CHAPTER 15

ORGANIC COMPOUNDS

After completing this lesson, you will be able to:

- define organic chemistry and organic compounds.
- explain why there is such a diversity and magnitude of organic compounds.
- classify organic compounds on structural basis.
- explain the use of coal as a source of both aliphatic and aromatic hydrocarbons.
- explain the use of plants as a source of organic compounds.
- explain that organic compounds are also synthesized in the lab
- define functional groups and homologous series.

Q1. What are main sources of Organic Compounds?

Answer

i) Fossil Remains

The main sources of organic compounds are coal, petroleum and natural gas. These are called fossil fuels.

i) Coal

Coal is another major source of organic compounds. It yields coke and coal-tar on pyrolysis or destructive distillation. More than 200 organic compounds have been directly isolated from coal-tar. These coal-tar products form the starting materials for the manufacture of thousands of useful aromatic compounds, including perfumes, drugs, dyes, photographic developers, and others.

ii) Petroleum

In some parts of the world, a black thick sticky liquid seeps out of the ground. This liquid is called petroleum or Crude Oil. Petroleum is a complex mixture of hydrocarbons whose composition varies according to its place of occurrence.

Origin of Petroleum

Nothing definite can be said about the organ of petroleum. Chinese used petroleum as a fuel as early as 200 BC. The word petroleum is derived from the Latin words "Petra" meaning rock and "Ole um" meaning oil. It is also called mineral oil.

Organic Theory about the Origin of Petroleum

Oil and gas are fossil fuels. They were formed million of years go when large area of earth was covered by sea water. Tiny sea creatures called plankton died and sank to the sea. They mixed up with mud. The bacteria in mud began to bring about the decay of these tiny creatures. Process of decay took place slowly due to little oxygen dissolved in the depth of the sea. The pressure on the decaying material increased due to gradual deposition of mud and silt. Bacterial decay at high pressure with little oxygen changed the organic matter into crude oil and natural gas. Petroleum and natural gas are found together held in between the layers of non-porous rocks in the ground. These fuels are extracted by drilling a pipe through the rock.

Petroleum as a source of Energy

Petroleum and gas are two big sources of energy. The whole world these days meets it energy requirements principally from this source. The biggest deposits of petroleum yet discovered in the world are located in Saudi Arabia, Iran, Iraq, Kuwait, Libya, Russia, Mexico, Nigeria, USA and Venezuela. In Pakistan some oil being extracted from Meyal and Tut in Punjab and some places in districts of Sindh i.e. Badin and Hyderabad. Huge deposits of natural gas are in Baluchistan.

Refining of Petroleum

Crude oil which is a mixture of various hydrocarbons does not burn very easily. Before petroleum can be used for different purposes, it must be separated into various components. The process of separating petroleum into useful fractions and removal of undesirable impurities is called refining. The refining of petroleum is carried out by the process of fractional distillation. In this process various fractions are separated according to the difference in their boiling points and it comprises evaporation and condensation.

The first step in the refining process is neutralization of crude oil by washing with acidic or basic solution as needed. The oil is then heated in an electric furnace above 400^{0}C and the vapors are fed into a tall fractionating tower.

The tower is divided into a number of compartments by means of shelves having holes in them. These holes are covered with bubble caps. The vapors go up the fractionating tower where hydrocarbons that have a high boiling temperature range are easily condensed to liquids in the lower part of the tower. The fraction like gasoline which has a lower boiling temperature range continue to move up the tower as vapors which are then led to the condensers where they change to liquids state. Condensed liquid fractions are collected on the various shelved and drained off to separate storage tanks. The fractions obtained in this process are not completely separated from one another and each fraction contains some impurity of the next lower fraction. The fractions so obtained are redistilled to have a better separation of the hydrocarbons.

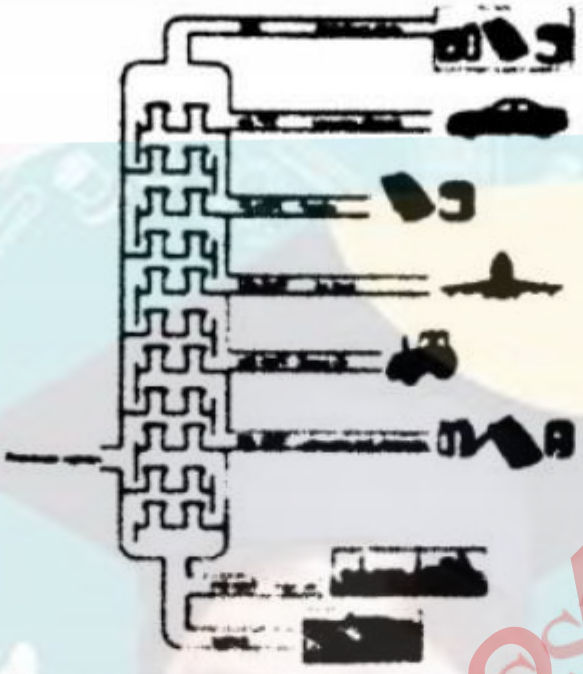


Fig. 18.1 Fractional Distillation of Petroleum

Table 18.1 Petroleum Fractions

Fraction	Approximate boiling temp range (°C)	Approximate number of carbon atoms per molecule	Uses
Petroleum Gas	0 - 25	1 - 4	Petroleum gases are liquified and sold as bottled gas for cookers and stoves.
Gasoline (Petrol)	40 - 75	5 - 6	Liquid at room temperature used to drive vehicles.
Naphta	75 - 150	6 - 10	Naphtha is used by petrochemical industry as a source of chemicals.
Kerosene Oil	150 - 240	10 - 14	Aviation fuel (jet fuel) and fuel used in paraffin stoves.
Diesel Oil	240 - 300	14 - 19	Used in buses, lorries and trains.
Lubricating Oil	300 - 350	19 - 35	Used in cars, buses, trucks, etc.
Fuel Oil	350 - 400	above 20	Used in ships, heating plants and power stations.
Bitumen	above 400	above 35	Used to tar roads and to waterproof roofs and pipes.

