SCHOLAR's

Federal Board Objective Chemistry

Part I & Part II

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An Approach To Physics

(Subjective Book)

Part I & Part II

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CHAPTER 15 ORGANIC COMPOUNDS

Old definitions of Chemicals Compounds

On the basis of sources from which compounds were derived, there are two main classes of chemical compounds:

Inorganic compounds

"The compounds which were of mineral origin were known as inorganic compounds."

Examples:

Table salt, marble, carbon dioxide etc.

Organic compounds

"Those compounds which have vegetable or animal origin were called organic compounds."

Examples:

Acetic acid (from vinegar), alcohol (from wine), tartaric acid (from grapes) etc.

Organic Chemistry

Organic chemistry is concerned with the chemistry of living material or substances which were at one time alive. It is therefore concerned with living plants or animals or substances like coal and oil which are derived from living plants (coal), or from microscopic sea organisms (oil).

Modern definitions

Organic compounds

"All those compounds which contain carbon as an essential element along with hydrogen, oxygen, nitrogen, sulphur, phosphorus, halogens, etc. are called organic compounds."

Examples: Glucose, methane, benzene etc.

Exception: However there are several compounds like carbon monoxide (CO), carbon dioxide (CO_2), carbon disulphide (CS_2), carbonates (CO_3^{-2}), bicarbonates (HCO_3^{-1}), Cyanides (CN^{-1}), thiocynates (SCN^{-1}) etc are studied in inorganic chemistry because of their properties.

Organic Chemistry:

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

SOURCES OF ORGANIC COMPOUNDS

Exercise: **Q.3(i) What are the main sources of organic compounds?**

Fossil Remains

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

(1) Coal

Coal is one of 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.

Points to Remember

Important products prepared from petroleum

Methane (CH_4)

Ethylene ($CH_2 = CH_2$)

Acetylene ($CH \equiv CH$)

Propene ($CH_3CH = CH_2$)

Benzene C_6H_6

Toluene $C_6H_5CH_3$

Xylene $C_6H_4(CH_3)_2$

(2) Petroleum

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

(3) Natural Gas

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

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

Plants and Natural Product Chemistry

Many organic compounds are obtained directly from plant and animal sources by suitable methods of isolation. few familiar examples are:

- Carbohydrates (cellulose, sugars, starches)
- Proteins (silk, wool, casein, food proteins)
- Fats and oils (cotton seed, soybeans oils, lard, butter)
- Alkaloids (quinine, morphine, strychnine)
- Hormones, vitamins, perfumes, flavors, resins.

Partial and Total Synthesis

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

Synthetic organic chemistry touches almost every phase of life.

Fermentation / Biotechnology

Fermentation is defined as the production of chemicals by the action of micro-organism. By employi appropriate organism useful substances are produced. For example, the fermentation of molasses or sugar produc alcohol, vinegar and many other products.

QUICK QUIZ

1. Define modern definition of organic chemistry.

Ans. Organic chemistry is that branch of chemistry which deals with the study of compounds of carbon and hydrogen (Hydrocarbons) and their derivatives.

2. Enlist different sources of organic compounds.

Ans. (i) Coal
(ii) Natural Gas
(iii) Petroleum
(iv) Animals and plants

3. Write important products from petroleum.

Ans. Natural gas, Petroleum ether, Ligroin or naphtha, Gasoline, Kerosene, Gas oil, Lubricating oils and greases Paraffin, Asphalt, or petroleum coke

4. What are alkaloids?

Ans. Alkaloid is a class of naturally occurring organic nitrogen-containing bases. Alkaloids have diverse and important physiological effects on humans and other animals. Well-known alkaloids include morphine, strychnine, quinine, ephedrine and nicotine.

5. Define fermentation?

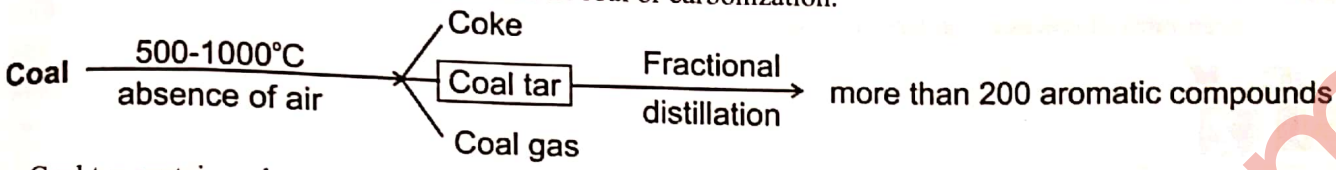
Ans. It is a biochemical process which occurs in the presence of certain enzymes secreted by microorganisms such as yeast. Useful substances like alcohols, acids, vitamins and antibiotics are produced by this process.

