Chapter 15

Organic Compounds

Major Concepts

15.1 Sources
- 15.1.1 Fossil remains: Coal, Petroleum, and Natural Gas
- 15.1.2 Plants and Natural Products
- 15.1.3 Partial and Total Synthesis
- 15.1.4 Biotechnology

15.2 Coal as a source of Organic Compounds
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15.3 Characteristics of Organic Compounds

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15.6 Functional Groups and Homologous Series

15. 7 Detection of Elements in Organic Compounds

Learning Outcomes:

Students will be able to:

- Define organic chemistry and organic compounds. **(Remembering)**
- Explain why there is such a diversity and magnitude of organic compounds. **(Analyzing)**
- Classify organic compounds on structural basis. **(Analyzing)**
- Explain the use of coal as a source of both aliphatic and aromatic hydrocarbons. **(Understanding)**
- Explain the use of plants as a source of organic compounds. **(Understanding)**
- Explain that organic compounds are also synthesized in the lab. **(Understanding)**
- Define functional groups and homologous series. **(Remembering)**

Introduction

In the late eighteen and the early nineteenth centuries, the chemists classified compounds into two main classes, organic and inorganic. Compounds obtained from plants or animals were called organic, whereas compounds obtained from non-living sources were called inorganic. For example, the acetic acid (from vinegars) and tartaric acid (from grapes) were called organic, whereas the marbles (from rocks) and sodium chloride (from rocks) were called inorganic.

Today organic compounds are the chemical compounds containing carbon and many other elements such as hydrogen, oxygen, nitrogen, sulphur, phosphorus and the halogens. A small number of carbon containing compounds not categorized as organic include carbonates, bicarbonates, carbides, cyanides, cyanates, CO, CO_2 and CS_2. Carbon is the major element in organic compounds. Carbon is highly essential to life. All living things such as plants, animals, fungi and micro-organism on earth are made of carbon compounds. Because of the great variety of ways that carbon can link with itself and other elements, there are more than 16 million carbon containing compounds. Chemists make thousands of new compounds every year, about more than 90% of them contain carbon. Much more than half of the world's chemists are organic chemists.

A somewhat more useful definition of organic compounds is: the hydrocarbons and their derivatives are called organic compounds. The compounds that contain carbon and hydrogen atoms are called hydrocarbons and the compounds that contain oxygen, nitrogen, sulphur, phosphorus and the halogens along with carbon and hydrogen are called derivatives of hydrocarbons.

Definition of organic chemistry

The branch of chemistry in which we study about hydrocarbons and their derivatives is called organic chemistry.

15.1 Sources of Organic Compounds

There are two main sources of organic compounds: (i) natural sources and (ii) synthetic sources. Natural organic compounds are present in our earth throughout our environment and they do not need to be made whereas the synthetic organic compounds are man-made and they do not occur naturally in the environment. The natural sources of organic compounds are: (i) fossil remains i.e. coal, petroleum and natural gas (ii) Plants (iii) animals.

15.1.1 Fossil Remains: Coal, Petroleum, Natural Gas

There are three major types of fossil remains: coal, petroleum and natural gas. They are formed by long time (over millions of years) decay of plants and animals.

Coal

Coal is a major source of organic compounds. It is a black solid fuel found under the earth. It is formed by decay of plants which were buried under the surface of earth for hundred millions (about 300 million) of years at high temperature and pressure. It yields coke (mostly carbon) and coal tar (complex mixture of organic compounds) on destructive distillation.

There are three main types of coal on the basis of carbon content that are lignite (about 70% C), bituminous (about 80% C) and anthracite (92–98% C). The quality of coal mainly depends on carbon content. Higher the carbon content better is the quality of coal. Older coal generally has higher carbon content than young ones.

Petroleum

Petroleum is the major sources of organic compounds. Petroleum (Latin: petra= rock, oleum = oil) is formed by bacterial decomposition of plants and animals buried deep under porous rocks due to pressure and heat. The deposits of petroleum are comparatively younger than coal. It is a mixture of gaseous and liquid hydrocarbons. Petroleum on fractional distillation yields gasoline, kerosene, diesel, lubricating oil, paraffin waxes etc.