Refining of Petroleum in Pakistan

Very small quantities of petroleum have been discovered in Pakistan and the demand of the country is fulfilled by the imported crude oil. The oil obtained form the oil field of Dhulian, Khaur, Balkasar and Joyameer is refined by Pakistan Oil Fields Limited near Rawalpindi. The imported crude oil is refined at Karachi.

The main refineries of Pakistan are:"

1) Attock oil refinery
2) Pakistan oil refinery
3) National oil refinery
4) Pak-Arab refinery

Points to Remember

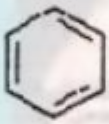
Important products prepared from petroleum

Methane (CH_4)

Ethylene ($CH_2=CH_2$)

Acetylene

Propene ($CH_3CH=CH_2$)



Benzene C_6H_6

Toluene $C_6H_5CH_3$

Xylene $C_6H_4(CH_3)_2$

iii) Natural Gas:

It is mixture of low boiling hydrocarbons. Major portion of the natural gas is methane (CH_4 about 85%); other gases include ethane, propane and butane. It formed by the decomposition of organic matter.

In Pakistan there are vast reserves of gas at Sui in Baluchistan, Sind and Punjab.

2) Plants

Many organic compounds are obtained directly from plant or animal sources by suitable methods of isolation. A few familiar examples are carbohydrates (cellulose, sugars, starches), proteins (silk, wool, casein, food proteins, fats and oils (cottonseed, soybeans oils, lard, butter), alkaloids (quinine, morphine, strychnine), hormones, vitamins, perfumes, flavors, resins.

3) Partial and Total Synthesis

Simple organic compounds derived from petroleum or coal has been converted into thousands of useful materials by synthetic methods. Many examples might be cited of synthetic organic compounds replacing those obtained from natural sources, such as dyes, rubber, fibers plastics, drugs, vitamins. In many cases the synthetic materials are superior to the natural compounds replaced. For example, synthetic dyes are superior to those of natural origin. In other cases the synthetic material are entirely unknown in nature and fill the requirements not satisfied fm any other source. Examples are ether, glycol, mercurochrome, aspirin, and the sulpha drugs. Synthetic organic chemistry touches almost every phase of life.

4) Fermentation

Fermentation is defined as the production of chemicals by the action of micro-

organism. By employing appropriate organism hosts of useful substances are produced including alcohols, acids, vitamins and antibiotics.

Q2. Write a detailed note on coal (as a source of organic compound).

