or polar part ($-COO^{-}Na^{+}$) which is soluble in water. A molecule of soap can be represented as:



When soap molecules dissociate in water, they give rise to carboxylate ion ($RCOO^{-}$) and cation (Na^{+}). When soap is added to dirty clothes, dipped in water, the hydrocarbon part of the carboxylate group dissolves in greasy or oily dirt parts while the polar (COO^{-}) group remains attached to water and result in the formation of micelles. These micelles can not coalesce and hence form stable emulsion in water. These small droplets along with dirt can be easily washed away with water. Thus, soap helps in removing greasy dirt by producing a stable oil in water type emulsion.



Cleansing action of soap

Q) Difference between soaps and detergents?

Ans) The main points of difference between soaps and detergents are given below:

Soaps	Detergents
1) Soaps are sodium salt of long chain fatty acids	1) Detergents are sodium salt of long chain alkyl sulphates
2) They can not be used in acidic solutions.	2) They can be used even in acidic solutions.
3) Soaps are prepared from animal fat or vegetable oil.	3) Detergents are prepared from hydrocarbon of petroleum.
4) Soaps are not suitable for washing purpose when water is hard.	4) Synthetic detergents can be used for washing even when water is hard.
5) Soaps are biodegradable.	5) Some of the detergents are non-biodegradable.
6) Soaps have relatively weak cleansing action.	6) Synthetic detergents have a strong cleansing action.

Q) What are the limitations (disadvantages) of soaps?

Ans) Soaps are not suitable for washing clothes with hard water because of the following reasons:

1) Hard water contains salts of calcium and magnesium i.e. bicarbonates, chlorides and sulphates of calcium and magnesium when soap is added to hard water, these calcium and magnesium ions of hard water form insoluble greasy scum or ppt. with soap which sticks to the cloth and makes it dull. This makes cleansing of clothes difficult.
2) Soap is not suitable in acidic solutions. Since in acidic solutions free fatty acids are obtained which are not effective as cleansing agents. So washing has to be done in alkaline medium.

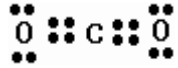
Textual questions

Q.1) What would be the electron dot structure of carbon dioxide which has the formula CO_2?

Ans) The distribution of electrons in carbon and oxygen is represented as:

Carbon		Oxygen	
K = 2	L = 4	K = 2	L = 6

Valency of carbon is 4 and that of oxygen is 2, therefore carbon atom shares its four valence electrons with two oxygen atoms. Thus the electronic dot structure of CO_2 is as:

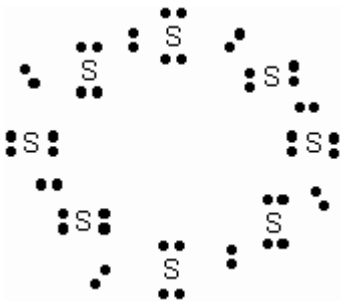


Q.2) What would be the electron dot structure of a molecule of sulphur, which is made up of eight atoms of sulphur? (Hint – The eight atoms of sulphur are joined together in the form of a ring.)

Ans) Sulphur has atomic no. 16. Its electronic configuration is

K	L	M
2	8	6

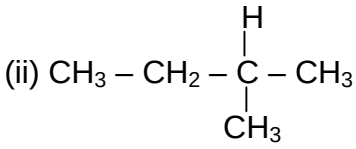
Since sulphur atom is short of two electrons so as to complete its octet. Therefore, each sulphur atom shares two valance electrons with two neighboring sulphur atoms and an eight membered ring is formed.

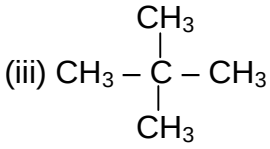


Q.3) How many structural isomers can you draw for pentane?
Ans)

we can draw three structural isomers for pentane

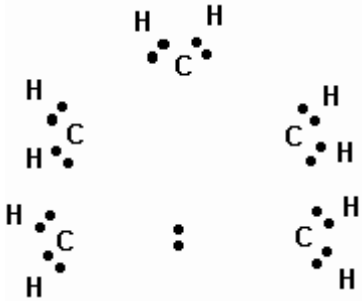
(i) $CH_3 - CH_2 - CH_2 - CH_2 - CH_3$ **n- pentane**

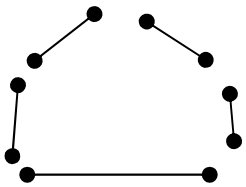
(ii)  **iso-pentane**

(iii)  **neo-pentane**

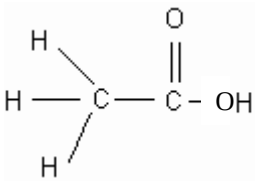
Q.4) What are the two properties of carbon that lead to the huge number of carbon compounds we see around us?
Ans) The two properties of carbon responsible for existence of huge number of carbon compounds are (i) Catenation (ii) Small size and tetra valency of carbon.
(i) Catenation: The property of forming bonds with atoms of the same element is called catenation (self linking property). Carbon shows maximum tendency for catenation in the periodic table. This is because of strong carbon – carbon bonds as compared to other atoms. It is due this property that organic compounds have long chain, branched chains and ring structure of carbon atoms, which is one of the reasons for existence of large number of organic compounds.
(ii) Tetra valency and Small size :- Due to its tetra valency, carbon atoms can form covalent bonds with four other carbon atoms or with a large number of other atoms such as hydrogen, oxygen, nitrogen, sulphur, chlorine and other more atoms.
Due to its small size, carbon forms multiple bonds with other carbon atoms or with oxygen and nitrogen. The reason for the formation of strong bonds by carbon with other elements is its small size. Thus tetra valency together with small size of carbon is the another reason for existence of large number of organic compounds.
Q.5) What will be the formula and electron dot structure of Cyclopentane?
Ans) In cyclopentane each carbon atom shares its two valence electrons with two neighbouring carbon atoms and two valence electrons with two hydrogen atoms.
Formula of Cyclopentane is C_5H_{10}

Electron dot structure Cyclopentane is

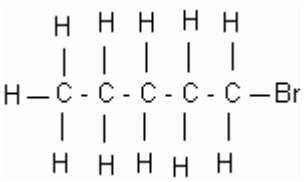




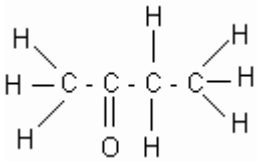
Q.6) Draw the structures for the following compounds.
i. Ethanoic acid ii. Bromopentane iii. Butanone iv. Hexanal
Ans)



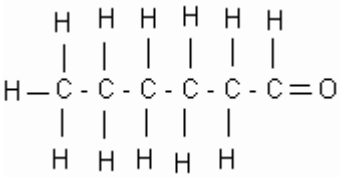
i. Ethanoic acid



ii. Bromopentane



iii. Butanone

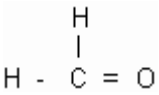


iv. Hexanal

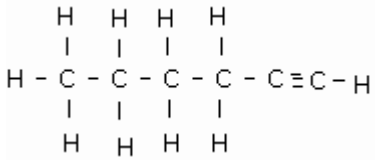
Q.7) How would you name the following compounds?

i. $CH_3 - CH_2 - Br$

1– bromo ethane

ii. 

Methanal

iii. 

1 – Hexyne

Q.8) Why is the conversion of Ethanol to Ethanoic acid an oxidation reaction?

Ans) The conversion of ethanol into ethanoic acid is called an oxidation reaction because oxygen is added to it during this conversion.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} + \underset{\text{Nascent Oxygen}}{2[O]} \xrightarrow{\text{alkaline KMno4}} \underset{\text{Ethanoic acid}}{CH_3COOH} + \underset{\text{Water}}{H_2O}$$

Q.9) A mixture of oxygen and ethyne is burnt for welding. Can you tell why a mixture of ethyne and air is not used?

Ans) When a mixture of oxygen and ethyne is burnt, it burns completely producing a blue flame. This blue flame is extremely hot which produces a very high temperature which is used for welding metals. But the mixture of ethyne and air is not used for welding purposes because burning of ethyne in air produces a sooty flame due to incomplete combustion, which is not too hot to melt metals for welding.

Q.10) What are oxidizing agents?

Ans) The substances which are capable of adding oxygen to other substances are called as oxidizing agents, e.g. alcohols are converted to carboxylic acids in presence of alkaline potassium permagnate or acidified potassium dichromate. In this reaction potassium permagnate and potassium dichromate act as oxidizing agents.

$$CH_3\,CH_2 - OH \xrightarrow{\text{alkaline KMno4 + heat}} CH_3\,COOH$$

Also oxidizing agents are the substances that gain electrons in a redox reaction and whose oxidation number is reduced.

Q.11) Explain the nature of the covalent bond using the bond formation of CH_3Cl.

Ans) The atomic numbers and the electronic configuration of C,H and Cl are given below.

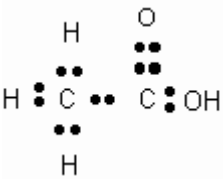
	Carbon	Hydrogen	Chlorine
	C	H	Cl
Atomic No.	6	1	17
K	K=2	K=1	K=2
L	L=4		L=8
			M=7

CH_3Cl(methyl chloride) is made up of one carbon atom, three hydrogen atoms and one chlorine atom. Carbon atom has 4 valence electrons, each hydrogen atom has one valence electron, and chlorine atom has 7 valence electrons. Carbon atom shares its four valence electrons with three hydrogen atoms and 1 chlorine atom to form methyl chloride as follows:

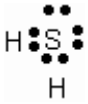
From the above reaction, in the dot structure of methyl chloride (CH_3Cl) there are four pairs of shared electrons between carbon and other atoms. Each pair of shared electrons constitutes one single covalent bond. So, methyl chloride has four single covalent bonds.

H
|
H – C – Cl
|
H

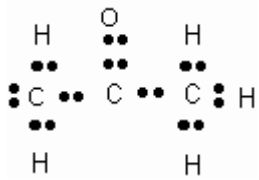
Q.12) Draw the electron dot structures for
i. Ethanoic acid ii. H_2S iii. Propanone iv. F_2
Ans)



i Ethanoic acid



ii. H_2S



iii. Propanone

iv. F_2

Q.13) How can ethanol and Ethanoic acid be differentiated on the basis of their physical and chemical properties?
Ans) (i) Ethanol has a pleasant smell whereas ethanoic acid has the smell of vinegar.
(ii) Ethanol has a burning taste whereas ethanoic acid has a sour taste.
(iii) Ethanol has no action on litmus paper whereas ethanoic acid turns blue litmus paper red.
(iv) Ethanol has no reaction with sodium hydrogencarbonate but Ethanoic acid gives brisk effervescence with sodium hydrogencarbonate.
(v) Alkaline potassium permagnate loses its colour in ethanol while as it retains its colour in ethanoic acid.

Q.14) Why does micelle formation take place when soap is added to water? Will a micelle be formed in other solvents such as ethanol also?
Ans) The soap consists of two parts (i) the organic tail or non polar part which is soluble in oil and greese and is insoluble in water. (ii) The polar part which is soluble in water and is insoluble in oil.

When soap is added to water, the ionic part dissolves in water while as non-polar part remains insoluble in water. Because of mutual repulsion of the ionic part of the soap molecules they achieve a unique orientation by forming a cluster of molecules. This cluster of molecules is called micelle. In this organic tail remains in the interior of the cluster and ionic ends are on the surface of the cluster.

15. Why are carbon and its compounds used as fuels for most applications?
Ans) Carbon and its compounds are used as fuels for most of the applications because they burn in air releasing a lot of heat energy.

Q.16) Explain the formation of scum when hard water is treated with soap.
Ans) The hard water contains calcium and magnesium ions. When water is treated with soap, the calcium and magnesium ions of water combine with soap molecules to form an insoluble precipate of calcium and magnesium salts of soap. This precipate formed by the action of soap with hard water is called scum.

Q.17) What change will you observe if you test soap with litmus paper (red and blue)?
Ans) Soap is the salt of a strong base (NaOH) and a weak acid (carboxylic acid), so a solution of soap in water is basic in nature. Being basic, a soap solution turns red litmus paper blue.

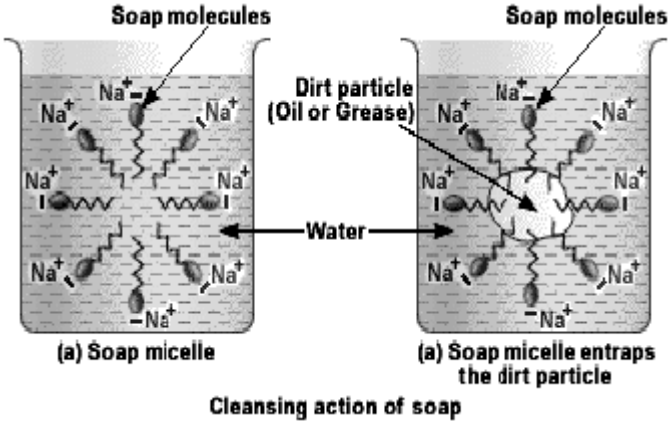
Q.18) What is hydrogenation? What is its industrial application?
Ans) Hydrogenation is a process in which unsaturated hydrocarbons are converted into saturated hydrocarbons by the addition of hydrogen in presence of a catalyst.
The process has a great industrial applications as it is used to convert vegetable oils to vanaspati ghee.
Vegetable oil + H_2 $\xrightarrow{\text{catalyst}}$ vanaspati ghee

Q.19) Which of the following hydrocarbons undergo addition reactions:
C_2H_5, C_3H_8, C_3H_6, C_2H_2 and CH_4
Ans) Alkenes and alkynes (unsaturated hydrocarbons) undergo addition reactions. From the above hydrocarbons C_2H_2 is an alkyne, whereas C_3H_6 is an alkene. So, C_3H_6 and C_2H_2 will undergo addition reactions.

Q.20) Give a test that can be used to differentiate chemically between butter and cooking oil.
Ans) Butter contains saturated compounds while as cooking oil contains unsaturated compounds. Since bromine water is decolourized by the addition of unsaturated compounds. Thus bromine water test can be used to differentiate chemically between butter and cooking oil. Add bromine water to a little of cooking oil and butter taken in separate test tubes.
a. Decolourising of bromine water by cooking oil shows it is a unsaturated compound.
b. Butter does not decolourise bromine water shows it is saturated compounds.

Q.21) Explain the mechanism of the cleaning action of soaps.
Ans) We all know that soap is used to remove dirt and grime from substances. Generally dirt and grime get stuck because they have an oily component, which is difficult to remove by plain brushing or washing by water. A soap molecule has two parts, a head and a tail i.e. the long chain organic part and the ionic part.
A soap molecule has a tadpole like structure shown below.