Natural Gas

Natural gas is also the major sources of organic compounds. It is a mixture of low molecular mass hydrocarbons such as methane, ethane, propane and butane. Methane is nearly 85% while other compounds are present in very small amounts. It is formed by decay of organic matter. It is found in porous rocks near petroleum deposits.

15.1.2 Plants and Natural Products Chemistry

Plants and animals are the major sources of organic compounds. Many organic compounds are obtained directly from plants and animals by using suitable methods of isolation. The compounds that are obtained from living organisms (plants and animals) are called natural products and the study of such compounds is called natural product chemistry. The important natural products that are obtained from animals are proteins, hormones, animal fats, urea, insulin and the important natural products that are obtained from plants are carbohydrates (cellulose, sugars, starches), vitamins, alcohols, acetone, acids, esters, vegetable oil, dyes, drugs, perfumes and fibres (cotton, jute).

Society, Technology and Science

Important Medicines Obtained from Plants

Many plants are used to extract medicines. These medicines are useful in treating many diseases. Medicines obtained from plants are used in Ayurveda, Unani and Siddha systems of medicines. The ancient Chinese, Egyptians and Native Americans all used medicinal plants for the treatment of diseases. Some important medicinal plants, names of medicines and their uses are:

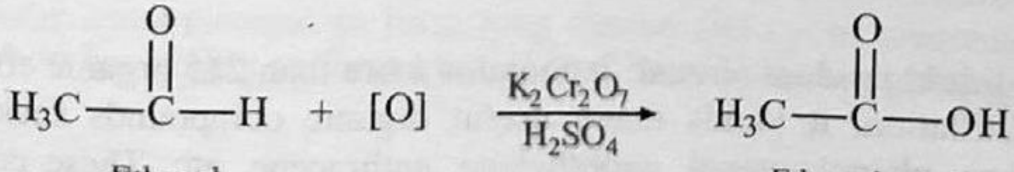
Medicine	Use	Medicinal Plants
Caffeine	CNS stimulant	Tea leaves, coffee beans, kola nuts, etc.
Aspirin	Analgesic, antipyretic	Willow tree and bark
Quinine	Antimalarial, antipyretic	Cinchona bark

Cocaine	Local anaesthetic	Coca plant
Ephedrine	hypotension, antihistamine	Ephedra
Morphine	Analgesic	Opium Poppy
Rutin	Treatment for capillary fragility	Citrus fruits such as orange, grapefruit, etc.
Papain	Proteolytic, mucolytic	Papaya
Nicotine	Neuroprotective, anti-inflammatory, insecticide	Tobacco
Menthol	Rubefacient	Mint
Gossypol	Male contraceptive	Cotton
Camphor	Rubefacient	Camphor tree
Bromelain	Anti-inflammatory, proteolytic	Pineapple
Senna glycoside	Laxative	Cinnamon

15.1.3 Partial and Total Synthesis

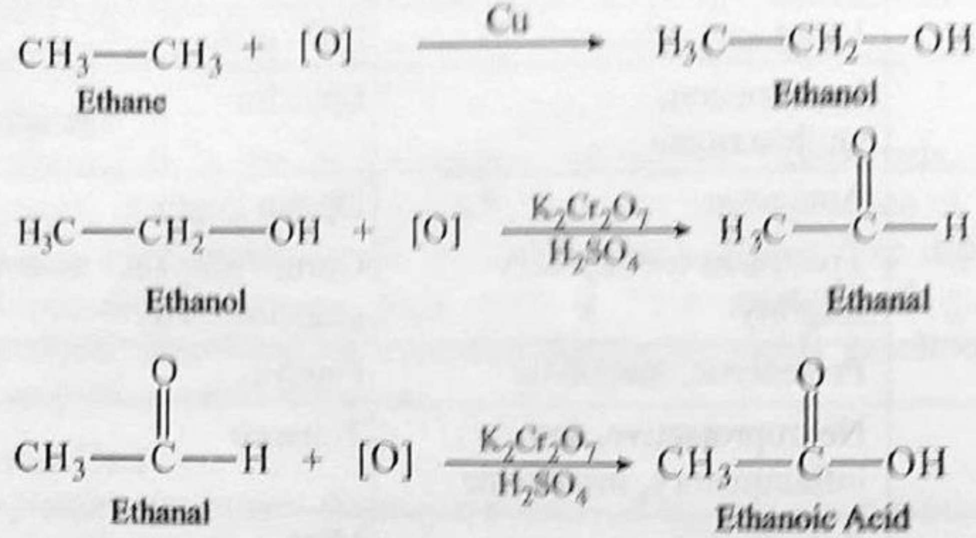
Many useful organic compounds including ether, glycol, drugs, rubber, fibres, dyes, plastics etc. are synthesized in the laboratory. Now-a-days synthesis is the most important source of organic compounds. The organic compounds that are synthesized in the laboratory are called synthetic compounds and the study of chemistry of such compounds is called synthetic chemistry.