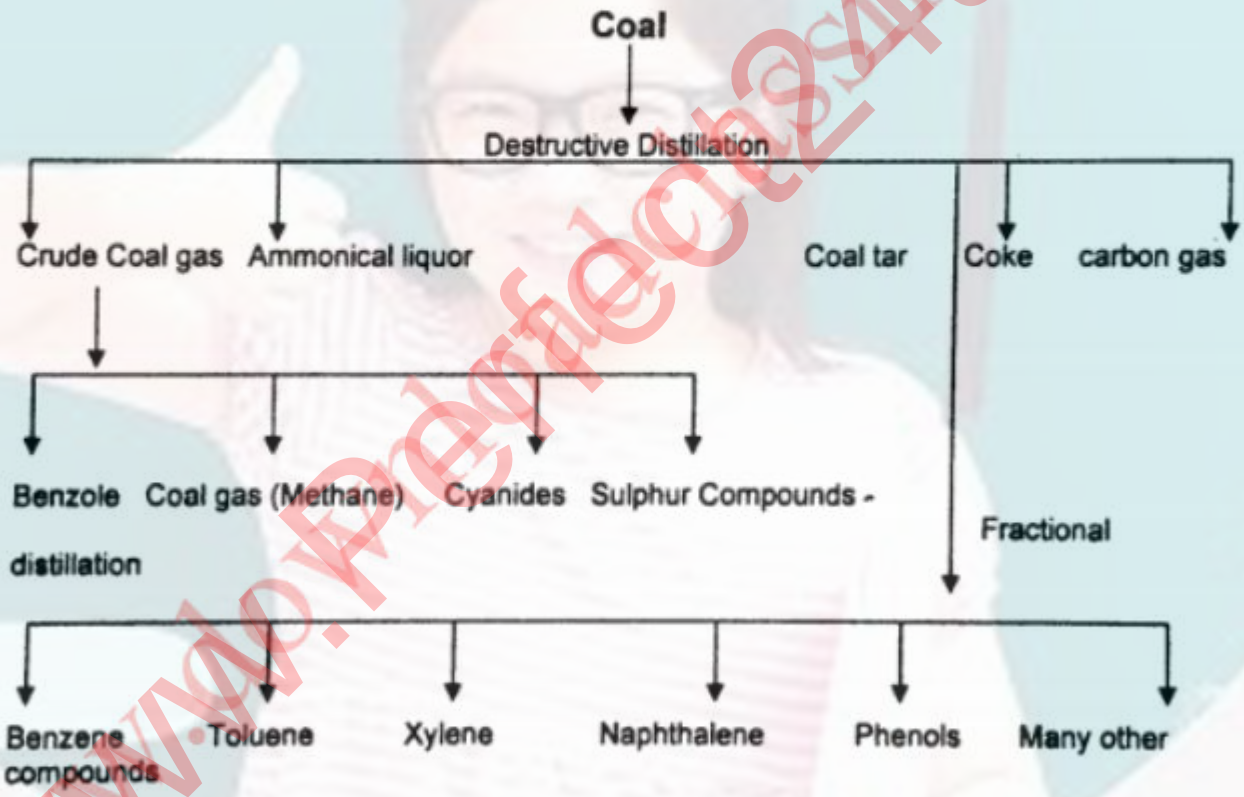
Answer

Coal is produced by the decaying of trees buried under the earth crust under the influence of temperature and pressure. These trees got converted into coal.

Destructive Distillation of Coal

When coal is heated in the absence of air (temperature ranging from 500-1000°C); it is converted into coke coal gas and coal tar. Coal tar contains a large number o organic compounds which separate out on fractional distillation.

The total coal reserves of Pakistan are estimated by the geological survey of Pakistan to be 184 billion tones.



Characteristics of Organic Compounds

Organic compounds have entirely different properties from inorganic compounds. Some of their general properties are described below:

1) **Composition**
Carbon is an essential constituent of all organic compounds.

2) **Combustion**
Organic compounds with high percentage of carbon are generally combustible in nature.

3) **Melting and Boiling Points**
Organic compounds generally have low melting and boiling points and are volatile in nature.

4) **Solubility**
Organic compounds with non polar linkages are generally soluble in organic solvents such as alcohol, ether, benzene, etc. they are less soluble in water.

5) **Stability**
Since organic compounds have low melting and boiling points. They generally decompose at high temperature into simple substances.

6) **Electrical Conductivity**
Due to the presence of covalent bonds, organic compounds are poor conductor of electricity both in fused state and in so9lution form.

7) **Source**
Most of organic compounds are obtained from plants and animal sources

8) **Rate of Reaction**
Their rates of reaction very slow and need specific conditions.

Q3. What are different uses of organic compounds?

Answer

No field of science is so closely related with our daily activities as is organic chemistry. The food we eat is mainly organic in nature. The changes which this food undergoes in our bodies are organic chemical reactions. Metabolism growth and maintenance of our bodily functions involve organic chemistry as do the analogous changes taking place throughout the entire living world, plant and animal.

The clothes we wear, the dyes that colour them, the soap and starch used to launder them the leather in our shoes as well as the dye and shoe polish, are products of organic chemical industry. Many of the structural materials in our houses and furniture, as well as the paints and varnishes used for finishing them are all organic. Many of the equipments in our motor cars, their fuels and lubricants and the fuels which power our industrial plants are all organic in nature.

The tremendous importance of organic compounds in modern everyday life is illustrated by the following list:

i) ***Food:*** Proteins, fats, carbohydrates, oils,

ii) ***Clothing:*** (Cotton, silk, wool, nylon, rayon, Dacron)
The natural fiber like cotton, silk and wool have plant and animal origin. Synthetic fiber like rayon, Dacron and nylon are prepared in the industry.

3) ***Shelter:*** (Wood, paints, varnishes)

4) ***Power and Transportation:*** (Natural gas, petroleum products, coal)
Natural gas, petroleum and gas used for power and transportation are organic substance: .

5) ***Medicines and Drugs:*** (Penicillin G. streptomycin, LSD)

All types of the medicines used in the allopathy, homeopathy and desi-tib involve the organic compounds.

6) ***Insecticides:*** Insecticides like DDT, which are being widely used are organic substances
7) ***Hormones and Steroids:*** Hormones and steroids are complex organic compounds.
8) ***Vitamins and Enzymes:*** All the vitamins which are dietary factors are organic compounds. Similarly enzymes are organic substances.
9) ***Antiseptics and Anesthetics:*** These are the families of the medicines and are organic in nature.
10) ***Pigments and Dyes:*** Pigments and dyes are used for paints and clothes and are organic in nature
11) ***Paper and Inks:*** Paper and inks are the sources of civilization and organic materials.
12) ***Perfumes and Flavors:*** Perfumes and flavors and all cosmetics are organic in nature.
13) ***Plastics, Rubbers, and Resins:*** Plastics, rubber and resins are organic in nature.
14) ***Propellants and Explosives:*** Propellants, explosives and refrigerants are well-known organic materials.
15) ***Soaps and Detergents:*** Soaps and detergent are organic compounds
16) ***Refrigerants***
17) ***Herbicides:*** Teflon, 2,4,-D
18) ***Photographic films and Developers***
19) **Biological Problems and Organic Chemistry:**
Most of the biologic problems are concerned with organic chemistry. For example, organic reactions are involved in formation of tissues and foods. These changes happen in metabolism and growth process etc.

Q4. What are new allotropes of Carbons: Bucky Balls?

Answer

The full name of Bucky Balls is Buckminister Fullerenes. Scientists named it after an architect Buckminister, who designed a Bucky balls shaped building in Montreal. Bucky balls are used as semi-conductors and lubricants.

In 1985, a new group of allotropic forms of carbon was discovered. These have carbon atoms ranging from forty to hundred. The carbon atoms are arranged in a hollow cage like structure. They are called Bucky Balls. The simplest of them is C_{60} and its molecule is made up of sixty carbon atoms. The carbon atoms fold around and make a ball shaped molecule. The new molecule looks just like a football. The carbon atoms join together to form pentagon and hexagon structures.