The organic part is water insoluble but is soluble in organic solvents or in oil or grease. The ionic part is soluble in water, as water is a polar solvent. When soap is added to water in which dirty clothes are soaked, the two parts of the soap molecule dissolve in two different media. The organic tail dissolves in the dirt, grime or grease and the ionic head dissolves in water. When the clothes are rinsed or agitated, the dirt gets pulled out of the clothes, by the soap molecule. In this way soap does its cleaning work on dirty and grimy clothes or hands.
The soap molecules actually form a closed structure because of mutual repulsion of the positively charged heads. This structure is called a micelle. The micelle pulls out the dirt and grime more efficiently.



Cleansing action of soap

Q.22) Would you be able to check if water is hard by using a detergent?
Ans) Detergents are generally ammonium or sulphonate salts of long chains of carboxylic acids. The charged ends of these compounds do not form insoluble precipitates with calcium and magnesium ions in hard water. Thus we would not be able to check whether a sample of water is hard by using a detergent, this is because a detergent forms lather easily even with hard water.

Q.23) People use a variety of methods of wash clothes. Usually after adding the soap, they 'beat' the clothes on a stone, or beat is with a paddle, scrub with a brush or the mixture is agitated in a washing machine. Why is agitation necessary to get clean clothes?
Ans) It is necessary to shake to get clean clothes because the soap micelles, which entrap oily or greasy particles on the surface of dirty clothes, have to be removed from their surface. When the clothes which are wet by soap solution are beaten, the micelles containing oil or greasy dirt particles get removed from the surface of dirty clothes and go into water and the dirty cloth gets cleaned.

EXTRA QUESTIONS

Q.1) A piece of black electrode used in dry cell on strong heating in air gave a colourless gas which turned lime -water milky. What was the material of the electrode?
Ans) We know that graphite is used for making the electrodes. So, the piece of black electrode used in the dry cell is made of graphite (which is an allotrope of carbon element). This is confirmed by the fact that the piece of electrode, on strong heating in air, gave a colourless gas, carbon dioxide which turned lime- water milky. As graphite on strong heating yields carbon dioxide. Thus, the material of the electrode is graphite.

Q.2) Why does graphite conducts electricity, but not diamond?
Ans) In case of diamond, each carbon atom of a single crystal is surrounded by four other carbon atoms by covalent bonds such that they form four corners of a regular tetrahedron. Because of four covalent bonds with each carbon atom there are no free electrons available. Due to the non-availability of free electrons within crystalline structure, diamond acts as a bad conductor of electricity.

In case of graphite, every carbon atom in a single crystal is covalently bonded to three carbon atoms. As each carbon atom has four valence electrons, one valence electron is left free for each carbon atom. These free electrons can be easily made to flow within the crystalline structure of graphite by applying electric potential. Thus, graphite is a good conductor of electricity.

Q.3) Write three important uses of ethanol.
Ans) The three important uses of ethanol are:
(i) Ethanol is used as a solvent to dissolve varnishes, medicines and other organic compounds
(ii) It is used as beverage (for drinking as an intoxicant) in different forms, viz; Brandy,

Whisky etc.,
(iii) It is used for industrial purposes in the name of denatured spirit.
(iv) It is used as a fuel in cars and spirit lamps.

Q.4) State what you will observe when sugar crystals is heated strongly. State what you will observe when sugar crystals is treated with conc. Sulphuric acid.
Ans) The sugar crystal will initially melt. Gradually, they turn brown and start swelling up. They give off large amount of steam. Finally black porous residue of carbon is left behind.
The sugar crystals will initially turn brown. Lot of frothing takes place with the evolution of large amount of heat and steam is given off. Finally a black porous residue of carbon is left behind.

Q.5) How are the molecules of aldehyde and Ketone structurally different?
Ans) In aldehyde, the carbon atom of the carbonyl group is attached to one alkyl group (R) and one hydrogen atom but in ketone, the carbonyl group is attached to two alkyl groups.

Q.6) What change has been made in the composition of detergents to make them biodegradable?
Ans) Branched chain detergents are generally non-degradable. Detergents made from long chain hydrocarbons having the minimum branching in their molecules are degraded more easily.

Q.7) A hydrocarbon molecule contains 4 hydrogen atoms. Give its molecular formula, if it is an: (i) alkane, (ii) alkene (iii) alkyne.
Ans) (i) An alkane containing 4 hydrogen atoms in its molecule is methane, CH_4.
(ii) An alkene containing 4 hydrogen atoms in its molecule is ethane, C_2H_4
(iii) An alkyne containing 4 hydrogen atoms in its molecule is propyne, C_3H_4.

Q.8) Why common salt is added in soap making?
Ans) Common salt is added to the mixture to make the soap come out of solution. Though most of the soap separates out on its own but some of it remains in solution. Common salt is added to precipitate out all the soap from the aqueous solution. Actually, when we add common salt to the solution, then the solubility of soap present in it decreases, due to which all the soap separates out from the solution in the form of a solid.

Q.9) What is meant by denatured alcohol? What is the need to denature alcohol?
Ans) The alcohol which is rendered unfit by mixing it with some poisonous substances, such as methanol, pyridine, copper sulphate, etc is known as denatured alcohol. Ethanol is an important industrial chemical. Therefore, it subjected to very small excise duty. To prevent its misuse for drinking purpose, there is a need to denature alcohol.

Q.10) What is meant by the term "functional group"?
Ans) A functional group in an organic compound is an atom (other than hydrogen) or a group of atoms binded together in a unique fashion which determines the properties of the molecule and is usually the site of chemical reactivity in an organic molecule.
e.g. In CH3 CH2 – OH (-OH) is the functional group (-OH is the functional group for alohols).
In CH3 CHO (-CHO) is the functional group (– CHO is the functional group of aldehydes).

Chemistr 10th /11 (Chemical Equations)

(Q.1) What are chemical reactions?
Ans) Chemical reactions are the processes in which a rearrangement of atoms takes place between the reacting substances to form new substances having entirely different properties. During a chemical reaction breaking down of old bonds and formation of new bonds takes place. In a chemical reaction atoms of one element do not change into those of another element, only a rearrangement of atoms takes place. A few examples are rusting of iron, spoiling of milk in summer, cooking of food, digestion of food etc.

(Q.2) What are reactants and products?

Ans) **Reactants:** The substances which take part in chemical reaction are called as reactants.

Products: The new substances formed as a result of a chemical reaction are called products. For example: In the burning of coke in air, carbon and oxygen are the reactants while carbon dioxide formed is the product.

$C + O_2$ ----------→ CO_2

(coke)

Reactants Product

Similarly, in the burning of magnesium in air, magnesium and oxygen are the reactants. While magnesium oxide formed is the product.

$2Mg + O_2$ ----------→ $2MgO$

Reactants Products

(Q.3) State the characteristics of chemical reactions.

Ans) The easily observable changes that take place in a chemical reaction are called the characteristics of the chemical reaction. Some important characteristics of chemical reactions are given below:

(1)Formation of precipitate: Precipitate is a solid substance formed on mixing of two solutions. Some chemical reactions are accompanied by the formation of a precipitate between the reactants. e.g.

$AgNO_3$ (ar) + NaCl (aq) ----------→ AgCl (↓) + $NaNO_3$ (aq)

ppt

(2) Evolution of a gas: In some chemical reactions evolution of a gas takes place.

e.g. in the reaction between zinc and dilute sulphuric acid hydrogen gas is evolved.

Zn + H_2SO_4 (aq) ----------→ Zn SO_4 (aq) + H_2↑

(3) Change of colour: In some chemical reactions change in colour takes place as a result of chemical reaction, e.g. Lead nitrate and potassium iodide solutions are colourless, but on mixing the two, yellow coloured ppt of lead iodide is formed.

$PbNO_3$ (aq) + KI (aq) ----------→ Pb I + KNO_3 (aq)

(colourless) (colourless) (yellow colour ppt)

(4) Change in state: In some chemical reactions change in state takes place as a result of chemical reaction, e.g. solid wax (in the form of candle) burns to form water vapours and carbon dioxide which are the gases.

Wax + air ----------→ CO_2 + H_2O

(sol) (gas) (g) (g)

(5) Change in temperature: In some chemical reactions, rise or fall in temperature takes place as a result of chemical reaction e.g. when water is added to quick lime (CaO), it results in the formation of slaked lime, Ca $(OH)_2$. During this reaction a large amount of energy is evolved.

CaO + H_2O ----------→ Ca $(OH)_2$ + heat

Similarly, when barium hydroxide $Ba(OH)_2$ is added to ammonium chloride NH_4Cl a ppt of $BaCl_2$ is formed . Only when heat energy is absorbed from the surroundings.

Ba $(OH)_2$ + $2NH_4Cl$ + heat ----------> $BaCl_2$ + NH_4OH

(Q.4) What is a chemical equation? What are the steps involved in writing a chemical equation?

Ans) A shorthand representation of a chemical reaction in terms of symbols and formula of different reactants and products is called a chemical equation. While writing a chemical equation the following steps are involved:

(a) The symbols and formula of the reactants are written on the left hand side (LHS) with plus (+) sign between them.

(b) The symbols and formulae of the products are written on the right hand side (RHS) with plus (+) sign between them.

(c) An arrow (-----→) sign is put between the reactants and the products, pointing from reactants towards products.

Example: Consider the reaction between zinc and sulphuric acid. This reaction can be written as follows: $Zn + H_2SO_4 \text{ ----------} \rightarrow ZnSO_4 + H_2\uparrow$

Reactants Products

(Q.5) Write notes on: (a) Balanced chemical equation (b) Unbalanced chemical equation?

Ans) **(a) Balanced chemical equation:** A balanced chemical equation is an equation in which the number of atoms of each element on the two sides of the equation are equal. Consider the following equation,

$$Zn + H_2SO_4 \text{ ----------} \rightarrow Zn\,SO_4 + H_2\uparrow$$

In this equation, the number of atoms of different elements on the two sides are as follows:

Element	No. of atoms In reactants (LHS)	No. of atoms in Products (RHS)
Zn	1	1
H	2	2
S	1	1
O	4	4

Since the number of atoms of each element on the two sides of the above equation are equal, therefore, the equation is said to be a balanced chemical equation.

(b) Unbalanced chemical equation: An unbalanced chemical equation is an equation in which the number of atoms of different elements is not equal on the two sides of the equation. Consider the following equation:

$$KClO_3 \text{ ----------} \rightarrow KCl + O_2$$

Potassium Chlorate — Potassium Chloride

In this equation, the number of atoms of different elements on the two sides are as follows:

Element	No. of atoms In reactants (LHS)	No. of atoms in Products (RHS)
K	1	1
Cl	1	1
O	3	2

In the above equation, number of K atoms and Cl atoms are equal on both sides but the number of O atoms is not equal on both sides. Therefore, such an equation is an unbalanced chemical equation.

(Q.6) Write down the steps involved in balancing chemical equation?

Ans) Balancing of a chemical equation means to equalize the number of atoms of different elements or compounds present on reactant and product sides. Following steps are followed for balancing a chemical equation:

(a) Write down the equation in the word form by writing the names of reactants and products.
(b) Write down the symbols and formulae of the various reactants and products. This gives us the skeletal chemical equation.
(c) List the number of atoms of different elements present in the unbalanced equation.
(d) Select the compound (reactant or a product) which contains maximum number of atoms and start balancing.
(e) To balance the atoms of an element put a small whole number co-efficient before the formula of the compound or symbol of the element. This gives us the partly balanced chemical equation.
(f) To precede further pick up any of the unbalanced atoms and repeat the above procedure till we get balanced chemical equation.

(g) Finally check the correctness of the balanced chemical equation by counting the number of atoms of each element on both sides of the equation.

Example: Write the chemical equation for the following reaction and balance it by hit and trial method.

Iron + water ⟶ iron oxide + hydrogen gas

Solution:

(i) The skeleton equation for the reaction is: $Fe + H_2O \longrightarrow Fe_3O_4 + H_2$

(ii) For balancing we start with Fe_3O_4 because it contains maximum number of atoms. There are four oxygen atoms on RHS and only one on LHS. To balance oxygen atoms, put co-efficient 4 before water.

$Fe + 4H_2O \longrightarrow Fe_3O_4 + H_2$

(iii) Fe and H are still unbalanced. To equalize hydrogen atoms, make the number of molecules of hydrogen as four on RHS.

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

(iv) To balance iron, count the number of iron atoms on both sides.

Atoms of iron in reactants = 1

Atoms of iron in products = 3

To balance, multiply Fe by 3 on the LHS.

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

(v) Let us examine the number of atoms of different elements on both sides.

Element	No. of atoms on LHS	No. of atoms on RHS
Fe	3	3
H	8	8
O	4	4

The number of atoms of each element on both sides are equal. This equation is now balanced.

(Q) How to make chemical equations more informative?

Ans) The chemical equations can be made more informative in following ways:

(1) By indicating the "physical states" of the reactants and products.
(2) By indicating the "heat changes" taking place in the reaction.
(3) By indicating the "condition" under which the reaction takes place.

(1) **By indicating the "physical states" of the reactants and products**: The reactants and products of a chemical reaction could be in any of following four states:

Solid state which is represented by "S".
Liquid state which is indicated by "L"
Aqueous solution which is indicated by "aq".
Gaseous state which is represented by "g".

These stated symbols of the reactants and products are written just after their formula in an equation, e.g. consider the following reaction:

$Ca(OH)_2$ (aq) + CO_2 (g) ⟶ $CaCO_3$ (s) + H_2O (l)

Calcium hydroxide (Lime water) — calcium carbonate (white ppt) — water

Further, if a reaction involve an acid as reactant. The acid may be dilute or concentrated. For dilute acids symbol "dil." is used and for concentrated acids symbol "conc." is used.

Zn (s) + dil. H_2SO_4 ⟶ $ZnSO_4$ (aq) + H_2 (g)

Zinc — sulphuric acid — zinc sulphate — hydrogen

(2) **To indicate the heat changes in an equation:** There are two types of reactions on the basis of heat changes involved. (i) Endothermic reaction (ii) Exothermic reactions

(i) **Exothermic reactions:** The chemical reactions in which heat energy is given out (evolved) are called exothermic reactions, e.g.

$C(s) + O_2(g) \longrightarrow CO_2(g) + \text{heat}$

In exothermic reaction heat evolved is indicated by writing "+ heat" on product side.