Organic compounds can be synthesized either through partial synthesis or through total synthesis. The difference between partial and total synthesis is the starting material. In partial synthesis (semi-synthesis), the desired product is obtained from an intermediate product of reaction. For example, carboxylic acid is obtained by the oxidation of aldehyde by passing the oxidation of alkane and alcohol.



Ethanal — Ethanoic Acid

However, in total synthesis the starting material converts through various steps into desired product. For example, carboxylic acid can be obtained by the oxidation of alkane through various steps.



15.1.4 Products of Biotechnology

Biotechnology involves the use of living organisms' especially microorganisms or other biological systems in the manufacture of products or in industrial, agricultural, medical and technological applications. The compounds that are obtained by means of biotechnology are called products of biotechnology. Some of the important products of biotechnology are ethylene glycol, ethyl alcohol, hormones, acids, vitamins, vaccines, antibiotics, etc.

15.2 Coal as a Source of Organic Compounds

Coal is a most important source of organic compounds.

15.2.1 Destructive Distillation of Coal

When coal is heated strongly at 500–1000°C, in the absence of air, it is converted into various useful organic and inorganic products. This process is called destructive distillation of coal. The major products of coal are: coal gas, coal tar, ammoniacal liquor, and coke.

Coal Gas

It is mixture of hydrogen (H_2), methane (CH_4), carbon monoxide (CO) and other gases. It is an excellent fuel. In the past, it was used for domestic cooking and lighting. Nowadays it is used as fuel in industries.

Coal Tar

It is a liquid product of coal. It contains more than 215 organic compounds. On fractional distillation, it yields many useful organic compounds such as benzene, toluene, xylene, phenol, cresol, naphthalene, anthracene, etc. These compounds are used in the manufacture of explosives, pesticides, perfumes, synthetic fibres, naphthalene balls, dyes and paints. Now a days these compounds are generally obtained from petroleum. The residue left is called pitch and is used for metalling of roads and as a binder for roof making.

Ammoniacal liquor

Am: onium compounds are obtained during the destructive distillation of coal. When dissolved in water, they produce ammoniacal liquor. It is used for making nitrogenous fertilizers such as ammonium sulphate, ammonium superphosphate etc.

Coke

It is a solid product. It is an almost pure form of carbon. It is an excellent fuel and burns without smoke. It is used in the manufacture of steel, calcium carbide, graphite, silicon carbide, and carbon disulphide as a reducing agent. It can also be used for making fuel gases such as water gas ($CO + H_2$) and producer gas ($CO + 2N_2$).

15.2.2 Conversion of Coal to Petroleum

The coal can be converted into a liquid fuel such as gasoline, kerosene or diesel through Fischer-Tropsch process. In this process, the coal gas that is obtained during the destructive distillation of coal, is converted into high quality, ultraclean liquid fuel products. The Fischer–Tropsch process is a collection of chemical reactions that converts a water gas into liquid hydrocarbons. The water gas is mixed with half of its volume of hydrogen. These reactions occur at temperatures of 150–300°C and pressures of 1 to 10 atmosphere in the presence of certain metal catalysts (cobalt, iron, nickel and ruthenium).

$$\underset{\text{(Water Gas)}}{CO + H_2} \xrightarrow{\text{Cobalt}} \text{Mixture of hydrocarbons} + H_2O$$

Liquid coal can become a petroleum substitute (gasoline, kerosene or diesel) and can be used in the transportation industry. It is used in synthetic lubricants and synthetic waxes.

15.3 Characteristic of Organic Compounds

Organic compounds, in the same way as inorganic compounds, obey all the fundamental laws of chemistry. There is no clear cut division in the properties among organic and inorganic compounds. It is, therefore, difficult to isolate the properties of organic compounds from inorganic compounds. However, organic compounds are studied as a separate branch of chemistry due to the following reasons:

Catenation

The self-linking property of an element by which an atom combines with the other atoms of the same element to form long chains and cyclic structures is called catenation. Carbon has ability to form long chains, loops, sheets, and rings of carbon atoms.