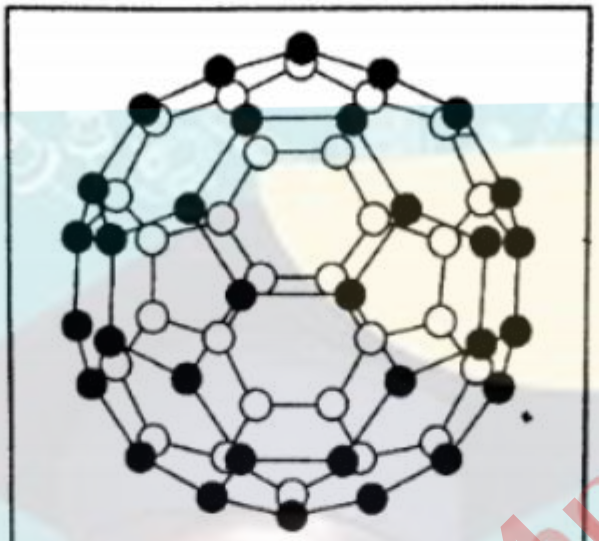


Fig.15.2 Bucky Balls

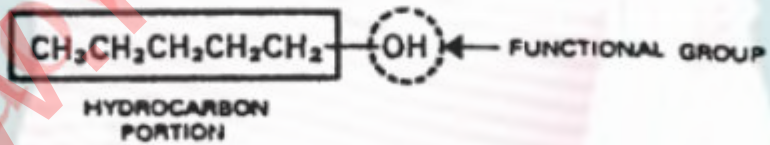
Q5. Functional Groups and Homologous Series.

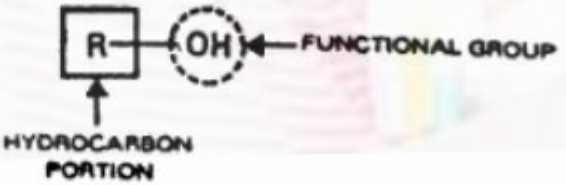
Answer

Functional Group

The basic idea of the functional group is at the heart of much of the organic chemistry we shall study. We will carry out many transformations of organic molecules. In most cases the change will occur at one "spot" in the original reacting molecule. That spot is the *functional group*.

A functional group is an atom or group of atoms in a molecule that gives the molecule its characteristic chemical properties. Double and triple bonds are functional groups. Other examples include -Cl, -Br, -OH,-NH_2 groups. Remember that the functional group is the action group. The hydrocarbon portion remains inert.





We often use the symbol R- to represent t the hydrocarbon portion to which the functional group is attached. Thus R- can CH_3- , CH_3CH_2-, $(CH_3)CH$- or any other group of C and H atoms with one free valence by which the functional group is attached. The table shows some common functional groups and the corresponding classes of compounds.

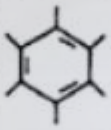
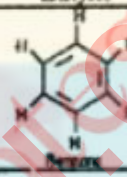
Each functional group undergoes characteristic reactions. By recognizing the functional group in a molecule, it is possible to predict the reactions which that molecule will undergo. The concept of functional group is important to organic chemistry for three reasons:

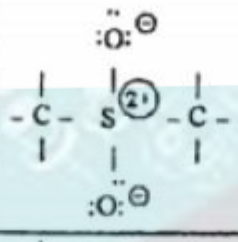
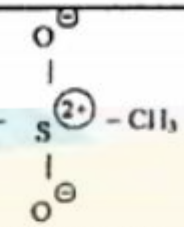
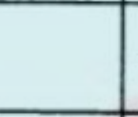
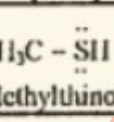
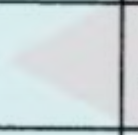
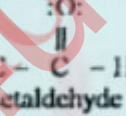
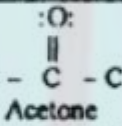
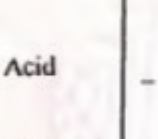
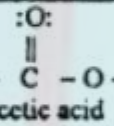
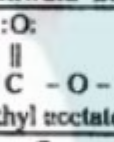
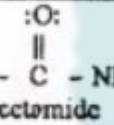
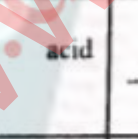
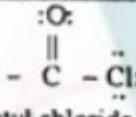
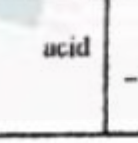
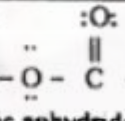
1) Functional groups serve as basis for nomenclature (naming) of organic compounds.
2) Functional groups serve to classify organic compounds into classes/families. All compounds with the same functional group belong to the same class.
3) A functional group is a site of chemical reactivity in a molecule. Compounds in the same class have similar chemicals properties.

A molecule can contains more than one functional group. It is then said to be **Polyfunctional**, and the properties of each functional group may be modified by the presence of the others.

Following is the list of some common functional groups.