(ii) **Endothermic reactions:** The chemical reactions in which heat energy is absorbed are called endothermic reactions

$CaCO_3$ (s) + heat ⟶ CaO (s) + CO_2 (g)
Calcium oxide; carbon dioxide

In endothermic reaction heat absorbed is indicated by writing "+heat" on reactant side or "– heat" on product side or the sign delta (Δ) is put over the arrow of the equation.

$$2KClO_3(s) \xrightarrow[MnO2]{\Delta} 2KCl(s) + 3O_2(g)$$

Potassium Chlorate; Potassium chloride

(3) To indicate the conditions under which the reaction takes place. If the reaction takes place in presence of a catalyst then the symbol or the formula of the catalyst is also written above or below the arrow sign in the equation, e.g.

$$CO(g) + 2H_2(g) \xrightarrow[ZnO+CrO_3 \text{ (catalyst)}]{300^0C,\ 300\ atm} CH_3OH$$

Carbon Monoxide; Hydrogen; methanol

(Q) Name and discuss the various types of chemical reactions.

Ans) Depending upon the types of chemical change, the chemical reactions have been classified into the following types:

(i) Combination reactions
(ii) Decomposition reactions
(iii) Displacement reactions
(iv) Double displacement reactions
(v) Precipitation reactions
(vi) Neutralization reactions
(vii) Reduction-oxidation (redox) reactions

(i) **Combination reactions:** Combination reactions are those reactions in which two or more compounds react to form single product. Combination reactions are also called as synthesis reactions.

$2H_2$ + O_2 ⟶ $2H_2O$
hydrogen; oxygen; water

2Na + Cl_2 ⟶ 2NaCl
sodium; chlorine; sodium chloride

Decomposition reactions: Decomposition means the breaking down of a compound into two or more simpler compounds or elements. The reactions in which a compound breaks up into two or more simpler compounds are called decomposition reactions. Most of the decomposition reactions are endothermic in nature and require energy in the form of heat, light or electricity. Hence, decomposition reactions are of three types.

(a) Thermal decompositions: It is a decomposition reaction brought about by heat, e.g.

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

(b) Photolysis: It is a decomposition reaction brought about by light, e.g.

$$2AgCl(s) \xrightarrow{sunlight} 2Ag + Cl_2$$

(c) Electrolysis: It is a decomposition reaction brought about by electricity.

$$2NaCl \xrightarrow[current]{electric} 2Na(s) + Cl_2(g)$$

(ii) **Displacement reactions:** Displacement reactions are also called as substitution reactions. The reactions in which an atom or group of atoms in a molecule is displaced by another atom or group of atoms are called as displacement reactions.

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

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

$Cl_2(g) + 2NaBr(aq) \longrightarrow 2NaCl + Br_2(l)$

These reactions are accompanied by the displacement of a less active element by a more reactive element from its compound.

(iii) **Double displacement reaction:** A chemical reaction in which there is an exchange of atoms or group of atoms between the reactants to form new substances is called a double displacement reaction. The reactions generally occurs in aqueous medium and such double displacement reactions take place with the: (a) Formation of precipitate (b) Evolution of a gas (c) Change in colour, e.g.

$BaCl_2(aq) + Na_2SO_4(aq) \longrightarrow BaSO_4\downarrow + 2NaCl(aq)$
Barium chloride sodium sulphate (white ppt) sodium chloride

$FeS(s) + \text{dil. } H_2SO_4 \longrightarrow FeSO_4(aq) + H_2S(g)\uparrow$
Iron sulphide sulpheric acid iron sulphate hydrogen sulphide

$CuSO_4(aq) + H_2S(g) \longrightarrow CuS\downarrow + H_2SO_4(aq)$
Copper sulphate (blue in colour) hydrogen sulphate copper sulphide (black ppt) sulphuric acid

(iv) **Precipitation reaction:** A ppt. is a solid substance formed on mixing two solutions. Reactions which are accompanied by the formation of ppt are known as precipitation reactions, e.g.

$NaCl(aq) + AgNO_3(aq) \longrightarrow AgCl(s)\downarrow + NaNO_3(aq)$
Sodium chloride Silver nitrate ↓Silver chloride (white ppt) sodium nitrate

$BaCl_2(aq) + Na_2SO_4(aq) \longrightarrow BaSO_4(s)\downarrow + 2NaCl(aq)$
Barium chloride sodium sulphate Barium sulphate Sodium chloride

(v) **Neutralization reactions:** A reaction in which an acid reacts with a base to form salt and water is called neutralization reaction.

Acid + base ⟶ salt + water

e.g. $HCl(aq) + NaOH(aq) \longrightarrow NaCl + H_2O$

$NH_4OH + HCl \longrightarrow NH_4Cl + H_2O$

(vi) **Oxidation-reduction reactions:** (a) Oxidation: Oxidation may be defined as a chemical process in which a substance gains oxygen or loses hydrogen, e.g.

$4Na + O_2 \longrightarrow 2Na_2O$
sodium oxygen sodium oxide

According to modern electronic concept, oxidation is a process in which an atom or an ion loses one or more electrons.

$Na \longrightarrow Na^+ + \bar{e}$ (oxidation)

(b) Reduction: Reduction is a process in which a substance gains hydrogen or loses oxygen, e.g.

$CuO + H \longrightarrow Cu + H_2O$
Copperoxide copper

According to modern electronic concept reduction is a process in which an atom or ion gains one or more electrons, e.g.

$Cu^{2+} + 2\bar{e} \longrightarrow Cu$ (reduction)
(Reduction reactions)

Oxidation and reduction take place simultaneously in a reaction and such a reaction is called redox reaction.

(Q) State the effect of oxidation reaction in everyday life?

Ans) The commonly observed effects of oxidation are as follows:

(a) Corrosion: The process of slowly eating up of the metals by the action of atmospheric gases such as oxygen, carbon dioxide, hydrogen sulphide and moisture is known as corrosion. During corrosion metals change into their oxides, carbonates, sulphides etc. Some examples of corrosion are:

(i) Formation of oxide layer on the surface of aluminum.

(ii) Tarnishing of silver metal on exposure to hydrogen sulphide.
(iii) The formation of reddish brown layer on the surface of iron articles etc.

Corrosion in case of iron is called rusting. Chemically rust is hydrated ferric oxide, i.e. Fe_2O_3 x H_2O

Rusting can be prevented by any of the following methods:

(1) By painting the iron articles.
(2) By greasing and oiling the iron articles.
(3) By galvanization of iron objects.

(b) Rancidity: When oils and fats or foods containing oils and fats are exposed to air or oxygen, they get oxidized due to which the food becomes stale and its colour and smell changes. It is called rancidity.

The rancidity of fatty foods can be prevented by adding antioxidants and flushing the food container with nitrogen to prevent food from oxidation. At home, oxidation process of food can be prevented/slowed down by keeping it in refrigerator.

Text Book Questions

Q1: Why should a magnesium ribbon be cleaned before burning in air?

Ans: Magnesium ribbon when exposed to humid air, forms a white layer of magnesium oxide over it.

$$Mg + O_2 \longrightarrow MgO \text{ (Magnesium oxide)}$$

This oxide layer prevents it from burning. Therefore, to burn magnesium ribbon, the oxide layer is first peeled off by rubbing it with sand paper.

Q2: Write balanced equation for the following chemical reaction.

(i) Hydrogen + Chlorine ⟶ Hydrogen Chloride

Ans: $H_2 + Cl_2 \longrightarrow 2HCl$

(ii) Barium Chloride + Aluminium Sulphate ⟶ Barium Sulphate + Aluminum Chloride

Ans: $3BaCl_2 + Al_2(SO4)_3 \longrightarrow 3BaSO_4 + 2AlCl_3$

Q3: Write the balanced chemical equation with state symbols for the following reactions?

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

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

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

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

Q4: A solution of a substance "X" is used for white washing.

(i) Name the substance "X" and write its formula.

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

(ii) Write the reaction of substance 'X' named in (i) above with water.

Ans: During mixing of Quick lime with water, following reaction takes place.

$$\underset{\text{Quick lime}}{CaO(S)} + H_2O\ (l) \longrightarrow \underset{\text{Slaked lime}}{Ca(OH)_2\ (aq)}$$

Q5: Why is the amount of gas collected in one of the test tubes, double of the amount collected in the other on electrolysis of water? Name this gas

Ans: On electrolysis water decomposes into hydrogen gas and oxygen gas as follows:-

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

From the above equation, it is clear that Hydrogen and oxygen gas are produced in the ratio of 2:1 by volume. The volume of hydrogen gas produced is double to that of oxygen. Because of the reason the amount of gas collected in one of the test tube is double than the other.

Q6: When you mix the solutions of lead nitrate and potassium iodide.

(i) What is the colour of precipitate formed?

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

(iii) Is this also a double displacement reaction?

Ans: The precipitate formed is yellow in colour.

(ii) In this reaction, yellow ppt. of lead iodide is formed.

Lead nitrate + potassium iodide $\longrightarrow$ lead iodide + potassium nitrate

The balanced chemical equation for this reaction is follows:

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

(ii) Yes, it is double displacement reaction.

Q7: A magnesium ribbon burning with a dazzling flame in air (oxygen) and changes into a white substance, magnesium oxide. Is magnesium being oxidized or reduced in this reaction?

Ans: (i) The chemical reaction between magnesium and oxygen is shown below:

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

(ii) In this reaction since oxygen is added to magnesium. Therefore, it is oxidation reaction and magnesium is oxidized to magnesium oxide.

Q8: Why does the colour of copper sulphate changes. When an iron nail is dipped in it?

Ans: When iron nail is dipped into the copper sulphate solution, iron being more reactive than copper, displaces Cu from copper sulphate resulting in the formation of iron sulphate.

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

Therefore, the blue colour of copper sulphate fades due to formation of iron sulphate

Q9: Give an example of a double displacement reaction other than the one between barium chloride and sodium sulphate solutions.

Ans) The reaction between silver nitrate and sodium chloride is an example of double displacement reaction.

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

Silver Nitrate Sodium Chloride Silver chloride Sodium Nitrate

Q10: Identify the substances oxidized and the substances reduced in the following reactions.

(i) $4Na(S) + O_2(g) \longrightarrow 2Na_2O(S)$

(ii) $CuO(S) + H_2(S) \longrightarrow Cu(S) + H_2O(l)$

Ans:

(i) $4Na(S) + O_2(g) \longrightarrow 2Na_2O(S)$

In this reaction, oxygen gets added to Na. Therefore, sodium gets oxidized into Na_2O and oxygen itself gets reduced.

(ii) $CuO(S) + H_2(S) \longrightarrow Cu(S) + H_2O(l)$

CuO loses oxygen and gets reduced to Cu and the released oxygen gets added to hydrogen, therefore, hydrogen gets oxidised.

Q11: What is the balanced chemical equation? Why the chemical equation should be balanced.

Ans. The chemical equation in which the number of atoms of each element on both the sides of the equation is equal is called balanced chemical equation.

A chemical equation must be balanced so as to obey law of conservation of mass. To follow this law, the number of atoms of each element on reactant side must be equal to the number of atoms on product side.

Q.12. Translate the following statements into chemical equations and then balance them.

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

Ans. The word equation for the above reaction is as follows

Hydrogen + Nitrogen ⟶ ammonia

The balanced equation is as under:

$3H_2 + N_2 \longrightarrow 2NH_3$

Q13. Hydrogen sulphide gas burns in air to form water and sulphur dioxide.

Ans. The word equation for this reaction is as under:

Hydrogen Sulphide + oxygen ⟶ Water + Sulphur dioxide

The balanced skeltal equation is as follows:

$2H_2S + 3O_2 \longrightarrow 2H_2O + 2SO_2$

Q14. Barium chloride reacts with aluminium sulphate to give aluminium chloride and precipitate of barium sulphate

Ans. The word equation for this reaction is as follows:

Barium chloride + Aluminium sulphate ⟶ Aluminium chloride + Barium sulphate

The balanced skeltal chemical equation is as under:

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

Q15: Potassium metal reacts with water to give potassium hydroxide and hydrogen gas.

Ans: The word equation is as follows:

Potassium + water ⟶ Potassium hydroxide + Hydrogen gas

The skeletal chemical equation is:

$K + 2H_2O \longrightarrow 2KOH + H_2$

Now the balanced chemical equation is:

$2K + 2H_2O \longrightarrow 2KOH + H_2$

Q16: Balance the following equations.

(a) $HNO_3 + Ca(OH)_2 \longrightarrow Ca(NO_3)_2 + H_2O$

Ans: $2HNO_3 + Ca(OH)_2 \longrightarrow Ca(NO_3)_2 + 2H_2O$

(b) $NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O$

Ans: $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$

(C) $NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3$

Ans: The above equation is already balanced.

(d) $BaCl_2 + H_2SO_4 \longrightarrow BaSO_4 + HCl$

Ans: $BaCl_2 + H_2SO_4 \longrightarrow BaSO_4 + 2HCl$

Q17: Write the balanced chemical equations for the following reaction.

(a) Calcium hydroxide + carbon dioxide ⟶ Calcium carbonate + Water

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

(b) Zinc + Silver Nitrate ⟶ Zinc Nitrate + Silver

Ans: $Zn + 2AgNO_3 \longrightarrow Zn(NO_3)_2 + 2Ag$

(c) Aluminium + Copper Chloride ⟶ Aluminium Chloride + Copper

Ans: $2Al + 3CuCl \longrightarrow 2AlCl_3 + 3Cu$

(d) Barium chloride + Potassium sulphate ⟶ Barium Sulphate + Potassium chloride

Ans: $BaCl_2 + K_2SO_4 \longrightarrow BaSO_4 + 2KCl$

Q18: Write the balanced chemical equation for the following and identify the type of reaction in each case.

(a) Potassium bromide + Barium iodide ⟶ Potassium iodide + Barium bromide

Ans: $2KBr + BaI_2 \longrightarrow 2KI + BaBr_2$

This is a double displacement reaction.

(b) Zinc carbonate ⟶ Zinc oxide + Carbon dioxide

Ans: $ZnCO_3 \longrightarrow ZnO + CO_2$

This is decomposition reaction.

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

Ans: $H_2 + Cl_2 \longrightarrow 2HCl$

It is a synthesis (combination) reaction.

(d) Magnesium (S) + Hydrochloric acid (aq) ⟶ Magnesium Chloride (aq) + Hygen gas

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

It is a displacement reaction

Q19: What does one mean by exothermic and endothermic reactions? Give examples.

Ans(1) **Exothermic reaction:** Those reactions in which heat is evolved to the surroundings are known as exothermic reaction. For example, when carbon burns in oxygen to form carbon dioxide, a lot of heat is produced. Therefore this reaction is exothermic reaction.

$C(S) + O_2(g) \longrightarrow CO_2(g) + Heat$

Carbon Oxygen carbon dioxide

An exothermic reaction is indicated by writing " + Heat" on the product side of equation. Similarly, natural gas which contains methane as main constituent when burnt in presence of oxygen, it forms carbon dioxide with the evolution of heat.