Isomerism

Carbon atoms combine with other atoms in different ways to form different compounds. Such compounds have same molecular formula but different structural formulas. This process is called isomerism. Organic compounds show the phenomenon of isomerism.

Non-polar Character

Most of the organic compounds are non-polar and poor conductors of heat and electricity.

Solubility

Most of the organic compounds do not dissolve in water (polar solvents) but dissolve in non-polar solvents like ether, benzene, alcohol, acetone, etc.

Rate of Reactions

Organic compounds are generally covalent and hence their reactions are usually slow. They usually need heating, thoroughly mixing and catalyst to speed up the reaction.

Melting and Boiling Points

They generally have low melting and boiling points. This is due to the presence of weak intermolecular forces.

Flammability

They are generally volatile and flammable. Thus, many of fuel like natural gas, coal, wood, oil are all flammable and provides energy to us in the form of heat and light.

Stability

Most of the organic compounds are thermally unstable and decompose on heating (above 500°C).

15.4 Uses of Organic Compounds

Organic compounds play an important role in our daily life. The food we eat, the clothes we wear, the medicines we take for cure of disease, the paper we write on, the cosmetic we use for makeup, the soaps we use for washing the clothes are all organic compounds. The importance of organic compounds in our daily use is illustrated by the following list:

i) **Food:** Proteins, Carbohydrates, Fats, etc.

ii) **Clothes:** Cotton, Silk, Wool, Nylon, Rayon, etc.

iii) **Fuels:** Wood, Coal, Natural gas, etc.

iv) **Medicines and Drugs:** Penicillin, Aspirin, Cocaine, Morphine, etc.

v) **Insecticides and Herbicides:** DDT, Malathion, Treflan, etc.

vi) **Dyes:** Indigo, Alizarin, Malachite green, etc.

vii) **Explosives:** Trinitrotoluene (TNT), Nitroglycerine, etc.

viii) **Daily life Materials:** Soaps, Detergents, Perfumes, Flavours, Cosmetics, Plastics, Rubber, Resins, Paints, Varnishes, Inks, Leather, Preservatives, Fertilizers, etc.

15.5 New Allotrope of Carbon: Bucky balls (Fullerenes)

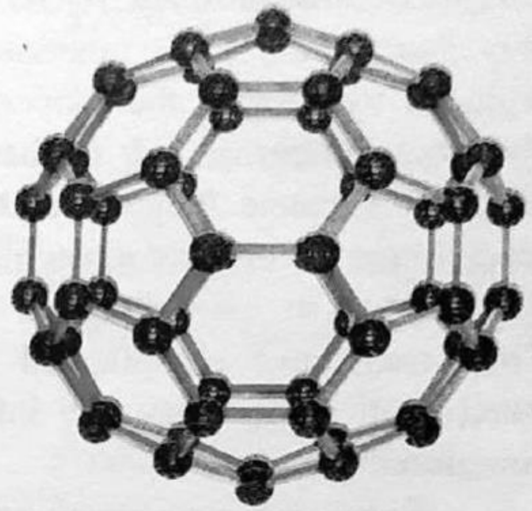


Figure 15.1: Buckyball C_{60}

Until the mid-1980s, the scientists thought that the pure carbon exist in only two allotropic forms i.e. diamond and graphite. In 1985, the new allotropic form of carbon i.e. the buckminsterfull-erene, commonly known as a "buckyball." was discovered by Richard Smalley, Robert Curl and Harry Kroto. Chemists worked with various models of carbon structures until they determined that 60 carbons were most stable when joined together in a shape that resembles a soccer ball. They proposed that the structure of the buckyball (C_{60}) was identical to that of a soccer ball, with 32 faces, 12 of them pentagons and 20 hexagons. Fullerenes (Bucky balls) consist of molecules composed entirely of carbon atoms arranged in the form of hollow spheres, ellipsoids or tubes. Each molecule generally has both pentagonal and hexagonal faces. The 1996 Nobel Prize in Chemistry was awarded to Robert Curl, Richard Smalley and Harold Kroto for their discovery of a third allotropic form of carbon, buckminsterfullerene. The smallest member of bucky ball has 20 carbon atoms (C_{20}). The fullerenes up to 100 carbon atoms are commonly obtained. The largest member of fullerenes has more than 600 carbon atoms. The most common bucky ball is C_{60}. Fullerenes are rare in nature. Small amounts of the fullerenes (bucky balls), in the form of C_{60}, C_{70}, C_{76}, C_{82} and C_{84} molecules, are produced in nature, have been found in soot and in the residue of carbon arc lamp. They are also formed by lightning discharges in the atmosphere. Bucky balls are a new family of aromatic organic molecules. They are soft like graphite.