Some functional groups:

Family	Structure of functional group	Simple example
Alkane	Containing only C – H and C – C single bond	$CH_3 - CH_3$ Ethane
Alkene	$>C=C<$	$H_2C = CH_2$ Ethene
Alkyne	$-C \equiv C-$	$H - C \equiv C - H$ Ethyne
Arene		 Benzene
Halide	$-\overset{\vert}{\underset{\vert}{C}}-\ddot{X}:$ (X = F, Cl, Br, I)	$H_3C - \ddot{Cl}:$ Methyl chloride (Gujranwala 2004)
Alcohol	$-\overset{\vert}{\underset{\vert}{C}}-\ddot{O}-H$	$H_3C - \ddot{O} - H$ Methyl alcohol
Ether	$-\overset{\vert}{\underset{\vert}{C}}-\ddot{O}-\overset{\vert}{\underset{\vert}{C}}-$	$H_3C - \ddot{O} - CH_3$ Dimethyl ether
Amine	$-\overset{\vert}{\underset{\vert}{C}}-\ddot{N}-H$, $-\overset{\vert}{\underset{H}{C}}-\ddot{N}-H$, $-\overset{\vert}{\underset{\vert}{C}}-\ddot{N}-$	$H_3C - \ddot{N}H_2$ Methyl amine
Nitrile	$-C-C \equiv N:$	$H_3C - C \equiv N$ Methyl cyanide (methyl nitrile)
Nitro	$-C-N^{+}(=O)-\ddot{O}:^{\ominus}$	$H_3C - N^{+}(=O)-\ddot{O}:^{\ominus}$ Nitromethane
Sulphide	$-C-\ddot{S}-C-$	$H_3C - \ddot{S} - CH_3$ Dimethyl sulphide
Sulphoxide	$-C-S^{\cdot}(\uparrow :\ddot{O}:^{\ominus})-C-$	$H_3C - S^{\cdot}(\uparrow \ddot{O}^{-}) - CH_3$ Dimethyl sulphoxide

Sulphone		 Dimethyl sulphone
Thinol		 Methylthinol
Carbonyl:		Aldehydes, ketones, acids and derivatives of acids
Aldehyde		 Acetaldehyde **(Gujranwala 2004)**
Ketone		 Acetone **(Gujranwala 2004)**
Carboxylic Acid		 Acetic acid **(Gujranwala 2004)**
Ester		 Methyl acetate
Amide		 Acetamide **(Gujranwala 2004)**
Carboxylic acid chloride		 Acetyl chloride
Carboxylic acid anhydride		 Acetic anhydride

Homologous Series

A homologous series is a series of compound in which adjacent members differ by a CH_4 unit. The individual members are called Homolog. For example, the homologous series of alcohols can be represented as:

General Formula is ROH or $C_nH_{2n+1}OH$

n	R	Formula
1	CH_3^-	CH_3OH
2	$CH_3CH_2^-$	CH_3CH_2OH
3	$CH_3CH_2CH_2^-$	$CH_3CH_2CH_2OH$
4	$CH_3CH_2CH_2CH_2^-$	$CH_3\ CH_2CH_2CH_2OH$

The general characteristics of a homologous series are:

1. All compounds in the series contain the same elements and the functional group.
2. All compounds in the series can be represented by a general formula
3. The molecular formula of each homolog differs from one above and one below it by a CH_2 unit.
4. All compounds in the series can be prepared by similar methods.
5. All compounds in the series have similar chemical properties.
6. There is a gradual variation in physical properties with increasing molecular weight.

Q6. How we can detect elements in Organic compounds?

Answer

Carbon is an essential constituent of all organic compounds. Hydrogen is also present in almost all organic compounds but some of them may contain Nitrogen Sulphur, and Halogen, Oxygen, Phosphorus and Metals.

a) Detection of Carbon and Hydrogen:

Carbon hydrogen can be detected by heating small amount of organic compound with CuO in a glass test tube as shown in the Fig. on heating the mixture carbon and hydrogen are oxidized to CO_2 and H_2O respectively. CO_2 turns lime water milky which proves the presence of carbon and the water vapors turn white anhydrous copper sulphate blue shows the presence of hydrogen in the organic compound.

$$C + 2CuO \rightarrow CO_2 + 2Cu$$

$$CO2 + Ca(OH)_2 \rightarrow CaCO_3 + H2O$$

Lime water

$$H_2 + CuO \rightarrow Cu + H_2O$$

$$CuSO_4 + 5H_2O \rightarrow CuSO_4.5H_2O$$

b) Detection of Nitrogen, Sulphur and Halogens

Preparation of Lassaigne's Solution/Sodium Extract

1) Cut a small piece of sodium metal with the help of knife
2) Put this piece of sodium metal in a fusion tube.
3) Head the fusion tube in a flame to melt sodium metal.
4) When sodium metal is melted, then add a small amount of powdered organic compounds into fusion tube.
5) Then heat fusion tube in flame till its bottom become red hot.
6) Break this fusion tube in a chine dish containing $20cm^3$ of distilled water.
7) Mixed, boil and then filter the solution.

8) The filtrate obtained is called Lassainge's solution or sodium extract.
9) Divide this filtrate into three portion and test, the presence of N, S ad (X) halogens respectively.

Reactions:

$$Na + C + N \rightarrow NaCN$$
$$2Na + S \rightarrow Na_2S$$
$$Na + X + C + N \rightarrow NaSCN$$
$$Na + X \rightarrow NaX$$

Where X = Cl, Br, I

Nitrogen Test:

To one portion of Lassaigne's filtrate a few drops of NaOH is added to make it alkaline, then freshly prepared ferrous sulphate solution is added to it. The solution is boiled and a few drops of $FeCl_3$ solution and HCl are added to it. The appearance of blue or greenish blue (Prussian blue) color or ppt. proves the presence of nitrogen in the organic compound.

$$Fe^{2+} + 6CN^- \rightarrow [Fe(CN)_6]^{-4}$$
$$4Fe^{3+} + 3[Fe(CN)_6] \rightarrow Fe_4[Fe(CN)_6]3$$