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

(2) **Endothermic reactions:-** Those reactions in which heat energy is absorbed from the surroundings are known as endothermic reactions. For example, when nitrogen and oxygen are heated to a very high temperature, they combine to form nitrogen monoxide, a lot of heat energy is absorbed in this reaction.

$N_2(g) + O_2 \longrightarrow 2NO(g)$

Nitrogen Oxygen ⟶ Nitrogen monoxide

An endothermic reaction is usually indicated by writing " + Heat" on the reactant side of the equation. Decomposition of calcium carbonate into calcium oxide and CO_2 requires heat energy. Therefore, it is an endothermic reaction.

In fact, all decomposition reactions are endothermic in nature.

$CaCO_3(S) + Heat \longrightarrow CaCO(S) + CO_2(g)$

Q20: Why respiration is considered as an exothermic process? Explain.

Ans: We need energy to stay alive. We get this energy from the food we eat. During digestion, food changes into simple carbohydrate called glucose. This glucose then undergoes slow combustion by reacting with oxygen in the cells of our body to produce energy in a process called respiration. Thus, during respiration process heat energy is produced. Therefore, it is an exothermic process. The reaction proceeds as follows:

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

Glucose Oxygen Carbon Dioxide

Q21: Why are decomposition reactions called opposite of composition reactions? Write equations for these reactions.

Ans: In a decomposition reaction, a single molecule splits to give two or more simpler molecules. Where as in a combination reaction, two or more simpler substances (elements or molecules) combine together to form a single compound. Hence, they are opposite to each other.

(i) Example of decomposition reaction:

$$CaCO_3 \xrightarrow{Heat} CaO(S) + CO_2(g)$$
Calcium Carbonate → Calcium Oxide + Carbon Dioxide

$$2FeSO_4(S) \xrightarrow{Heat} Fe_2O_3(S) + SO_2(g) + SO_3(g)$$
Serrons Sulphate → Ferric oxide + Sulphar dioxide + Sulphar trioxide

(ii) Examples of combination reactions:

$$2Mg(S) + O_2(g) \longrightarrow 2MgO(S)$$
Magnesium + Oxygen → Magnesium Oxide

$$CaO(S) + H_2O(l) \longrightarrow Ca(OH)_2(aq)$$
Calcium oxide + Water → Calcium hydroxide

Chem/.10th /10 Chapter No3 Metals and Non-metals

Some points to Remember:

1. **Metals:-** These elements are mostly solids, have bright lustre, high densities and are hard, good conductors of heat and electricity. They have tendency to lose one or more electrons e.g. Iron, Zinc, Sodium, Calcium, Aluminium**.**
2. **Non- Metals:-** These elements exist in all the three states. They have no lustre, generally low densities and are poor conductors of heat and electricity. They have tendency to gain one or more electrons. e.g. Nitrogen, Oxygen, Sulphur, Iodine, Bromine etc.
3. **Metalloids:-** The elements that show the properties of both metals and nonmetals e.g. Arsenic, Antimony, Silicon, Germanium, Tellurium etc.
4. **Activity Series of Metals:-** It is a series in which the various metals have been arranged in decreasing order of their reactivity. A part of this series is shown as below:-

   K>Na> Ca> Mg>Al>Zn>Fe>Pb>Cu>Hg>Ag> Au>Pt
5. **Mineral:-** The elementary state or the compounds in the form of which the metals occur in nature are called minerals.
6. **Ore:-** The mineral from which the metal, c an be extracted conveniently and economically is called an ore.
7. **Gangue Or Matrix:-** These are the earthy impurities like sand, lime stone, rocks etc. associated with minerals or Ores.
8. **Metallurgy:-** The process of extracting and refining of metals is known as metallurgy.
9. **Roasting:-** The process of heating of Ore strongly in presence of air to get metal oxide is known as Roasting.
10. **Calcination:-** The process of heating of carbonate ores to convert them into their corresponding oxides in absence of air, is known as calcination.
11. **Smelting:-** The process of reduction of metal oxides by heating them with coke is called smelting.
12. **Aluminothermy:-** The process of reduction of metal oxides by heating them in presence of Aluminium is called aluminothermy.
13. **Refining of Metals:-** The process of purifying the impure (crude) metals is called refining of the metals.
14. **Corrosion:-** It is the Slow eating up (decay) of metals by the action of air and moisture on their surfaces.
15. **Rusting:-**Corrosion of iron is called rusting. Chemically rust is hydrated ferric oxide ($Fe_2O_3 .x H_2O$)
16. **Alloy:-**It is a homogeneous mixture of two or more metals or metals and non-metals.

Additional Questions

Q. What are metals? Give physical and chemical properties of metals.

Metals:- Metals are defined as **t**hose elements which form positive ions (cations) by losing electrons i.e. they are electropositive elements. They have 1,2, or 3 electrons in their valence shell.

Physical Properties of metals:-

The general physical properties of metals are stated as follows:-

1. Metals in the pure state possess lustre i.e. shining surface.
2. Metals are generally hard. The hardness varies from metal to metal e.g. Iron, Copper, Aluminium, Lead are hard metals. They can't be cut with a knife.
   However, Lithium, Sodium and Potassium are soft metals. They can be cut even with a knife.
3. Metals are malleable i.e. they can be beaten into thin sheets .e.g. Iron, Copper, Aluminium etc.
4. Metals are ductile in nature i.e. they can be drawn into wires. e.g. 1gram of gold can be drawn into a wire of about 2km length.
5. Metals are good conductors of heat and possess high melting point. Silver is the best conductor of heat and copper is the second best followed by aluminium. Whereas, lead is the poorest conductor of heat.
6. Metals are good conductors of electricity. Silver is the best conductor of electricity where as mercury is very poor conductor of electricity.
7. Metals are sonorous i.e. they produce sound on striking hard surfaces.
8. Metals generally have high density. Exception is Lithium, Sodium, and Potassium which have low densities.
9. Metals have high tensile strength i.e. they possess load bearing capacity.
10. All metals are solids except mercury which is a liquid.

Chemical properties of Metals:-

Some of the chemical properties of metals are summarized as follows:-

1. Reaction of metals with oxygen:-

Metals react with oxygen to form their respective oxides. e.g.

a. Sodium reacts with oxygen at room temp.

$$4Na + O_2 \longrightarrow 2Na_2O$$

b. Magnesium reacts with oxygen on heating.

$$2Mg + O_2 \xrightarrow{\text{Heat}} 2MgO$$

c. The reacts with oxygen on strong heating.

$$2Zn + O_2 \xrightarrow[\text{Heating}]{\text{Strong}} 2ZnO$$

a. Basic/Amphoteric nature of oxides:- Most of the Metal oxides are basic in nature. e.g. Sodium reacts with oxygen at room temperature to form sodium oxide which is basic in nature.

$$4\ Na + O_2 \longrightarrow 2\ Na_2O$$

Similarly Magnesium reacts with oxygen on heating to form magnesium oxide which is also basic in nature.

$$2Mg + O_2 \xrightarrow{\text{Heating}} 2MgO$$

However, some metal oxides e.g. aluminium oxide (Al_2O_3) and Zinc oxide (ZnO) show basic as well as acidic character. Such metal oxides are called amphoteric oxides.

$$4\ Al + 3O_2 \longrightarrow 2\ Al_2O_3$$
$$2\ Zn + O_2 \longrightarrow 2\ ZnO$$

b. Solubility in water:- Most of the metal oxides are insoluble in water. But some metal oxides dissolve in water to form alkali.

e.g. $Na_2O + H_2O \longrightarrow 2Na\ OH$
$K_2O + H_2O \longrightarrow 2KOH$

2. Reaction of Metals with water:-

A number of metals react with water to form a hydroxide or an oxide along with the evolution of hydrogen gas.

However, the rate of reactivity of different metals is different towards water.

Some metals such as sodium and potassium react with water at room temp.

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

$2K + 2H_2O \longrightarrow 2KOH + H_2$

Some metals such as magnesium reacts with water on heating

$Mg + 2H_2O \xrightarrow{Heat} Mg(OH)_2 + H_2$

Similarly some other metals such as aluminium and iron react with steam.

$2Al + 3H_2O \xrightarrow{Steam} Al_2O_3 + 3H_2$

$3Fe + 4H_2O \xrightarrow{(Steam)} Fe_3O_4 + 4H_2$

3. Reaction of Metals with dilute acids:-

Metals displace H_2 gas from dilute acids. However, less reactive metals like Cu, Ag and Au do not displace Hydrogen gas when they are treated with dilute acids.

e.g. (i) Sodium reacts violently with dil. HCl.

$2Na + 2HCl \longrightarrow 2NaCl + H_2$

ii. Magnesium reacts quite rapidly with dil. HCl.

$Mg + 2HCl \longrightarrow MgCl_2 + H_2$

iii. Zinc reacts less rapidly than that of Mg with HCl

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

iv. Iron reacts slowly with dil HCl

$Fe + 2HCl \longrightarrow FeCl_2 + H_2$

v. Copper does not react with dil.HCl or dil. H_2SO_4

$Cu + HCl \longrightarrow$ NO reaction .

4. Reaction of metals with chlorine:-

Metals react with chlorine to form metal chlorides. Reactive metals like sodium, potassium, calcium and magnesium combine with chlorine even at room temp.

$2Na + Cl_2 \longrightarrow 2NaCl$

$Ca + Cl_2 \longrightarrow CaCl_2$

However, less reactive metals like zinc, iron, aluminium and copper react with chlorine on heating. e.g.

$Zn + Cl_2 \xrightarrow{Heat} ZnCl_2$

$2Fe + 3Cl_2 \xrightarrow{Heat} 2FeCl_3$

$2Al + 3Cl_2 \xrightarrow{Heat} 2AlCl_3$

5. Reaction of metals with hydrogen:-

Metals generally do not react with hydrogen. Only highly reactive metals like Na, K Ca and Mg combine with hydrogen to firm compounds called metal hydrides. e.g.

$2Na + H_2 \xrightarrow{Heat} 2NaH$

$Ca + H_2 \xrightarrow{Heat} CaH_2$

6. Reaction of metals with solutions of other metal salts:-

All metals are not equally reactive. The more reactive metals can displace less reactive metals from their compounds in solution. e.g. Iron can displace copper from copper sulphate solution.

$Fe + CuSO_4 \longrightarrow FeSO_4 + Cu.$

Similarly, copper can displace silver from silver nitrate solutions

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

7. Reducing behaviour:-

As metals can lose electrons, therefore, they act as reducing agents. e.g. sodium metal reduces chlorine to chloride ion. As follow:-

$2Na + Cl_2 \longrightarrow 2NaCl$

$(Na \xrightarrow{\text{Oxidation}} Na^+ + e^-$

$(Cl\ e^- \xrightarrow{\text{Reduction}} Cl^-$

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

Q.2 What are non-metals? Give their general physical and chemical properties.

Ans. Non metals are defined as the element which have the tendency to gain (accept) electrons i.e. they are electronegative in nature. Because of their electronegative nature they form negative ions (anions). Non metals have 4 to 7 electrons in their outer shells.

Physical properties of non-metals:-

Some of the general physical properties of non-metals are as follow:

(1) Non-metals do not possess any lustre except iodine which is non-metallic solid but has lustre.

(2) They are soft and brittle i.e. they break into pieces when hammered. The only exception is diamond, an allotropic form of carbon which is a non-metal but is the hardest substance known.

(3) They are neither malleable nor ductile.

(4) They are generally bad conductors of heat and electricity, except graphite which is an allotropic form of carbon and is a good conductor of electricity.

(5) They are non-sonorous i.e. they do not produce any sound when hit with any hard object.

(6) They have generally low melting and boiling point except boron, diamond and graphite which are non-metals but have high melting point.

(7) They have low densities i.e. they are light elements.

(8) They have low tensile strength i.e. they are easily broken.

(9) They may be solids, liquids or gases at room temperature. e.g. Carbon, Sulphur, phosphorus are solids and iodine is a liquid, while as hydrogen, oxygen, nitrogen and chlorine are gaseous non-metals.

Chemical properties of non-metals:-

Some important chemical properties (reactions) of non-metals are discussed below:

(1) **Reaction with oxygen :-** Non-metals when heated with oxygen form their respective oxides. These oxides may be either acidic or neutral. They never form basic oxides.

e.g.

$C + O_2 \longrightarrow CO_2$ (Acidic oxide)

$CO_2 + H_2O \longrightarrow H_2CO_3$ (Carbonic acid)

$S + O_2 \longrightarrow SO_2$ (Acidic oxide)

$SO_2 + H_2O \longrightarrow H_2SO_3$ (Sulphurous acid)

$2C + O_2 \longrightarrow 2CO$ (Neutral oxide)

$N_2 + O_2 \longrightarrow 2NO$ (Neutral oxide)

(2) **Reaction with water:-** Non-metals generally do not react with water. This is because non-metals can't reduce the hydrogen (H^+) ions of water to H_2 gas.

(3) **Reaction with dilute acids:-** Non-metals do not react with dilute acids. It is because non-metals them selves are acceptors of electrons and therefore do not give electrons to reduce the hydrogen (H^+) ions of an acid to hydrogen gas.

(4) **Reaction with chlorine:-** Non-metals react with chlorine to form chlorides. These non-metal chlorides are covalent chlorides and non-electrolytes. e.g.

$H_2 + Cl_2 \longrightarrow 2HCl$

(Covalent Chloride)

$$P_4 + 6Cl_2 \longrightarrow 4PCl_3$$

(Covalent Chloride)

(5) Reaction with hydrogen:-

Non-metals combine with hydrogen to form covalent hydrides. These hydrides are generally gases or liquids e.g.

$$8H_2 + S_8 \xrightarrow{\text{Heat}} 8H_2S$$
$$N_2 + 3H_2 \xrightarrow{\text{Heat}} 2NH_3$$

6. Reaction with Salts:-

A More reactive non-metal displaces a less reactive non-metal from its salt solution. e.g.

$$2NaBr + Cl_2 \longrightarrow 2NaCl + Br_2$$
$$2KI + Cl_2 \longrightarrow 2KCl + I_2$$

7. Oxidizing Behavior:-

Non-metals have a strong tendency to accept electrons to form negative ions. Therefore, non-metals behave as oxidizing agents. e.g. the non-metal fluorine (F_2) is the strongest oxidizing agent. It oxidizes water (H_2O) to oxygen, sulphur to sulphurhexa fluoride etc.

$$2H_2O + 2F_2 \longrightarrow 4HF + O_2$$
$$S_8 + 24F_2 \longrightarrow 8SF_6$$

Q.3 State some uses of metals:-

Ans. Metals are used for a large number of purposes. Some of the uses of metals are given below-

1. Copper and aluminium metals are used to make wires to carry electric current.
2. Iron, Copper and Aluminium metals are used to make house-hold utensils and factory equipments.
3. Iron is used as a catalyst in the preparation of ammonia gas by Haber's process.
4. Zinc is used for galvanizing iron to protect it from rusting.
5. Chromium and nicked metals are used for electroplating and in the manufacture of stainless steel.
6. The aluminium foils are used in packaging the medicines, cigarettes and food materials.
7. silver and gold are used to make jewelery.
8. The liquid metal, mercury is used in making thermometers.
9. Zirconium metal is used in making bullet proof alloy steels.