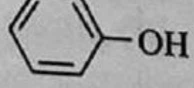
15.6 Functional Groups and Homologous Series

Functional Groups

Carbon forms millions of different organic compounds. It is difficult to study the properties of such a large number of organic compounds. Hence, a system is necessary for grouping of these compounds in an organized way. The organic compounds, are therefore, divided into different families on the basis of functional groups in order to make their study easy. A functional group is an atom or group of atoms in a molecule that is mainly responsible for the chemical behaviour of the molecule. Double and triple bonds are functional groups. Different compounds that contain the same functional groups have similar chemical properties, regardless of the compound of which it is a part. For example, the chemical properties of methanol (CH_3OH), ethanol (CH_3CH_2OH), and propanol ($CH_3CH_2CH_2OH$) are similar because they contain the same functional group (—OH group). If one functional group is replaced by another the properties of molecule will also change. For example, the chemical properties of methanol (CH_3OH) and methanoic acid (HCOOH) are different because they have different functional groups. Functional group is the reactive part of organic molecule; while the hydrocarbon portion is inert. A compound that has two or more than two functional groups is called polyfunctional compound. They may have complicated properties because the chemical behaviour of one functional group may be influenced significantly by the presence of another functional group.

Some common functional groups and classes of organic compounds are given in the table.

Table 15.1: Common Functional Groups in Organic Compounds for Nomenclature

Class	General Formula	Examples	IUPAC Name	Suffix / Prefix
		Hydrocarbons		
Alkanes	R—H	$CH_3—CH_3$	Ethane	-ane
Alkenes	RR′C═CR″R‴	$H_2C═CH_2$	Ethene	-ene
Alkynes	RC≡CR′	CH≡CH	Ethyne	(-yne)
Arenes	Ar—H		Benzene	-ene
		Halogen-containing Compounds		
Alkyl halides	R—X	$CH_3—CH_2Cl$	Chloroethane	halo-
		Oxygen Containing Compounds		
Alcohols	R—OH	$CH_3CH_2—OH$	Ethanol	-ol
Phenols	Ar—OH		Phenol	-ol
Ethers	R—O—R	$CH_3—O—CH_3$	Methoxymethane	
Aldehydes	R—CHO	$CH_3—CHO$	Ethanal	-al

Ketones	$RR'C{=}O$	$(H_3C)_2C{=}O$	2-Propanone	-one
Carboxylic acids	$R{-}COOH$	$CH_3{-}COOH$	Ethanoic acid	-oic acid
Carboxylic Acid Derivatives				
Acyl halides	$R{-}C({=}O){-}X$	$H_3C{-}C({=}O){-}Cl$	Ethanoyl chloride	-oyl halide
Esters	$R{-}C({=}O){-}OR'$	$H_3C{-}C({=}O){-}OCH_3$	Methyl ethanoate	-oate
Amides	$R{-}C({=}O){-}NH_2$	$H_3C{-}C({=}O){-}NH_2$	Ethanamide	-amide
Acid anhydrides	$R{-}C({=}O){-}O{-}C({=}O){-}R'$	$H_3C{-}C({=}O){-}O{-}C({=}O){-}CH_3$	Ethanoic anhydride	-oic anhydride
Nitrogen Containing Compounds				
Amines	$R{-}NH_2$	$H_3C{-}NH_2$	Methanamine	-amine

Homologous Series

A group of organic compounds in which each member differs from the next member by a methylene group ($—CH_2—$) is called homologous series. The members of homologous series are called homologs. For example, butane ($CH_3CH_2CH_2CH_3$) and pentane ($CH_3CH_2CH_2CH_2CH_3$) are homologs.