Note: if a blood red color is produced instead of Prussian blue color then it proves that nitrogen and Sulphur both are present in the organic compound.

$$Na + C + 1/2N_2 + S \rightarrow NaCNS$$
$$3NaCNS + Fe(CNS)_3 \rightarrow Fe(CNS)_3 + 3NaCL$$

Sulphur Test:

The second portion of Lassaigne's filtrate is acidified with acetic acid and boiled to expel H_2S gas which turns lead acetate paper black that indicates the presence of Sulphur in the compound.

$$S^{2-} + 2CH_3COOH \rightarrow H_2S + 2CH_3COO^-$$
$$H_2S + 2CH_3COO^- + Pb_2+ \rightarrow PbS + 2CH_3COOH$$

Halogen Test:

i) **Sodium Test**

A third portion of Lassaigne's solution is boiled with nitric acid to expel cyanide ion and sulphide ion and the $AgNO^3$ solution is added. The formation of precipitate shows the presence of a halogen, a white ppt. Soluble in NH_4OH shows the presence of chlorine, a pale yellow ppt. partially soluble in NH_4OH shows the presence of bromine and a deep yellow ppt. insoluble in NH_4OH indicated iodine.

$$X^- + Ag^+ \rightarrow AgX\ (X^- = Cl^-, Br^- I^-)$$

ii) **Copper Wire Test (*Beilstein's Test*)**

The copper wire flattened at one end is heated in an oxidizing Bunsen flame till it ceases to impart any green color to the flame. A small quantity of substance under investigation is now taken on the flattened end of the wire which is re-inserted in the Bunsen flame. Upon heating for a while, the halogen present in the substance is converted to a volatile copper halide which imparts a blue or green color to the flame. This test though very sensitive, is not always reliable. A substance like urea which contains no halogen also colors the flame green.

c) Detection of Oxygen

There is no conclusive test for oxygen, though its presence in organic compounds is often inferred by indirect methods.

1) The substance is heated alone in a dry test-tube, preferably in an atmosphere of nitrogen. Formation of droplets of water on cooler parts of the tube obviously shows the presence of oxygen. A negative result, however, does not necessarily show the absence of oxygen.
2) The second method is to test for the presence of various oxygen containing groups such as hydronyl (OH), carbonyl (COOH), aldehyde (CHO), nitro (NO_2) etc. if any of these is detected, the presence of oxygen is confirmed.
3) The sure test for oxygen depends on the determination of the percentage of all other elements present in the given compound. If the sum of these percentages fall short of hundred the remainder gives the percentage of oxygen and thus confirms.

d) Detection of Phosphorus

The solid substance is heated strongly with an oxidizing agent such as concentrated nitric acid and mixture of sodium carbonate and potassium nitrate. The phosphorus present in the substance has oxidized to phosphate. The residue is extracted with water, boiled with some nitric aced, and then a hot solution of ammonium molydbate is added to it in excess. A yellow coloration of precipitate indicated the presence of phosphorus.

e) Detection of Metals

The substance is strongly heated in a crucible, preferably of platinum, till all reaction ceases. An incombustible residue indicated the presence of a metal in the substance. The residue is extracted with dilute acid and the solution is test for the presence of metallic radical by the usual scheme employed for inorganic salts.

Q7. What different drugs may be obtained from plants?

Answer

Quinine- an antimalarial and antipyretic medicine- is obtained from Cinchona ledgeriana (quinine tree).

Nicotine-an insecticide- is obtained from Nicotiana tabacum (tobacco).

Menthol-a rubefacient (a substance for topical application that causes dilation of the capillaries and an increase in blood circulation)-is obtained from Mentha species (mint).

Camphor- a rubefacient- is obtained from Cinnamomum camphora (camphor tree).

Rutin - used for the treatment of capillary fragility- is obtained from citrus species e.g. orange, grapefruit etc. .

Hesperidin- used for the treatment of capillary fragility- is obtained from citrus species e.g. orange.

Curcumin- a choleretic- is obtained from Curcuma longa (turmeric).

Cocaine- a local anaesthetic- is obtained from Erythroxylum coca (coca plant).

Caffeine- a CNS stimulant- is obtained from Camellia sinensis (tea, coffee and cocoa).

Bromelain-an anti-inflammatory drug- is obtained from Ananas comosus (pineapple).

Q2: Give brief answers for the following questions.

Q1: What is functional group?

Answer

Please see Answer of Q17 of Chapter Notes.

Q2: What is the Difference between partial and total synthesis of organic compounds?

Answer

Total Synthesis

In an organic chemistry a total synthesis is in principle, the complete chemical synthesis of complex organic mole cubes from simpler pieces, usually without the aid of biological processes. In practice these simpler pieces are commercially available in bulk and semi – bulk quantities and are often petrochemicals precursors.

Sometimes bulk natural products (e.g sugar) are used as starting materials and it assumed that these have been or can be synthesised from constituent elements. The target molecules can be natural products, medicinally important active ingredients or organic compounds of the oratical in chemistry or biology. A new route for synthesis is developed in the course of the investigation, and the route may be the first one to developed for the substance.

Examples:

Cholesterol, cortisone, strychnine, lysergic acid, chlorophyll, vitamin B and quinine etc.

Partial Synthesis

Partial synthesis is a type of chemical synthesis that uses compounds isolated from natural sources (e.g plant material or bacterial or cell cultures) as a starting material. These natural biomolecules ore usually large and complex molecules.

This is opposed to a total synthesis where large molecules are synthesised from a stepwise combination of small and cheap (Usually petrochemicals) building blocks.