Q.4 State some important uses of non-metals.

Ans. The important uses of non-metals are summarized as follows.

1. Hydrogen is used in the hydrogenation of vegetable oils to make vegetable ghee (or venaspati ghee.) Hydrogen is also used in the manufacture of ammonia. The later is used for the manufacture of fertilizers.
2. Carbon is one of the most important non-metal because life is based up on it. For example carbohydrates, proteins, oils and fats, vitamins, enzymes etc. which are all made up of carbon compounds are the basic units of life supporting substance. Carbon in form of graphite, is also used as electrodes in electrolytic cells and dry cells.
3. Oxygen gas in air imparts its use in different life processes and combustion processes.
4. Nitrogen is used in the manufacture of ammonia, nitric acid and fertilizers. Some of the compounds of nitrogen, such as trinitrotoluene (TNT), nitroglycerine etc. are used as explosives.
5. Sulphur is present in many of the substances found in plants and animals. It is present in proteins, hair, Onion, garlic, wool etc. it is used in as a fungicide and in making gunpowder.

Q. What is the cause of chemical combination? "OR" Why do metals and non-metals react?

Ans. Two theories or concepts are used to explain the cause of chemical combination these are:-

i. Tendency of the atoms to acquire the stable nearest noble gas electronic configuration (Electronic theory or octet rule).

This theory was given by Kossel and Lewis. The noble gases have eight electrons (octet) in their valence shells except helium which has two electrons (duplet) and are chemically less reactive. This configuration was regarded as extra stable electronic configuration.

The atoms of all other elements have less than eight electrons in their valence shells and are reactive in nature. The atoms of these elements combine with each other with the redistribution of electrons in the valence shells so that they acquire the stable nearest noble gas configuration (duplet or octet).

ii. Tendency to acquire a state of minimum energy (modern concept),

According to modern concept, the atoms of various elements combine with each other only if the chemical combination leads to the decrease in the energy of the system. If on chemical combination the energy of the system increases, no bond is said to be formed between them.

Q. What are the different modes of chemical combination? OR How do atoms combine?

Ans. To acquire stability, all atoms tend to complete their octets (i.e. outer most shell with eight electrons) or duplet (i.e. outer most shell with two electrons) if K-shell is the outer most shell. As a result, they acquire the nearest noble gas configuration and hence become stable.

When the atoms combine, they complete their octet or duplet by any one of the following methods.

1. By transfer of one or more electrons from valance shell of one atom to the other forming an electrovalent (or ionic) bond.
2. By mutual sharing of one, two or three pairs of electrons between two atoms forming covalent bond.
3. By sharing one electron pair in which the shared electron pair is contributed by only one of the combining atoms resulting in the formation of a co-ordinate or dative bond.

Q. What is electron dot structure? Give electron dot structure of some elements.

Ans. In the formation of a chemical bond between two atoms, only the electrons of outer most shell are involved. These electrons present in the outer most shell are called valence electrons.

G.N. Lewis introduced a simple method of representing the valence electrons by dots or small crosses around the symbol of the atom. These symbols are known as electron dot symbols or Lewis symbols. A few examples of given below:

Element	symbol	At. No.	Valence electrons	Lewis symbol
Hydrogen	H	1	1	H or H
Helium	He	2	2	He: or He
Lithium	Li	3	1	Li. or Li
Beryllium	Be	4	2	Be: or Be
Boron	B	5	3	B or B
Carbon	C	6	4	C or C
Nitrogen	N	7	5	N or N
Oxygen	O	8	6	O or O
Flourine	F	9	7	F or F
Neon	Ne	10	8	Ne or Ne

Q. What is ionic or Electrovalent bond?

Ans. It is the chemical bond formed between the two atoms by the transfer of one or more electrons from the valence shell of one atom to the other. This bond is formed between metal atoms and non-metal atoms. One of the combining atoms (metal atom) loses one or more electrons and becomes cation. The other atom (non-metallic atom) gains one or more electrons and becomes an anion. The cation and anion attract each other and are held together by strong electrostatic forces of attraction called ionic bond or electrovalent bond.

Q. What are electrovalent (or ionic) compounds? Explain in light of formation of some ionic compounds.

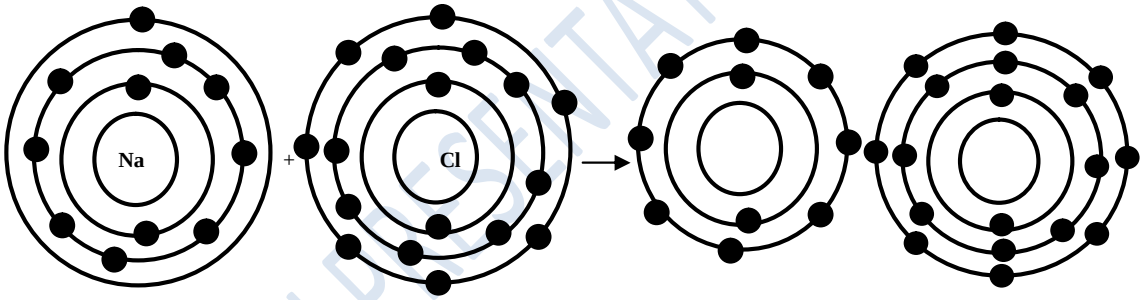
Ans. The compounds formed as a result of the transfer of electrons from one atom of an element to one atom of another element are called ionic or electrovalent compounds e.g. NaCl, $MgCl_2$ KCl etc. To illustrate the formation of ionic compounds, a few examples are given below:-

II Formation of sodium chloride (NaCl).

Atomic member of sodium, Na = 11 its electronic configuration, = 2, 8, 1
Atomic number of chlorine, Cl = 17 its electronic configuration = 2, 8, 7.
During the formation of sodium chloride, one electron is transferred from valence shell of sodium to valence shell of chlorine atom. The transfer of electron from sodium to chlorine may be represented as follows:-

$$Na + Cl \longrightarrow Na^+ Cl^- \text{ or } NaCl$$

This can be represented by writing complete structure of the atoms involved in the bond formation as under



Sodium Atom (Na) Chlorine Atom (Cl) Sodium Chloride (NaCl) (Molecule)

ii. **Formation of potassium chloride (KCl)**

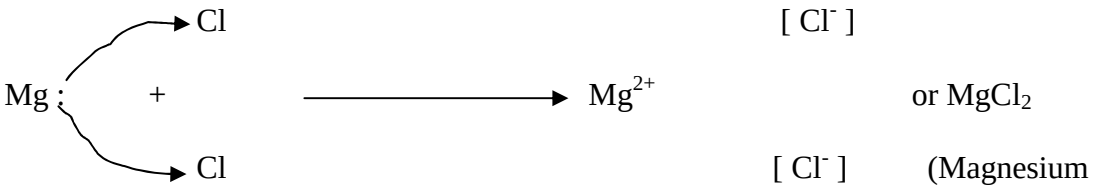
Atomic number of potassium, K=19 electronic configuration of K= 2, 8, 8, 1. it loses the valance electron to form K^+ ion and attains the nearest noble gas configuration as that of argon (2, 8, 8).
Atomic number of chlorine =17 electronic configuration of Cl = 2, 8. 7 it gains one electron in valence shell to form Cl^- and attains nearest noble gas configuration of argon thus, formation of KCl, by transfer of electron from K to Cl may be represented as follows:-

$$K + Cl \longrightarrow K^+ \; Cl^- \quad \text{or KCl}$$

Potassium atom chlorine atom Potassium Chloride

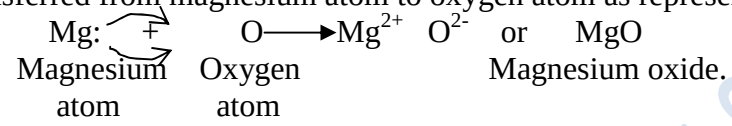
3. Formation of magnesium chloride ($MgCl_2$).

Atomic number of magnesium (Mg) =12 its electronic configuration = 2,8,2. it loses two electrons from the valence shell to acquire the nearest noble gas configuration. of neon (2,8) and form Mg^{2+} ion. Atomic no of Chlorine (Cl) = 17. it needs only one electron in the valence shell to acquire the nearest noble gas configuration of argon (2,8,8) and form chloride ion (Cl^-)
therefore, the transference of two electrons from one magnesium to two chlorine atoms takes place this can be represented as follows:-



4. Formation of Magnesium oxide (MgO):-

Atomic number of magnesium (Mg) = 12 its electronic configuration = 2, 8, 2. It loses two electrons to acquire stable configuration of neon (2,8) and form Mg^{2+} ion. Atomic No. of oxygen (O) = 8 Its electronic configuration = 2, 6 . it gains two electrons in the valence shell to acquire the stable configuration of neon (2,8) and form O^{2-} ion. Thus, in the formation of magnesium oxide, two electrons are transferred from magnesium atom to oxygen atom as represented below:-



Q. Give some important properties of ionic compounds.

Ans. Some of the important properties of ionic compounds are as follows:-

1. Physical state:- Most of the ionic compounds are crystalline solids. They are relatively hard because of strong electrostatic forces of attraction between the oppositely charged ions. They are britle and break into pieces on applying force.

2. Solubility:- They are soluble in water but insoluble in organic solvents such as alcohol, petrol, kerosene oil etc.

3. Melting points and boiling points:- They have high melting and boiling points.

4 Most of the ionic Salts:- When brought into the flame, ionic compounds impart characteristic colours to the flame. e.g. sodium chloride imparts golden yellow colour, potassium salts impart violet colour and barium salts impart green colour to the flame.

5. Electrical conductivity:- Upon dissolving in water ionic compounds dissociate into free ions. As these ions can conduct electricity, therefore ionic compounds conduct electricity in the aqueous solution.

Q. How do metals occur in nature?

Ans. Metals are found to occur in the nature either in free state (also called native state) i.e. free elements or in the combined state i.e. in the form of their compounds. This is because of the fact that different metals possess different chemical reactivities.

1. Free or Native State:- The metals at the bottom of the activity series are least reactive therefore, these are not attacked by moisture, oxygen and carbon dioxide in the air. Thus they occur in the native state. e.g. Gold and platinum.

2. Combined state:- The metals at the top of the activity series (K, Na, Ca, Mg etc.) are highly reactive. Therefore, these are easily attacked by moisture, oxygen and carbon dioxide of the air. They occur in the combined state in the form of their compounds called minerals.

The metals in the middle of the activity series (Al, Zn, Fe, Pb, etc.) are found in the earth's crust mainly as oxides, sulphides or carbonates.

Q. Where from the metals are obtained in nature? Give their relative abundance in nature?

Ans. The major source of metals (whether in free in state or combined state) is the earth's crust. Some metals (Na, K etc) which form soluble salts (like NaCl, $MgCl_2$) are also found to occur in the sea water in the form of their soluble salts.

The most abundant metal on the earth's crust is aluminum (about 7%) followed by iron (about 4%)calcium (3%) sodium (2.7%) potassium (2.5%) magnesium (2%) and

titanium (about 0.6%). The remaining metals are present on the earth's crust in very small amounts.

Q. Write note on:-

1. Mineral:- The elementary state or the compounds in the form of which the metals occur in nature are called minerals. Minerals are the compounds of metals which occur in nature.

2. Ore:- The mineral from which the metal can be extracted conveniently and economically is called ore. All minerals are not ores.

3. **Gangue:-** When the minerals are mined from the earth's crust, they are always contaminated with earthy, sandy and rocky impurities. These earthy, sandy and rocky impurities associated with the mineral are called gangue or matrix.

The ores of some common metals are given below:-

Metal	**Name of ore**	**Name of compound present in the ore**	**Formula of the ore**
1. Sodium (Na)	Rock Salt	Sodium Chloride	NaCl
2. Calcium (Ca)	Dolomite	Calcium Magnesium carbonate	$CaCO_3$ $MgCO_3$
3. Aluminium (Al)	Bauxite	Aluminium Oxide	Al_2O_3 $2H_2O$
4. Copper (Cu)	i. Cuprite ii. Copper glance iii. Copper Pyrite	Copper (i) Oxide Copper (i) sulphide Copper Iron sulphide	Cu_2O Cu_2S Cu Fe S_2
5. Iron (Fe)	i. Iron Pyrite ii. Hematite	Iron sulphide Iron (iii) oxide	Fe S_2 Fe_2 O_3
6. Zinc (Zn)	i. Zinc Blend ii. Calamine	Zinc Sulphide Zinc Carbonte	ZnS $ZnCO_3$
7. Mercury (Hg)	Cinabar	Mercury (ii) Sulphide	HgS
8. Silver (Ag)	Argentite	Silver sulphide	Ag_2S
9. Lead (Pb)	Galena	Lead Sulphide	PbS

Q. What is metallurgy? Describe in detail the various process involved in metallurgy.

Ans. The various steps involved in the extraction of the metal from its ores followed by refining of the metal is called metallurgy.

The actual process employed for the extraction of a particular metal from its ore depends upon a number of factors e.g.

i. Nature of the ore.
ii. Nature of the impurities present.
iii. Nature of the metal to be extracted.

The three main steps involved in the extraction of any metal are:-

1. Enrichment of the ore or Concentration of the ore
2. Extraction of the metal from the concentrated ore.
3. Refining of the impure metal.

1 concentration of the ore or enrichment of the ore:- The process of removal of gangue from the powdered ore is called concentration of the ore or enrichment of the ore or ore dressing. The method used for the concentration of the ore depends upon the nature of ore and nature of impurities present in the ore.

The two main methods employed are:

i. Physical method

ii. Chemical method

i. **Physical method:-** Physical method of concentration of ore is of following types:-

a. **Gravity separation or hydraulic washing:-** This method is used for the concentration of oxide ores of heavy metals such as lead, tin, iron etc. the method is based upon the difference in the densities of the ore and the gangue. The powdered ore is spread on special type of table having grooves on the top. A stream of water is thrown from one side of the table. The gangue particles being lighter are washed away with the stream of water leaving behind heavy ore particles on the table.

b. **Froth floatation process:-** This method is base upon the principle that the ore particles are preferentially wetted by oil where as gangue particles are preferentially wetted by water. This method is used for concentration of sulphide ores of copper, Zinc and lead.