Table 15.2: The Homologous Series of Alkanes

Name of Alkanes	Number of C Atoms	Molecular Formula	Condensed Structural Formula
Methane	1	CH_4	CH_4
Ethane	2	C_2H_6	CH_3CH_3
Propane	3	C_3H_8	$CH_3CH_2CH_3$
Butane	4	C_4H_{10}	$CH_3(CH_2)_2CH_3$
Pentane	5	C_5H_{12}	$CH_3(CH_2)_3CH_3$

Name of Alkanes	Number of C Atoms	Molecular Formula	Condensed Structural Formula
Hexane	6	C_6H_{14}	$CH_3(CH_2)_4CH_3$
Heptane	7	C_7H_{16}	$CH_3(CH_2)_5CH_3$
Octane	8	C_8H_{18}	$CH_3(CH_2)_6CH_3$
Nonane	9	C_9H_{20}	$CH_3(CH_2)_7CH_3$
Decane	10	$C_{10}H_{22}$	$CH_3(CH_2)_8CH_3$

General Characteristics of Homologous Series

i) All the members of homologous series have same structural formula.

ii) All the members of homologous series have same functional groups.

iii) They have similar chemical properties due to same functional groups.

iv) They have different physical properties because different members of homologous series have different molecular masses.

v) The molecular mass of the successive members of a homologous series differ by 14 unit ($CH_2 = 12 + 2 = 14$).

vi) The molecular formula of each successive homolog differs by a CH_2 group.

vii) All compounds in the series have same type of elements.

viii) All the members of homologous series are prepared by the same methods.

ix) All the members of homologous series are represented by the same general formula. For example:

Alkane: C_nH_{2n+2}

Alkene: C_nH_{2n}

Alkyne: C_nH_{2n-2}

Alcohol: $C_nH_{2n+1}OH$

Alkyl Halide: $C_nH_{2n+1}X$

Where 'n' is number of carbon atoms.

15.7 Detection of Elements in Organic Compounds

All the organic compounds contain carbon and most of the organic compounds (except CCl_4, CS_2, etc.) contain hydrogen. Oxygen is generally present in organic compounds. In addition to carbon, hydrogen, and oxygen other elements which are less commonly present in organic compounds are nitrogen, sulphur, halogens and phosphorus. Some metals like sodium, calcium, iron, magnesium, and copper are also present in some organic compounds but they are rare. Since, nearly all the organic compounds contain carbon as well as hydrogen and it is usually not necessary to test the presence of these two elements. There is no direct method for the detection of oxygen. The presence of other elements which are less commonly present are usually detected by Lassaigne's Test.

Preparation of Lassaigne's Solution for the detection of Nitrogen, Halogens and Sulphur

Take a small piece of freshly cut sodium metal (pea size) in a fusion tube. Heat the tube with a flame until the sodium melts. Then add a small amount of unknown organic compound. Heat the tube first gently and then strongly till its bottom become red hot. The red hot tube is then plunged into a china dish containing about 10-15 mL of cold distilled water. The contents are crushed, boiled and then filtered. The filtrate obtained is called Lassaigne's solution or sodium extract. The fusion reactions are shown by the following equations:

$Na + C + N \longrightarrow NaCN$ (Sodium cyanide)

$Na + C + N + S \longrightarrow NaCNS$ (Sodium sulphocyanide)

$2Na + S \longrightarrow Na_2S$ (Sodium sulphide)

$Na + X \longrightarrow NaX$ (Sodium halide)

Caution

- Never touch sodium metal with your fingers, use forceps.
- Sodium metal reacts violently with water and it cause serious burns.
- Carry out the fusion reaction in the hood and wear safety googles.

The Lassaigne's solution is divided into four portions and is used for the detection of nitrogen, sulphur and halogens (Cl, Br and I).