Partial synthesis is usually used when precursor molecule is too structurally complex. For Example artemether.

Q3: How organic compounds are derived by fermentation process?

Answer

In fermentation process some enzymes are used to decompose naturally occurring substances into some other useful substances.

For example to get ethyl alcohol there are added diastase, invertase and zymase enzymes in starch. Reactions involving process of fermentation of starch are as follows

i) $nC_6H_{10}O_5 \xrightarrow[(Enzyme)]{Diastase} C_{12}H_{22}O_{11}$

starch maltose

ii) $C_{12}H_{22}O_4 \xrightarrow[(enzyme)]{\text{invertase zymase}} C_6H_{12}O_6 + C_6H_{12}O_6$

maltose glucos functor

iii) $C_6H_{12}O_6 \xrightarrow[\text{(enzyme)}]{\text{zymase}} C_2H_5OH + H_2O + CO_2$

ethyl alcohol

Q4: What is coal? How is coal used as a source of organic compound?

Answer

Please see Answer of Q9 of Chapter Notes.

Q5: What is the name of new allotropic from of carbon? Give is definition?

Answer

Please see Answer of Q14 of Chapter Notes.

Q6: What is Homologous series?

Answer

Please see Answer of Q15 of Chapter Notes.

Q7: How metals can be detected in organic compounds?

Answer

The substance in a crucible preferably of platinum, till all reaction ceases. An incombustible residue indicated the presence of a metal in a substance. The residue is extracted with dilute acid and the solution is test for the presence of metallic radical by the usual scheme employed for inorganic salts.

Q3. Give detailed Answers for the following questions.

Q1. What are the main sources of organic compounds? Also give the fractions of petroleum.

Answer

Please see Answer of Q1 and Q2 of Chapter Notes.

Q2: Write down the characteristics of organic compunds from inorganic compounds.

Answer

Please see Answer of Q10 of Chapter Notes.

Q3: How organic compounds are used in our daily life?

Answer

Food, vitamins, clothes etc are all organic compounds.

Q4: Write down any ten functional groups of organic compounds? Give reasons for the importance of organic chemistry.

Answer

Please see Answer of Q17 of Chapter Notes.

Q5: Give the chemical tests for the detection of elements in organic compounds?

Answer

Please see Answer of Q20 of Chapter Notes.

Short Questions & Answers

Q1: What is modern definition of organic chemistry?

Answer

Organic chemistry is the branch of chemistry which deals with the study of compounds of carbon and hydrogen and their derivatives.

Q2:a) What is Petroleum?

A black thick sticky liquid seeps out of the ground is called petroleum.

b) What is coal?

Answer

Coal is an organic compound which yields coke and coal bar on destructive distillation.

Q3: What do you know about the origin of petroleum?

Answer

Nothing definite can be said about the origin of petroleum. The word petroleum is derived from the Latin words "pera" meaning rock and "oleum" meaning oil. It is also called mineral oil. It is formed million of years ago when large area of years earth was covered by sea water tiny sea creatures died and sank to the sea and decay and decaying result in formation of petroleum.

Q4: What are planktons?

Answer

Planktons are the tiny sea creatures includes phytoplanktors meaning drifting plants and 200 plankton meaning drifting animals.

Q5: Which countries have biggest deposits of petroleum name them.

Answer

These include Saudi Arabia, Iran, Iraq, Kuwait, Libya, Russia, Mexico's, Nigeria, USA and Venezuela.

Q6: What is refining?

Answer

The process of separating petroleum into useful fractions and removal of undesirable impurities is called refining.

Q7: What is fractional distillation?

Answer

The process in which various fractions are separated according to the difference in their boiling points and it comprises evaporation and condensation is called fractional

distillation.

Q8: What is Neutralization?

Answer

It is the first step in the refining process in which crude oil is washed with acidic or basic solution than oil is heated in an electrical furnace above 400c° and the vapours are fed in to a tall fractionation lower.

Q9:a)Give uses of petroleum gas?

Answer

Petroleum gases are liquefied and sold as bottled gas for cookers and stores.

b) Give the names of refineries of Pakistan.

Answer

These are:

i) Attock oil refinery
ii) Pakistan oil refinery
iii) National oil refinery
iv) Pak – Arab refinery

Q10: What is natural gas?

Answer

It is a mixture of low boiling hydrocarbons major protion of the natural gas is methane (CH_4 about 85%). In Pakistan vast reserves of gas at Sui in Baluchistan, Sindh and Punjab.

Q11: Define fermentation.

Answer

The production of chemicals by the action of micro organisms is called fermentation.

Q12: Briefly describe destructive distillation of Coal.

Answer

Organic chemistry is the branch of chemistry which deals with the study of compounds of carbon and hydrogen and their derivatives.

Q13: Briefly discuss the uses of organic compounds.

Answer

They are used as food i.e. proteins, fats, clothing i.e. paints, power and transportation i.e. natural gas, petroleum products etc..

Q14: Briefly explain bucky balls.

Answer

Bucky balls named it after an architect Buckminister, who designed a Bucky balls shaped building in Montreal. Bucky balls are used as semi-conductors and lubricants. They have carbon atom ranging from forty to hundred. The carbon atoms are arranged in a hollow cage like structure.

Q15: Define functional group. Give example.

Answer

A functional group is an atom or group of atoms in a molecule that gives the molecule its characteristic chemical properties. Example: –Cl, –Br, –OH.

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Q16: Define sublimation.

Answer

The process in which the solids directly changes it into vapours without undergoing liquid phase is called sublimation.