The powdered ore is mixed with water in a large tank. Then some pine oil or ethyl xanthate is added to it. The mixture is agitated with air. The lighter ore particles are wetted by the oil and form a froth. The froth being lighter floats on the surface. Then the froth formed is transferred to another tank. However, the gangue particles being heavier settle at the bottom of the tank.

c. **Magnetic separation:-** This method is based upon the principle that the magnetic particles are attracted by a magnet where as non-magnetic particles are not attracted by a magnet and get separated.

The powdered ore is placed on a leather belt which passes over two rollers, one of which is magnetic and other is non magnetic. When the magnetic particles come over the roller they are attracted to the magnetic roller and fall apart from the non-magnetic particles.

ii. **Chemical separation or by leaching:-** It is based upon the principle that gangue and ore have different properties and behave differently towards a chemical reagent.

In this case, the powdered ore is treated with a suitable reagent (like acid, base etc.) which dissolves the ore particles where as gangue is left behind and are removed by filtration. This process is called leaching.

For example, bauxite ore ($Al_2O_3\ 2H_2O$) can be concentrated by this method. The powdered bauxite ore is heated with concentrated (45%) sodium hydroxide. As a result, aluminium oxide present in the ore reacts with NaOH solution to form water soluble sodium aluminate.

$$Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$$

Silica present in the ore also reacts with NaOH to form water soluble sodium silicate.

$$SiO_2 + 2NaOH \longrightarrow Na_2SiO_3 + H_2O$$

Iron oxide present in the ore does not dissolve in NaOH and thus remains as insoluble. It is separated out by filtration.

The filtrate containing sodium aluminate and sodium silicate is diluted with water and stirred.

Sodium aluminate reacts with water to form a precipitate of aluminium hydroxide where as sodium silicate does not react and remains in the solution.

$$NaAlO_2 + 2H_2O \longrightarrow Al(OH)_3 + NaOH$$

The precipitate is washed, dried and then heated strongly. It decomposes to give pure alumina.

$$2Al(OH)_3 \xrightarrow[\text{Heating}]{\text{Strong}} Al_2O_3 + 3H_2O$$

2. **Extraction of the metal from the concentrated ore:-** The method used for the extraction of the metal from the concentrated ore depends upon the nature of the

metal. Based on their reactivity, the metals have been grouped into the following three categories.

a. Metals of low reactivity (low in the activity series)
b. Metals of medium reactivity (in the middle of the activity series)
c. Metals of high reactivity (At top of the activity series)

a. Extraction of metals low in the activity series (Cu, Hg, Ag, Au, Pt)

Among these metals gold and platinum are found in their native states. Taking examples of Cu and Hg, the basic principles of their extraction from the concentrated ore are explained below:-

As their most common ore are sulphides therefore, the step required for extraction is roasting. As a result metal sulphides are converted into metal oxides, the oxides formed on further heating are reduced to metals. For example:-

$$2HgS + 3O_2 \xrightarrow{\text{Heating}} 2HgO + 2SO_2$$

(Cinnabar ore of Hg)

$$2HgO \xrightarrow{\text{Heat}} 2Hg + O_2$$

Similarly,

$$2\,Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$$
$$2\,Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$$

b. Extraction of metals in the middle of the activity series (Fe, Zn, Pb etc.)

These metals are found in nature in the form of their oxides, sulphides and carbonate ores. Further, as it is easier to reduce oxides than sulphides and carbonates, therefore, the sulphide and carbonate ores are first converted into the corresponding metal oxides. The different steps involved are as follows:-

i. Calcination (For carbonate ores):- It is the process of heating the carbonate ore strongly in the absence of air, so as to form metal oxide e.g.

$$ZnCO_3 \xrightarrow{\text{Heating}} ZnO + CO_2$$

(Calamine ore of Zinc)

ii. Roasting (for sulphide ores):- It is the process of heating the sulphide ore strongly in presence of air.

$$2ZnS + 3O_2 \xrightarrow[\text{Presence of air}]{\text{Heating}} 2ZnO + 2SO_2$$

The metal oxides obtained above can not be reduced alone into their corresponding metals. Therefore, a suitable reducing agent such as carbon (Coke) is used. e.g.

$$Fe_2O_3 + 3C \xrightarrow{\Delta} 2Fe + 3CO$$
$$ZnO + C \longrightarrow Zn + CO$$

The reduction of metal oxides by heating with coke is called smelting.

However, the oxides of metals like chlorine and manganese can not be reduced by using coke. Therefore, such metal oxides are reduced by strongly heating the mixture with aluminium e.g.

$$Cl_2O_3 + 2Al \longrightarrow 2Cl + Al_2O_3$$
$$3\,MnO_2 + 4\,Al \longrightarrow 3\,Mn + 2Al_2O_3$$

The reduction of metals oxides to metal using aluminium as reducing agent is called as aluminothermy.

b. Extraction of metals High up in the activity series (K, Ca, Mg, and Al) (Electrometallurgy):- The process of extraction of the metal from the concentrated ore using electric current or by electrolysis is called electro metallurgy.

The highly electro positive metals such as Li, Na, K, Ca, Mg etc are extracted by this method. These metals are extracted by the electrolysis of their molten halide or oxides. The metal is produced at cathode. e.g. sodium is obtained by the electrolysis of molten Na Cl.

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

At cathode

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

At Anode

$2Cl^- - 2e \longrightarrow 2Cl$

$2Cl \longrightarrow Cl_2$

The active metals can't be obtained by reduction of their oxides with coke because these metal oxides are very stable. Similarly electrolysis of Al_2O_3 can be represented as follows:

At Cathode.

$Al^{3+} + 3e^- \longrightarrow Al$

At anode

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

$O + O \longrightarrow O_2$

3. Refining of impure metals:- The process of purifying the impure (crude) metal is called refining of the metal.

The most commonly employed method for the purification of metals is electrolytic refining. A large number of metals such as copper, silver, gold, nickel, chromium, zinc, aluminium, tin, lead etc are purified by this method. To understand the process, let us take the example of electrolytic refining of copper.

To follow up the procedure, a container called electrolytic tank is taken. In this tank a solution of copper sulphate is taken as an electrolyte. The impure copper is taken as anode. A thin plate of pure copper acts as cathode. On passing electric current, pure copper from the anode passes into the solution as Cu^{2+} ions. An equivalent amount of Cu^{2+} ions from the solution are deposited on the cathode as pure copper. The reactions that take place at cathode and anode are shown as follows:-

At Anode

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

Copper atom — Copper ions

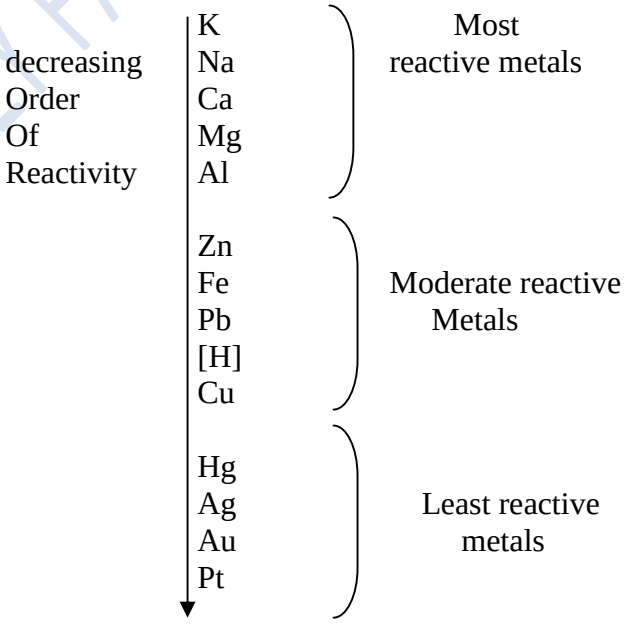
At Cathode

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

Copper ions — Copper atom

Q. What is activity series?

Ans. The arrangement of metals in a vertical column in order of their decreasing reactivity with respect to each other is called activity series of metals. In activity series, the most active metal is placed at the top, where as the least reactive metal is placed at the bottom.



Q. What is corrosion? Explain by suitable examples.

Ans. The process of slow eating up (decay) of metals due to their conversion into oxides, carbonates, sulphides, sulphates etc. by the action of atmospheric gases and moisture is called corrosion. A few examples of corrosion are given below:

i. When iron is exposed to moist air for a long time, its surface gets covered with a coating of a brown, flaky (or non-sticky) substance called rust. This is due to the reaction of oxygen and moisture (present in the air) on the surface of iron. Rust is mainly hydrated ferric oxide.

$$2Fe + {}^{3}/_{2}\,O_2 + X\,H_2O \longrightarrow Fe_2O_3\ X\,H_2O$$

Iron (air) moisture (Rust)

ii. Similarly copper objects when remain exposed to air, their surface reacts with CO_2 and moisture present in the air forming a green carting of basic copper carbonate.

$$2Cu + CO_2 + O_2 + H_2O \longrightarrow CuCO_3\text{-}Cu(OH)_2$$

Copper (From moist air) (Basic copper green)

iii. The surface of silver metal gets tarnished on exposure to air. This is due to the formation of a coating of black silver sulphide (Ag_2S) on its surface by the action H_2S gas present in air.

$$2Ag + H_2S \longrightarrow Ag_2S + H_2$$

Silver — Silver Sulphide (Black)

Q. What is Rusting? State the conditions necessary for rusting.

Ans. Corrosion of iron is called rusting i.e. when iron is exposed to moist air for a long time, its surface acquires a coating of a red brown flaky substance called rust. Rust is mainly hydrated iron oxide. ($Fe_2O_3\ X\,H_2O$)

During rusting of iron, iron metal combines with oxygen of air in presence of moisture to form hydrated iron oxide. The number of molecules of water varies in it, but is not fixed. Rust can be commonly observed in the form of red brown flaky substance on screws, nails, pipes and railings. It is not only the iron which rusts, even the steel rusts on being exposed to damp air or on being kept in water but steel rusts less readily than iron.

The conditions necessary for rusting are:-

a. Presence of air
b. Presence of moisture.

Q. What are alloys? How alloys are prepared? Discuss various types of alloys with suitable examples.

Ans. An alloy is a homogeneous mixture of two or more metals, or a metal and a non-metal e.g. brass, bronze, alnico etc.

An alloy is usually prepared by first melting the main metal and then dissolving the other elements in it in definite proportions. It is then cooled to room temperature.

Alloys have been divided in to following three types.:-

1. **Ferrous Alloys:-** An alloy in which iron is present as one of the constituents is called as ferrous alloy. e.g. manganese steel (Fe = 86 %, Mn = 13% C= 1%) and nickel steel (iron = 96 – 98% Ni = 4- 2 %)
2. **Non- Ferrous alloys:-** An alloy which does not contain iron as a one of the constituents is called non-ferrous alloy. e.g.
   Brass (Cu = 80% Zn = 20 %)
   Bronze (Cu = 90% Sn = 10%)
3. **Amalgam:-** An alloy containing mercury as one of the constituent metals is known as amalgam e.g. sodium amalgam, zinc amalgam etc.

Q. What are the objectives/ advantages/ merits of alloy making?

Ans. Alloys are prepared to develop certain specific properties which are not possessed by constituent elements. The main objectives of alloy making are:-

1. To increase hardness. e.g. when carbon is added to iron, its hardness increases. This hardened iron is called steel.
2. To increase tensile strength. Chrome steel prepared by mixing iron and chromium has high tensile strength.
3. To increase resistance to corrosion. Stain less steel which is an alloy of iron, chromium and nickel resist corrosion.
4. To lower melting point Solder an alloy of tin and lead has a lower melting point than either of its constituents. It is therefore, used for joining electrical wires together.
5. To modify chemical reactivity. Sodium is highly reactive metal. Its reactivity can be reduced by making its alloy with mercury i.e. amalgam.
6. To reduce electrical conductivity. e.g. copper is not a good conductor when it is alloyed with other metals.
7. To modify colour. Aluminium is silvery white while copper is brown but aluminium bronze, an alloy of aluminium and copper has beautiful yellow colour and is used for making coins, picture frames and cheap jewelry.

Text Book Questions
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Q.1 Give an example of a metal which
a. is a liquid at room temp?
b. can be easily cut with a knife.
c. is the best conductor of heat.
d. is the poorest conductor of heat.

Ans. a. Metal which is liquid at room temp. is mercury.
b. Metals such as Lithium, Sodium, Potassium etc ca be cut with a knife.
c. Silver is the best conductor of heat.
d. Lead is the poorest conductor of heat.

Q. Explain the meaning of malleable and ductile.

Ans. **Malleability:** The property which allows the metals to be hammered into thin sheets is called malleability. Malleability is an important characteristic property of metals. Most of the metals are malleable. Gold and silver are the most malleable metals
Ductility:- The property which allows the metals to be drawn into thin wires is called ductility. Ductility is another characteristic property of metals. Most of the metals are ductile. Gold and silver are the most ductile metals. Gold is so ductile that 1 gram of gold can be drawn in to a wire of about 2 kilo meter.

Q. Why is sodium kept immersed in kerosene oil?

Ans. Sodium is a very reactive metal. It reacts with oxygen of the air to form sodium oxide. It also reacts with moisture present in air to form sodium hydroxide and hydrogen. The hydrogen thus produced some times catches fire & results in explosive type of reaction.

$$4\,Na + O_2 \longrightarrow 2Na_2O$$
$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

Therefore, to protect the metal and also to prevent accidental fires sodium is kept immersed in kerosene oil.

Q. Write equations for the reactions of:-
a. Iron with steam.
b. Calcium and potassium with water.

Ans. a. Iron reacts with steam to form magnetic oxide and hydrogen gas

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

(iron) (steam) (Magnetic oxide of iron)

b. Potassium reacts violently with cold water producing potassium hydroxide and hydrogen gas.

$$2K + 2H_2O \longrightarrow 2KOH + H_2 + Heat$$

Calcium reacts less violently with cold water as compared with that of potassium.

$$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$$

Q. Question in tabulated form available on book :

Ans. a. A can displace Cu, B can displace Fe, C can displace Ag. As order of reactivity of Cu, Fe and Ag is Fe > Cu> Ag. Hence B is the most reactive metal.

b. As B is more reactive than copper, it will displace copper from Cu (II) sulphate solution. Hence blue colour of $CuSO_4$ will fade.

c. B can displace Fe, A can displace Cu, C can displace Ag and D can displace none. Hence order of decreasing reactivity will be B>A>C>D.

Q. Which gas is produced when dilute hydrochloric acid is added to a reactive metal? Write the chemical reaction when iron reacts with dilute H_2SO_4.

Ans. When dilute hydrochloric acid is added to active metals like Zn, H_2 gas is produced.

$$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$$

Iron reacts with dilute sulphuric acid to produce hydrogen gas.

$$Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2$$

Q. What would you observe when Zinc is added to a solution of Iron (II) sulphate? Write the chemical equation that takes place.