Detection of Nitrogen

The sodium extract is boiled with freshly prepared ferrous sulphate solution in the presence of a little sodium hydroxide solution. The mixture is cooled and then a few drops of ferric chloride solution and excess of conc. hydrochloric acid are added to it. The formation of a green or Prussian blue colour confirms the presence of nitrogen in an organic compound. The reactions are shown by the following equations:

$$FeSO_4 + 2NaOH \longrightarrow Fe(OH)_2 + Na_2SO_4$$

$$\underset{\text{(Green ppt.)}}{Fe(OH)_2} + \underset{\text{(From sod.extract)}}{6NaCN} \longrightarrow \underset{\text{(Sod.ferrocyanide)}}{Na_4[Fe(CN)_6]} + 2NaOH$$

$$3Na_4[Fe(CN)_6] + 4FeCl_3 \longrightarrow \underset{\substack{\text{(Ferric ferrocyanide)} \\ \text{(Prussian Blue)}}}{Fe_4[Fe(CN)_6]_3} + 12NaCl$$

Keep in Mind

It is noted that when sulphur is present along with nitrogen in the given organic compound, a blood red colouration of ferric sulphocyanide is obtained.

$$3NaCNS + FeCl_3 \longrightarrow \underset{\substack{\text{(Ferric sulphocyanide)} \\ \text{(Blood Red Colouration)}}}{Fe(CNS)_3} + 3NaCl$$

Detection of Sulphur

Sodium Nitroprusside Test

Sodium nitroprusside solution is added to the sodium extract. The formation of deep violet colour confirms the presence of sulphur in the given organic compound.

$$2Na + S \longrightarrow Na_2S$$

$$Na_2S + \underset{\text{(Sodium nitroprusside)}}{Na_2[Fe(CN)_5NO]} \longrightarrow \underset{\text{(Deep violet colouration)}}{Na_4[Fe(CN)_5NOS]}$$

Lead Acetate Test

Freshly prepared lead acetate solution is added to the sodium extract in the presence of dilute acetic acid. The formation of black ppt. of lead sulphide confirms the presence of sulphur in the given organic compound.

$$Na_2S + (CH_3COO)_2Pb \longrightarrow \underset{\text{(Black ppt.)}}{PbS} + 2CH_3COONa$$

Detection of Halogens

The sodium extract is boiled with concentrated nitric acid for some time (to expel the HCN or H_2S if produced that would otherwise give a white ppt. of silver cyanide or a black ppt. of silver sulphide with silver nitrate that is needed for identification of halogen). Cool the mixture and add silver nitrate solution to it. The formation of: (i) white precipitate, soluble in cold ammonium hydroxide, indicates the presence of chlorine (ii) light yellow precipitate, sparingly soluble in cold ammonium hydroxide and soluble in hot conc. ammonium hydroxide, indicates the presence of bromine while (iii) yellow precipitate, insoluble in ammonium hydroxide, indicates the presence of iodine in the given organic compound.

The reactions are shown by the following equations:

$$2Na + X_2 \longrightarrow 2NaX$$

$$NaX + AgNO_3 \longrightarrow AgX\downarrow + NaNO_3$$

$$AgCl + 2NH_4OH \longrightarrow \underset{\text{(Soluble)}}{[Ag(NH_3)_2]Cl} + 2H_2O$$

$$AgBr + 2NH_4OH \longrightarrow \underset{\text{(Sparingly Soluble)}}{[Ag(NH_3)_2]Br} + 2H_2O$$

Summary of Facts and Concepts

- Organic chemistry is the sturdy of hydrocarbons and their derivatives.
- Chemical compounds were generally classified as organic and inorganic on the basis of their origin. The compounds obtained from living things were called organic and those obtained from mineral sources were called inorganic.
- The natural sources of organic compounds are: (i) fossil remains i.e. coal, petroleum and natural gas (ii) Plants (iii) animals.
- The abundance of organic compounds is mainly due to unique behaviour of carbon.
- Most of commercially important products such as carbohydrates, proteins, nylon, natural gas, aspirin, penicillin, treflan, TNT, soaps, detergents, perfumes, flavours, plastics, rubber, paper, paints, etc. are organic in nature.
- Bucky ball is the allotropic form of carbon consisting of molecules composed entirely of carbon atoms arranged in the form of hollow spheres, ellipsoids or tubes. Each molecule generally has both pentagonal and hexagonal faces.
- A functional group is an atom or group of atoms in a molecule that is mainly responsible for the chemical behaviour of the molecule. Functional group is the active part of organic compounds. Different compounds that contain the same functional groups have similar chemical properties, regardless of the compound of which it is a part.
- A group of organic compounds in which each member differs from the next member by a methylene group ($—CH_2—$) is called homologous series. The members of homologous series are called homologs. For example, ethane (C_2H_6) and propane (C_3H_8) are homologs.