Q17: What are terpenoids?

Answer

A large class of natural products consisting of isoprene units are called terpenoids.

Q18: Define homologous series.

Answer

A homologous series is the series of compound in which adjacent members differ by CH_2 group and molecular mass 14.

For Example

$CH_3 - CH_3$	(Ethane)
$CH_3 - CH_2 - CH_3$	(Propane)
$CH_3 - CH_2 - CH_2 - CH_3$	(Propane)
$CH_3 - CH_2 - CH_3 - CH_2 - CH_3$	(Propane)

Q20: How carbon and hydrogen are detected in organic compounds?

Answer

Carbon and hydrogen can be detected by heating small amount of organic compound with CuO in a glass test tube and then passing obtained gases through dry CuO & lime water.

Q21: How nitrogen is detected in organic compound?

Answer

Take one portion of Lassaigne's filtrate, a few drops of NaOH is added to make it alkaline, then freshly prepared ferrous sulphate is added to it. The solution is boiled to it. The solution is boiled and a few drops of FeCl3 solution and HCl are added to it. The appearance of blue or greenish blue (Prussian blue) colour or ppt proves the presence of nitrogen in organic compound.

Q22: Give sulphur test for the identification of sulphur.

Answer

The second portion of Lassaigne's fillerate is acidified with acetic acid and boiled to expel H_2S gas which turns lead acetate the presence of sulphur in the compound.

Q23: Give sodium test for the identification of Halogens.

Answer

A third portion of Lassaighe's solution is boiled with nitric acid to expel cynrdeion and sulphide ion and the Ag NO_3 solution is added. The formation of precipitate shows the presence of the halogen, a white ppt. Soluble in NH_4OH shows the presence of chlorine a pale yellow ppt partially soluble in NH_4OH shows the presence of chlorine a pale yellow ppt partially soluble in NH4)H shows the presence of bronire and a deep yellow ppt insolu ɔle in NH4OH indicates iodine.

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Q24: Give copper wire test (belistein's Test)

Answer

The copper wire flattened at one end heated in an oxidizing Bunsen flame till it ceases to impart any green colour to the flame. A small quantity of substance under investigation is now taken on the flattened end of the wire which is re-inserted in the Bunsen flame, upon heating for a while, the halogen present in the substance is converted to a volatile copper halide which imparts blue or green color to the flame. A substance like urea which contains no halogen also colors the flame green.

Q25: How oxygen is detected in the organic compound?

Answer

The substance is heated alone in a dry test tube, preferably in an atmosphere of nitrogen. Formation of droplets of water on cooler parts of the tube obviously shows the presence of oxygen.

Q26: How phosphorus is letected in the organic compound?

Answer

The solid substance is heated strongly with an oxidizing agent such as concentrated nitric acid and mixture of sodium carbonate and potassium nitrate. The residue is extracted with water, boiled with some nitric acid, and than a hot solution of ammonium molydbate is added to it in excess. A yellow coloration of precipitate indicated the presence of phosphorus.

Q27: How metals are detected in organic compounds?

Answer

The substance is strongly heated in a crucible, preferably of platinum, till all reaction ceases. An incombustible residue indicated the presence of a metal in the substance. The residue is extracted with dilute acid and the solution is test for the presence of metallic radical by the usual scheme employed for inorganic salts.

Q28: What is oxidation?

Answer

The loss of electrons or the gain of oxygen to a substance is called oxidation.

For Example:

$$Fe^{2+} \longrightarrow Fe^{3+} \text{ and } Fe + O_2 \longrightarrow Fe_2O_3$$

Q29: What is reduction?

Answer

The gain of protons or hydrogen and the loss of oxygen to a substance is called reduction.

Q30: What are volatile substances?

Answer

Those substances which have very low boiling or melting point are called volatile substances. E.g. ether, petrol etc.

Q31: What are precipitates?

Answer

The solid crystals which are left when the substance is extensively boiled.

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Q32: What is oxidizing agent?

Answer

Those substances which add electrons or oxygen to a substance are called oxidizing agent. Examples are $KMnO_4$, $K_2Cr_2O_7$ etc.

Q33: What is reducing agent?

Answer

Those substances which added protons or hydrogen or remove oxygen from a substance are called reducing agents. Example Al_2Cl_3. NH_3, NHO_3 etc..

Q34: What are anhydrous compounds?

Answer

Those compounds which remove are called anhydrous compounds.

Q35: What is filtrate?

Answer

The residue which left when the substance or liquid is passing through the filter paper is called filtrate.

Q35a): What is use of Quinine? And how is it obtained.

Answer

Quinine is used as antimalarial and antipyretic medicine. It is obtained from the quinine tree.

b) What is use of Nicotine? And how it is obtained?

Answer

Nicotine is used as insecticide. It is obtained from tobacco.

Q37: What is use of Menthol? And how it is obtained?

Answer

It is used as dilation of the capillaries and an increase in blood circulation. It is obtained from the mint i.e. Mentha species.

Q38: What is Rutin? And how it is obtained?

Answer

Rutin is used for the treatment of capillary fragility. It is obtained from citrus species e.g. orange, grapefruit etc.

Q39: What is use of cocaine? And how it is obtained?

Answer

Cocaine is used as an anaesthetic. It is obtained from coca plant.

Q40: What is use of caffeine? And how it is obtained?

Answer

Caffeine is CNS stimulant. It is obtained from tea, coffee and coca.

Q41: What is use of Bromelain? And how it is obtained?

Answer

Bromelain is anti inflammatory drug. It is obtained from pineapple.

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