Ans. From the activity series, it is evident that Zinc is more reactive than iron. Therefore, when Zinc is added to $FeSO_4$, iron gets displaced by Zinc as shown.

$$Zn + FeSO_4 \longrightarrow ZnSO_4 + Fe$$

Q. a. Write the electron dot structures of sodium, oxygen and magnesium.

Ans. The electronic configuration of Na is:-

K,	L	M
2	8	1

∴, Electron dot structure of Na

$Na^{\bullet}$

The electric configuration of oxygen is.

K	L
2	6

∴, Electron dot structure of oxygen is

$:\ddot{O}:$

Electronic Configuration of Magnesium is

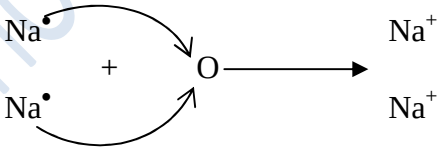
K	L	M
2	8	2

∴Electron dot structure of Mg is.

$Mg:$

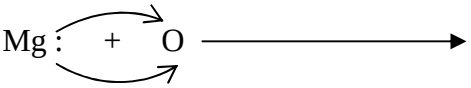
b. Show the formation of Na_2O and MgO by transfer of electrons.

Ans. Formation of Na_2O.



O^{2-} Or $[Na^+]_2\ [O^{2-}]$ or Na_2O

Formation of MgO



$Mg^{2+}\ [O]^{2-}$ or MgO

c. What are the ions present in these compounds.

Ans. a. In Na_2O, ions present are sodium Cation (Na^+) and oxide anion (O^{2-})

b. In MgO, ions present are magnesium cation (Mg^{2+}) and oxide anion (O^{2-})

Q. Why do ionic compounds have high melting point?

Ans. the compounds formedby the transfer of electrons from one atom to another are known as ionic compounds. These compounds are composed of cations and anions. These constituents (cations and anions) of ionic compounds are held together by very strong electrostatic forces of attraction. To break down these forces, a large amount of energy is needed. As a result, the melting points of ionic compounds are quite high.

Q. Name two metals which are found in nature in the free state.

Ans. Gold and Platinum.

Q. What chemical process is used for obtaining a metal from its oxide?

Ans. Metal is obtained from its oxide by reduction. This reduction can be done by heating metal oxides with carbon (coke) or by using highly reactive metals such as sodium, calcium, aluminium etc. e.g.

$ZnO + C \longrightarrow Zn + CO$

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

Q. Metallic oxides of Zinc, Magnesium and copper were heated with the following metals.

Metal Zinc Magnesium Copper Zinc oxide Magnesium oxide

Copper oxide=?

Ans. The position of the above given metals in the activity series is as follows:-

K> Na > **Mg** > Ca> Al> **Zn** > Fe > **Cu** > Ag > Au > Pt.

It is evident from the activity series that magnesium is more reactive than zinc followed by copper. Therefore, magnesium can displace both zinc and copper from their respective oxides as follows

$Mg + ZnO \longrightarrow MgO + Zn$

$Mg + CuO \longrightarrow MgO + Cu$

Also zinc can displace copper from copper oxide but can not displace magnesium from magnesium oxide

$Zn + CuO \longrightarrow ZnO + Cu$

$Zn + MgO \longrightarrow$ No reaction

Copper being least reactive among the given series of metals can neither displace magnesium nor zinc from their respective oxides.

$Cu + MgO \longrightarrow$ No reaction

$Cu + ZnO \longrightarrow$ No reaction

Q. Which metals do not corrode?

Ans. Metals such as Au, Ag and Pt which lie low in the activity series are highly un reactive. Therefore they are not attacked by atmospheric gases and moisture and hence do not corrode.

Q. What are amphoteric oxides? Give examples of two amphoferic oxides.

Ans. Oxides which react with both acids and bases to form salts and water are called amphoteric oxides. The well known examples of amphoferic oxides are Zinc oxide (ZnO) and aluminium oxide (Al_2O_3). They react with acids and bases as shown below:-

$ZnO + 2HCl \longrightarrow Zn\,Cl_2 + H_2O$ (Acid)

$ZnO + 2NaOH \longrightarrow Na_2\,ZnO_2 + H_2O$ (Base)

$Al_2O_3 + 6HCl \longrightarrow 2Al\,Cl_3 + 3H_2O$ (Acid)

$Al_2O_3 + 2NaOH \longrightarrow 2Na\,AlO_2 + H_2O$ (Basic)

Q. Difference between metals and non-metals on the basis of their physical properties.

Ans. The main features that distinguish metals from non-metals are given below:

Metals	Non –metals
1. Metals are generally solid in nature at room temp. (except Hg which is a liquid)	1. Non- metals exist in all the three states i.e. solid, liquid and gaseous state.
2.Metals possess bright luster.	2. Non-metals have dull appearance.
3. Metals have high density (except Na and K which are lighter than H_2O)	3. Non –metals have low densities (except diamond which has a high density.)
4. Metals are usually malleable (except zinc and Hg)	4. Non-metals are non-malleable.
5. Metals are usually ductile (except Zn and Hg)	5. Non-metals are not ductile.
6. Metals are hard and have high tensile strength	6. Non-metals are soft in nature (except diamond which is hardest substance known)
7. Metals are hard but not brittle	7. Non-metals are brittle in nature
8. Metals are good conductors of heat and electricity	8. Non metals are non-conductors of heat and electricity except carbon (graphite).
9. Generally metals have high melting and boiling points	9. Non-metals have low melting and boiling points (except carbon, boron and silicon).

Q. Compare metals with non-metals on the basis of their chemical properties.

Metals	Non-metals
1. Atoms of metals usually have 1,2, or 3 electrons in their outer most shells.	1. Atoms of non-metals usually have 4 to 7 electrons in their outer most shells.
2. Metals form positive ions by losing electrons i.e. they are electropositive	2. Non metals form negative ions by gaining electrons i.e. they are electronegative in nature.
3. Metals above hydrogen in the activity series usually replace hydrogen from dilute acids.	3. Non- metals do not react with acids.
4. Almost all metals react with oxygen to form oxides. The oxides of metals are generally basic in nature.	4. Non-metals react with oxygen to form oxides, which are generally acidic in nature.
5. Metals have a tendency to lose electrons and hence act as reducing agents. $Na - e^- \longrightarrow Na^+$	5. Non –metals have a tendency to gain act as oxidizing agents. $Cl + e^- \longrightarrow Cl^-$
6. Metallic chlorides are ionic in nature. They act as electrolytes	6. Non-metal chlorides are covalent in nature and act as not-electrolytes.

Chemistry. 10th/10 (Periodic Classification of elements)

Q. Why is there need for classifications of Elements?

Ans. There are 115 elements (natural and synthetic) known at present. It is very difficult to study the properties of all these elements separately. To ease out this problem, there is necessity of classifying these elements into groups having some what similar properties. Based upon similarities in physical and chemical properties, various elements have been arranged in several groups or families in order to simplify and systematize the study of these elements. The arrangement of putting the elements with similar properties together and separating the elements with dissimilar properties from one another is known as classification of elements and the table which classifies the elements into such families is called the periodic table.

Doberenier's Law of triads. :-

In 1817, Johann wolfgang Dobereiner a great German chemist identified certain groups of three elements having similar properties. These groups of three elements were called Dobereiner's triads after his name. This classification is based upon the law known as Dobereiner's law of triads. The law states that when the three elements are arranged in order of their increasing atomic masses the atomic mass of the middle element is approximately the arithmetic mean of the other two elements.

Some examples of triads are as follows:

i. The three elements Lithium (L_i), sodium (Na) and potassium (K) have similar properties, these elements constitute a Dobereiar Triad, because the atomic mass of middle element i.e. sodium is 23 u which is very nearly the average (22.95 u) of atomic masses of lithium and potassium as shown below:-

i.	Elements of Triad	At. mass	average. Of At. Mass
	Lithium (Li)	7	of Li + K= $\frac{7 + 39}{2}$
	Sodium (Na)	23	= 23
	Potassium (K)	39.	

ii.	Triad:	At. mass	
	Chlorine	35.5	
	Bromine	80	Mean $\frac{= 35.5 + 127}{2}$ =81.2
	Iodine	127	

iii.	Triad	At. mass	
	Calcium	40	
	Strontium	88	Mean $\frac{= 40 + 137}{2}$ = 88.5
	Barium	137	

Q. What were the limitations of Dobereiner's classification of elements? Or what were the reasons of rejection of D – Classification?

Ans. The limitations of Dobereiner's classification are:-

1, He failed to arrange all the known elements of that time into triads.

2, Some of the known elements in spite of having similar chemical properties do not constitute a triad. e.g. nitrogen (N), phosphorus (P) and arsenic (As).

Thus this system of classification by Dobereiner was rejected.

Q. What is Newland's law of Octaves? Explain with an example?

Ans. In 1866, John Alexander Newland proposed a new system of grouping elements based on Newland's law of octaves. According to Newland's law of octaves when elements are arranged in order of their increasing atomic masses, the properties of every eighth element are similar to the first element like the eighth note of a musical scale.

For example, if we take lithium (Li) as the first element then the eight element from it will be sodium, according to Newland's law of octaves, these two elements must have similar properties.

Again if we take sodium (Na) as the first element then eighth element from it will be potassium (K), according to Newland's law of octaves, these two elements must have similar properties. In fact, all the three elements, Lithium. Sodium and potassium have similar properties. This can be illustrated by the following table.

H	Li	Be	B	C	N	O
1	7	9	11	12	14	16
F	Na	Mg	Al	Si	P	S
19	23	24	27	28	31	32
Cl	K	Ca				
35.5	39	40				

Q. What were the limitations of Newland's law of classification?

OR

What were the reasons for discarding (Rejecting) Newland's law of octaves?

Ans 1. Newland's law of octaves was applicable only to the classification of elements up to calcium because after calcium, every eighth element did not possess properties similar to that of the first.

2. Newland assumed that only 56 elements existed in nature and no more elements would be discovered in future. But, later on, several new elements were discovered whose properties did not fit into the octaves.

3. In order to fit elements into his table, Newland not only placed two elements in the same slot but also placed some unlike elements in the same column e.g. Cobalt and Nickel were put together in one slot. The slot was placed in the column of chlorine, Bromine and fluorine which have different properties than Co and Ni. Element iron (Fe) which has properties similar to Cobalt and Nickel was placed far away from them.

4. Noble gases which were not discovered at that time, after their discovery the properties of eighth element were no longer similar to the first one.

Q. State Mendeleev's Periodic Law.

Ans. Mendeleev's Periodic Law states that, "the physical and chemical properties of elements are a periodic function of their atomic masses. It may also be stated as:

When elements are arranged in order of their increasing atomic masses, elements with similar properties are repeated after certain regular intervals.

Q. What is Mendeleev's Periodic table? Describe the essential features of Mendeleev's periodic table.

Ans. <u>Mendeleev's Periodic Table:-</u>

It is a table or chart in which the various elements have been arranged in order of their increasing atomic masses, such that the elements having similar properties occur in the same vertical column (or group). It is based upon the Mendeleev's periodic law.

<u>Essential or main features of Mendeleev's periodic table.:-</u>

The essential or main features of Mendeleev's Periodic table are as under:-

1, It is based upon Mendeleev's periodic law.

2. The table is divided vertically into columns called groups. These are numbered I, II, III, IV, V, VI, VII and VIII.

3. Except group VIII each group is further divided into two sub- families called sub-groups A and B.

4. The elements placed to the left in the column form sub-group A. These are called normal or representative elements.

5. The elements placed to the right in the column form the sub-group B. These are called transition elements.

6. Group VIII contains transition elements in three sets. Each set contains three elements. These three sets lie in the 4^{th}, 5^{th} and 6^{th} period.

7. The horizontal rows are called periods. There are seven periods which are numbered as 1, 2, 3, 4, 5, 6, and 7.

Q. What are the merits of Mendeleev's Periodic table?

Ans. 1, It made the study of elements simple and systematic.

2. It is based upon fundamental property of an element i.e. atomic weight or mass.

3. In Mendeleev's periodic table some gaps were left for the undiscovered elements like gallium (Ga) and Germanium (Ge) when these elements were discovered later on, they were placed in the gaps/spaces left by Mendeleev for those elements without disturbing the existing elements.

Q. What are the limitations of Mendeleev's periodic table?

Ans. The limitations of Mendeleev's Periodic Table are discussed as follows:-

i. <u>Position of hydrogen:-</u> The position of hydrogen is undecided in Mendeleev's Periodic table. It shows some chemical properties similar to both the alkali metals and the

halogens. And Mendeleev could not decide whether it should be placed at the head of the table in group I along with alkali metals or in group VII along with halogens

ii. **Position of Isotopes:-** Isotopes are the atoms of the same element having different atomic masses but the same atomic no. Therefore according to Mendeleev's classification, these should be placed at separate positions in the periodic table. For example three isotopes of hydrogen namely protium (H), deuterium (D) and tritium (T) with atomic masses 1, 2 and 3 respectively, have been placed in the same group in the periodic table. The placing of these three isotopes in the same group of periodic table could not be explained by M.P. law in Mendeleev's Periodic table,

iii. **Anomalous Pairs of elements:-** In Mendeleev's periodic table, the elements are arranged on the basis of their increasing atomic masses. How ever, there are such pairs in which atomic masses of preceding elements is more than that of the following elements e.g.

Preceding elements	Following elements
Cobalt (58.9)	Nickel (58.7)
Tellurium (127.6)	Iodine (126.9)

iv. **Uncertainty in prediction of new elements:-**

It was not possible to predict the number of elements that can be discovered between the two known elements especially among heavier elements. This is because atomic masses do not increase in regular manner in going from one element to another.

v. No attempt has been made to place metals and non-metals separately in the periodic table.

vi. **Cause of Periodicity:-**

Mendeleev did not explain the cause of periodicity among the elements when arranged in the order of increasing atomic mass.

Q. State Modern periodic law?

Ans. **Modern periodic law:-** In 1913 Henry Mosely showed that atomic number of an element is a more fundamental property than its atomic mass. Therefore, he suggested that the basis of classification of elements should be atomic number. This led to modern periodic law which states that, "the physical and chemical properties of the elements are a periodic function of their atomic numbers."

It means that if the elements are arranged in order of increasing atomic numbers, the elements with similar properties are repeated after certain regular intervals.

These regular intervals are called magic number which are 2, 8, 8, 18, 18, & 32

Q. What is modern periodic table? Give description of modern periodic table in detail.

Ans. It is a table or chart based upon modern periodic law. In this table the elements are arranged in order of increasing atomic numbers such that the elements having similar properties occur in the same vertical column called group.