Multiple Choice Questions

Select one answer from the given choices for each question:

i) The conversion of coal into petroleum products is carried out by
   a) Fischer-wood process
   b) Fischer-Tropsch process
   c) Brikeland-Eyde's process
   d) Landler process

ii) Organic compounds that show weak attractive forces have:
   a) High boiling points
   b) High melting points
   c) Low melting points
   d) Low vapour pressure

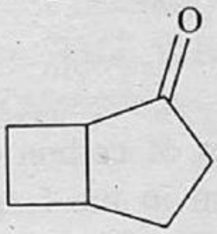
ii) Bucky ball consist of commonly

a) C_{60}, having 30 faces (20 hexagonal and 10 pentagonal)
b) C_{60}, having 32 faces (20 hexagonal and 12 pentagonal)
c) C_{60}, having 60 faces (40 hexagonal and 20 pentagonal)
d) C_{60}, having 62 faces (40 hexagonal and 22 pentagonal)

iv) All the members of homologous series have:

a) Different types of elements
b) Different physical properties
c) Different chemical properties
d) Different functional groups

v) Which type of functional group is present in the given compound



a) Carboxylic acid
b) Aldehyde
c) Ketone
d) Acid amide

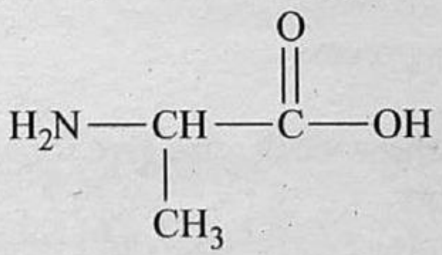
vi) Homologous compounds differ from each other by

a) Alkyl group
b) Methylene group
c) Methine group
d) Methyl group

vii) When hydrogen is removed from alkanes, the product obtained has general formula

a) C_nH_{2n+2}
b) C_nH_{2n-2}
c) C_nH_{2n+1}
d) C_nH_{2n-1}

viii) Which functional groups are present in the given amino acids:



a) Amino and hydroxyl group
b) Amino and alcoholic group

c) Amino and carboxylic acid group
d) Amino, carboxylic acid and alkyl group

ix) When nitrogen containing compounds are treated with Lassaigne' solution, the solution obtained is of :
a) Red colour
b) Prussian blue colour
c) Mixture of blue and green colour
d) Black colour

x) Black colour solution is obtained when sulphur containing compounds are treated with:
a) Sodium nitroprusside solution
b) Lead acetate solution
c) Tollens reagent
d) Both a and b

Short Answer Questions

Q.1. Where natural gas is usually found? Give its two important uses.
Q.2. What are the uses of coal tar?
Q.3. What is coke? What are its uses?
Q.4. Who discovered the bucky ball? How many sides are there on a bucky ball?
Q.5. What is the geometrical shape of a bucky ball?
Q.6. Can a bucky ball conduct electricity?
Q.7. Define synthetic compounds and synthetic chemistry.
Q.8. What are the two main functional groups found in amino acids?
Q.9. Why sodium metal is stored in kerosene oil?
Q.10. Why are organic compounds fused with sodium metal for preparing Lassaigne's solution?
Q.11. Why solution of ferrous sulphate is freshly prepared during detection of nitrogen?

Long Answer Questions

Q.1. Define organic chemistry. What is the importance of organic chemistry in our daily life?
Q.2. Define organic compounds. What are the uses of organic compounds?
Q.3. What are the natural sources of organic compounds? Explain.
Q.4. What are the common varieties of coal? Which variety of coal has the highest carbon content?

Q.5. Define natural product chemistry and describe the use of plants and animals as a source of organic compounds.

Q.6. Describe the synthesis of organic compounds in the lab. What is partial and total synthesis?

Q.7. What do you know about products of biotechnology?

Q.8. What do you know about destructive distillation of coal? What are the various products obtained from it? Discuss.

Q.9. How can coal be converted into petroleum? Discuss briefly.

Q.10. What are the important characteristics of organic compounds?

Q.11. Define and explain bucky ball.

Q.12. Define functional group. How does a functional group affect the properties of an organic compound? Give common examples of functional groups.

Q.13. What is meant by homologous series of carbon compounds? Give homologous series of alkanes.

Q.14. What are the general features of homologous series?