The periodic table is based on valence shell electronic configuration of elements. This table is also called as Bohr's periodic table. Since it follows the Bohr's scheme for arrangement of various electrons around the nucleus, the table is also called long form periodic table.

Structural features of long form of periodic table or Modern periodic table:-

The long form of the periodic table or modern periodic table consists of 18 vertical columns called groups and 7 horizontal rows called periods. The description of the various groups and periods is as follows:-

1. **Groups:-** Vertical columns in the periodic table are called groups or families. These are 18 in number. These groups are designated as IA, IIA, IIIB, IVB, VB, VIB, VIIB, VIIIB, IB, IIB, IIIA, IVA, VA, VIA, VIIA and zero. According to IUPAC system, these are numbered as 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, and 18. The important groups are.

a. Group 1 elements are called alkali metals.

b. Group 2 elements are called alkaline earth metals.
c. group 17 elements are called halogens.
d. Group 18 elements are called noble gases or zero group.
e. The elements of groups 1,2 on the extreme left and groups 13 to 17 on the extreme right are called normal or typical or representative elements.
f. The elements of groups 3 to 12 are called transition elements.

2. **Periods:-** Horizontal rows in the periodic table are called periods. There are seven periods and each period begins with an alkali metal and ends up with a noble gas.
a. The first period contains only two elements i.e, H and He and is the shortest period.
b. The 2^{nd} and 3^{rd} periods contain 8 elements each i.e. Lithium to Neon (Ne) and Sodium (Na) to Argon (Ar) respectively. These are also known as short periods.
c. The 4^{th} and 5^{th} periods contain 18 elements each i.e. Potassium (K) to Krypton (Kr) and Rubidium (Rb) to Xenon (Xe) respectively. These are also called long periods
d. The sixth (6^{th}) period is the longest and contains 32 elements i.e. cesium (Cs) to Radon (Rn)
e. The 7^{th} (seventh) period is an incomplete long period of 26 elements i:e Francium (Fr) to Ununbium (liub)
3. The two series of elements known as the lanthanides and actinides have been placed separately at the bottom of the periodic table these are collectively known as inner transition elements.
4. **Blocks:-** In the modern P. T. on the basis of outer electronic conjugation the elements have been classified into four blocks. These are
   a. S- Block elements
   b. P. block elements
   c. D- block or transition elements
   d. F- block or inner transition elements.

4, In modern periodic table there are four types of elements 1. metals, 2. Non-metals, 3. Metalloids and 4. Noble gases.

Q. **List the merits (Advantages) of modern periodic table.**

Ans. Following are the main advantages of modern periodic table.
1. It has simplified the study of elements.
2. The arrangement of the elements is based on a more fundamental basis i.e. atomic number.
3. It is a chart easy to remember and to reproduce.
4. It relates the position of an element to its outer electronic configuration.
5. It reflects the similarities, differences and trends in chemical properties more clearly.
6. Noble gases have been arranged at proper position in the periodic table.
7. It explains variations and similarities in properties of elements in terms of their electronic configuration.

Q. List the demerits of modern periodic table.

Ans. Following are the disadvantages (demerits) of modern periodic table:-
1, The position of hydrogen is not certain in the periodic table.
2. Lanthanides and Actinides do not find a proper position in the periodic table.
3. It doses not reflect the exact distribution of electrons among all the elements.
4. The Isotopes of an element occupy the same position in the modern periodic table.
5. In this table, there is a clear demarcation between active metals, non-metals, metalloids, transition elements, inert gases, lanthanides and actinides.

Q. What is meant by the term periodicity? What is the cause of periodicity?

Ans. **Periodicity:-** The repetition of elements with similar properties after certain fixed intervals in atomic numbers when arranged in order of their increasing atomic numbers called periodicity

Cause of Periodicity:- After intervals of 2,8,8,18,18 and 32 the elements with similar valence shell electronic configuration get repeated. Hence the cause of periodicity in the properties of elements is the repetition of elements with similar outer electronic configuration after certain, fixed intervals of atomic numbers.

In any group, the elements have similar outer electronic configuration and hence they have similar properties.

Q. Compare and contrast the arrangements of elements in Mendeleev's periodic table and modern periodic table.

Ans. Following are some of the main points of difference between Mendeleev's periodic table and Modern periodic table.

Mendeleev's Periodic Table	**Modern Periodic Table**
1, The elements are arranged in increasing order of their atomic masses	1, The elements are arranged in increasing order of their atomic numbers or proton numbers
2, It, has eight vertical columns called groups	2, It has eighteen vertical columns called groups.
3, Each group is further divided into two sub-groups.	3, There is no further division of the groups.
4, It accommodates only 63 elements	4, It accommodates almost 115 elements
5, It does not contain noble gases	5, It includes noble gases.
6, There is no provision for isotopes of an element, since their atomic masses are different.	6, Separate positions for isotopes of an element are not required because they have the same atomic no.
7, In this table many metals and non metals were grouped together .	7, In this table metals are on the left side and non metals are on the right side.

Q. State the trends in the physical and chemical properties of elements in the periodic table.

Ans. The physical and chemical properties of elements show regular gradation along a period and down a group. In the periodic table, some of these properties are described below:-

1. **Valency:-** It is defined as the combining capacity of an atom or element. It is equal to the numbers of electrons present in outer most shell for the elements in groups 1, 2, 13 and 14. For elements in groups 15, 16, 17 and 18 it is equal to eighteen minus group no (18-group No.)

   Variation of valency (for the elements of groups 1,2,13, 14, 15, 16, 17, & 18)

a. **Down Group:-** In a group all the elements have same no. of electrons in their valence shells hence in a group all the elements have same valency. e.g. consider Group 1 elements, all the elements of group 1 show valency of same because they have one electron in their valence shells.

b. **Along a Period:-** As we move from left to right along a period, valency changes from 1 to 4 and 4 to zero . e.g. consider the elements of 2nd period

Group No.	1	2	13	14	15	16	17	18
Elements	Li	Be	B	C	N	O	F	Ne
No of Valence Electrons.	1	2	3	4	5	6	7	8
Valency	1	2	3	4	3	2	1	0
					(18-15)	(18-16)	(19-17)	(18-18)

2. Atomic Radius (Atomic Size):-

Ans. Atomic radius (or atomic size) may be defined as,

the distance between the centre of the nucleus and the outer most shell which contains electrons. Atomic size is expressed in Angstrom unit or A^o ($1A^o = 10^{-10}m$)

Variation of atomic radius:-

a. **Down a Group:-** As we move from top to bottom in a group, the number of electronic shells increases which tends to increase atomic radius. Also the magnitude of nuclear charge increases which tends to decrease atomic radius. Since the first factor predominates the second factor, therefore, atomic size increases along a group.

b. **Along a period:-** As we move from left to right along a period, the no. of electronic shells remain the same but the magnitude of nuclear charge increases. Due to increase in nuclear charge, the electrons in the outermost orbit are attracted with a greater force. Thus the outermost shell is drawn closer and closer towards the nucleus. Hence the atomic radius decreases.
It may be noted, that in any period, the noble gas has the biggest size.

3. **Metallic Character:-** The elements which have a tendency to loose electrons and form positive ions (cations) are called metals. These elements are said to have metallic (or electro +ve) character.

e.g. $Na - \overline{e} \longrightarrow Na^+$
$K - \overline{e} \longrightarrow K^+$

The metallic character of an element also depends up on, atomic size and nuclear charge.

Variation of Metallic Character:-

a. **Along a Period:-** On moving from left to right along a period, the magnitude of nuclear charge increases and atomic size decreases. Therefore metallic character goes on decreasing e.g.

Consider the second period,

Li Be B C N O F Ne →
Metallic character goes on decreasing

b. **Down a group:-**

As we move from top to bottom in a group, the increase in atomic size predominates the increase in nuclear charge therefore, metallic character goes on increasing e.g.

Consider group -1 elements

Li
Na
K
Rb
Cs
Fr

Metallic character goes on increasing

4. **Non -Metallic character:-** The elements that have tendency to gain electrons to form negative ions (anion) are called non –metals. They do so in order to complete their Octet . e.g.

$Cl + \overline{e} \longrightarrow \overline{Cl} + \text{energy}$
$O + 2\overline{e} \longrightarrow O^{2-} + \text{energy}$

Variation of Non-metallic character:-

a. **Along a period:-** As we move from left to right along a period, the atomic size decreases and nuclear charge increases. This leads in increase in non-metallic character.

e.g. consider the third period,

Na Mg Al Si P S Cl
Metal Metal Metal Metalloid Non metal Non metal
Nonmetal →
Non- metallic character increases.

b. **Down a Group:-** As we move from top to bottom in a group, there is an increase in atomic size as well as in nuclear charge. However, increase in atomic size predominates the increase in nuclear charge. Therefore, the non-metallic character decreases. e.g. Consider group 14 elements.

N	(Non-metal)	
P	(Non – metal)	non metallic
As	(Metalloid)	character
Sb	(metalloid)	decreases.
Bi	(Metal**)**	

Text book questions

Q. Did Dobereiner's triads also exist in the columns of Newland's octave's? Compare and find out.

Ans. Yes, Dobereiner's triads do exist in the columns of Newland's Octave's. e.g. atomic mass of Na is the average atomic mass of Li and K as shown below:

Element	at. Mass
Li	7
Na	23
K	39

Average atomic mass of Li and K = $\frac{Li + K}{2} = \frac{7 + 39}{2} = \frac{46}{2} = 23$, which is equal to the atomic mass of Na. As the atomic mass is of Na is the average atomic mass of Li and K as shown above: Thus it is clear that Li,Na & K constitute a Dobereiner's Triad

Similarly, if we consider Li as the first element then the eighth element from it is Na and if we consider Na as the first element then eighth element from it is K. The elements from Li to Na constitute one Newland's Octave and elements from Na to K constitute another Newland's Octave as shown below.

First element eighth element ⋮ first element eighth element

Li Na ⋮ Na K

↑ Newland's Octave ↑ ↑ Newland's Octave ↑

This shows that Dobereiner's Triads also exist in the columns of Newland's Octaves.

Q. Use Mendleev's periodic table to predict the formula for the oxides of the following elements; K, C, Al, Si, Ba

Ans. By using Mendleev's periodic table we can predict the formulae of oxides of the following elements:

(i) Potassium (K) belongs to group 1 or IA (alkali metals) and shows valency of 1. Therefore, the formula of its oxide is K_2O.

(ii) Carbon and silicon belong to group 14 or IV A of the periodic table. Both these elements show valency equal to 4. Therefore, the formulae of their oxides is CO_2 and SiO_2 respectively.

(iii) Aluminum belongs to group 13 or IIIA of the periodic table. Its valency is 3 therefore, the formula of its oxide is Al_2O_3.

(iv) Barium belongs to group 2^{nd} of the periodic table. It shows a valency of 2 therefore, the formula of its oxide is BaO.

Q. Besides gallium, which other elements have since been discovered that fill the gaps left by Mendeleev in his periodic table? (Any two)

Ans. Besides gallium elements like germanium (Ge) of group IVA, polonium (Po) of group VIA and astanine (At) of group VIIA have been discovered after Mendeleev and filled the gapes left by Mendeleev in his periodic table and even predicted their properties.

Q. What were the criteria used by Mendeleev in creating his periodic table?

Ans. The criteria which Mendeleev used for creating his periodic table were:-

1, The physical and chemical properties of elements are a periodic function of their atomic masses.

2, Similarity in physical properties of the elements falling in same group.

3, Similarity in the formula of hydrides and oxides of these elements falling in same group.

Q. Why do you think the noble gases are placed in separate group?

Ans. Out of all the elements known, noble gases such as He, Ne, Ar, Kr and Xe are the most inert (un reactive) and all the noble gases have complete outer shell. Besides their properties do not match with any element in any group in the periodic table. That is why they are placed together in a separate group called zero group in the Periodic table.

Q. Name two elements you would expect to show chemical reactions similar to magnesium. What is the basis for your choice:-

Ans. Calcium (Ca) and strontium (Sr) are the two elements which show chemical reactions similar to magnesium.

The basis for the choice is that they belong to same group (2^{nd}) and have similar outer electronic configuration.

In addition to this the general chemical formula of their oxides and hydrides is same. e.g. both Ca and Sr have the general formula of their oxides as RO and hydrides RH_2.

Q. Name three elements that have a single electron in their outer most shell.

Ans. Lithium (Li) sodium (Na) and potassium (K) of group 1 of .P.T. are the three elements that have a single electron in their outer most shell e.g.

Element	At. No.	Electronic configuration
Li	3	2, 1
Na	11	2, 8, 1
K	19	2, 8, 8, 1

b. Name two elements that have two electron in their valence shells,

Ans. Beryllium (Be) and Magnesium(Mg) of group 2^{nd} of P. T. are the two elements that have two electrons in their valence shells.

Element	At. No.	Electronic configuration
Be	4	2, 2
Mg	12	2, 8, 2

c. Name three elements with filled outer most shells

Ans. Helium (He) Neon (Ne) and Argon (Ar) of group 18^{th} of the periodic table have filled outer most shells.

Element	At. No.	Electronic configuration
He	2	2
Ne	10	2, 8
Ar	18	2, 8, 8

Q. Lithium, Sodium, Potassium are all metals that react with water to liberate hydrogen gas. Is there any similarity in the atoms of these elements?

Ans. Lithium, Sodium and Potassium all react with water to form alkalies with the liberation of hydrogen gas

The similarity in the atoms of these elements is that all these atoms contain one electron in their respective outermost shells.

Q. By considering their position in the periodic table, which one of the following elements would you expect to have the maximum metallic character?

Ga, Ge, As, Se, Be.

Ans. Arranging the above elements in different groups and periods in order of their increasing atomic numbers we have

Periods	Group1	G2	G13	G14	G15	G16
-	-	-	-	-	-	-
2	-	Be	-	-	-	-
3	-	-	-	-	-	-
4	-	-	Ga	Ge	As	Se

We know that metallic character decreases from left to right in a period and increases down a group. There fore, out of these elements listed above, Be and Ga are expected to be most metallic. Out of Be and Ga, Ga is bigger is size and hence has greater tendency to loose electrons than Be therefore, Ga is more metallic than Be.

Q. What property do all elements in the same column of the periodic table as Boron have in common?

Ans. All the elements which lie in the same column as that of Boron belong to group 13. Therefore they have three electrons in their respective valance shells except Boron which is a non-metal. All other elements i.e. Aluminum, Gallium, Indium, and thallium in this group are metals.

Q. What property do all elements in the same column of periodic table as fluorine have in common?

Ans. The elements which lie in the same column as fluorine are called halogens. They belong to group- 17. All these elements have 7 electrons in the valance shell. Therefore, their valency is 18-17=1. All these elements, chlorine, bromine, iodine and astatine are non-metals.