Coal (as a source of organic compounds)

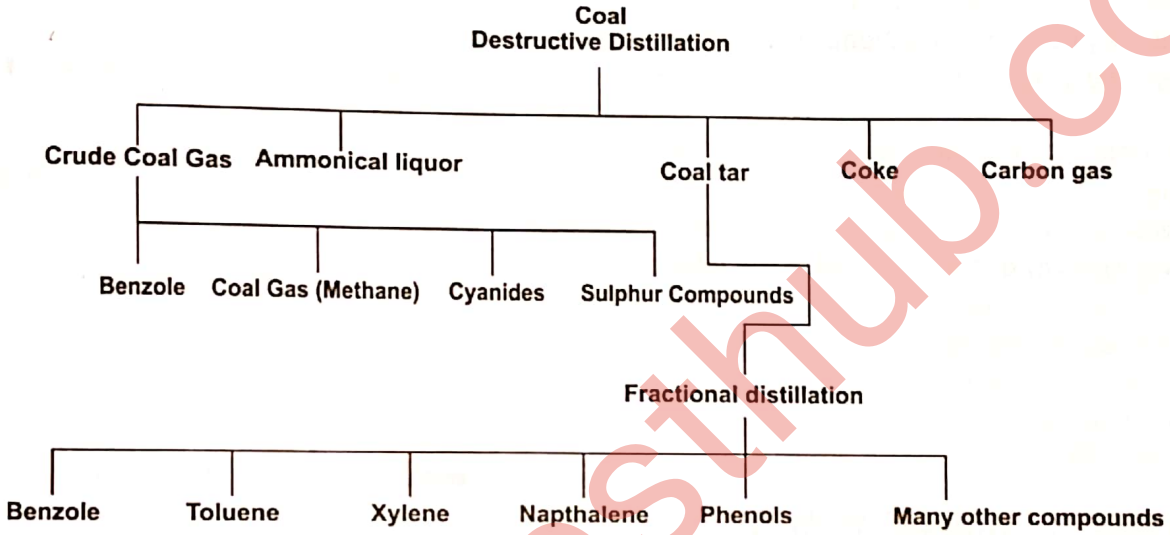
Coal is produced by the decaying of trees buried under the earth crust under the influence of temperature and pressure. These trees got converted into coal.

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. It is called destructive distillation of coal or carbonization.



- Coal tar contains a large number of 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.



Exercise

Q.3(ii) Write down the characteristics of organic compound differ from inorganic compounds.

Characteristics of Organic Compounds

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

(i) Composition

Carbon is an essential constituent of all organic compounds.

(ii) Combustion

Organic compounds with high percentage of carbon are generally combustible in nature.

(iii) Melting and Boiling Points

Organic compounds generally have low melting and boiling points and are volatile in nature.

(iv) 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.

(v) Stability

Since organic compounds have low melting and boiling points, they generally decompose at high temperature into simple substances.

(vi) Electrical Conductivity

Due to the presence of covalent bonds, organic compounds are poor conductor of electricity both in fused state and in solution form.

(vii) Source

Most of organic compounds are obtained from plants and animal sources.

(viii) Rate of Reaction

Their rates of reaction are very slow and need specific conditions.

QUICK QUIZ

1. **What is coal?**

Ans. Coal is a combustible black or brownish-black sedimentary rock usually occurring in rock strata. It is produced by the decaying of trees buried under the earth crust under the influence of temperature and pressure.

2. **What are the products of fractional distillation of coal tar?**

Ans. More than 200 compounds are obtained as a result of fractional distillation of coal tar. These include aromatic compounds (benzene, toluene, phenols, xylene, naphthalene etc) and many other compounds.

3. **What we obtain by fractional distillation of coal gas?**

Ans. Following products are obtained by the fractional distillation of coal gas:

(i) Benzole (ii) Coal gas (Methane) (iii) Cyanides (iv) Sulphur compounds

4. **How many types of distillation used in the laboratory?**

Ans. Usually four types of distillation is used in laboratory. These are:

(i) Fractional distillation
(ii) Vacuum distillation
(iii) Steam distillation
(iv) Destructive distillation

Uses of Organic Compounds

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 body functions involve organic chemistry as do the analogous changes taking place throughout the entire living world, plants and animals.
- The clothes we wear, the dyes that color 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.

Q3(ii) How organic compounds are used in our daily life?

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

1. **Food:** (proteins, fats, carbohydrates, oils)
2. **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 substances.
5. **Medicines and Drugs:** (Penicillin, streptomycin)

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 Anaesthetics:** These are the families of the medicines and are organic in nature.
10. **Pigments and Dyes:** Pigments and dyes are used for paints and are organic in nature
11. **Paper and Inks:** Paper and inks are the sources of civilization and are organic materials.
12. **Perfumes and Flavors:** Perfumes 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 detergents are organic compounds.
16. **Herbicides:** Teflon
17. **Photographic films and Developers**

iological Problems in Organic Chemistry:

Most of the biological problems are concerned with organic chemistry. For example, organic reactions are volved in formation of tissues and foods. These changes happen in metabolism and growth process etc.

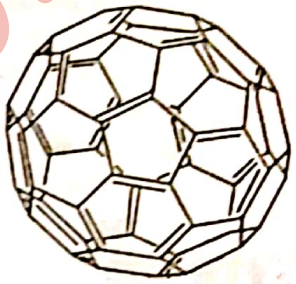
New Allotropes of Carbons: Bucky Balls

iscovery:

In 1985, a new group of allotropic forms of carbon was discovered.

aming:

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



Bucky balls

omposition & Structure:

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

QUICK QUIZ

1. **What are allotropes?**

Ans. Allotropes are different structural forms of the same element having different physical but same chemical properties. e.g. diamond and graphite are the allotropes of carbon.

2. **Why it was given the name Bucky balls?**

Ans. 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.

3. **Define the third allotropic forms of carbon?**

Ans. After graphite and diamond, the third allotrope of carbon is Bucky balls. These have carbon atoms ranging from 40 to 100. The carbon atoms are arranged in a hollow cage like structure.

FUNCTIONAL GROUPS AND HOMOLOGOUS SERIES

Functional Group

"A functional group is an atom or group of atoms in a molecule that gives the molecule its characteristic chemical properties."

- The functional group is the action group. The hydrocarbon portion remains inert.

- They are the chemically functional parts of molecules.
- Each functional group defines an organic family.

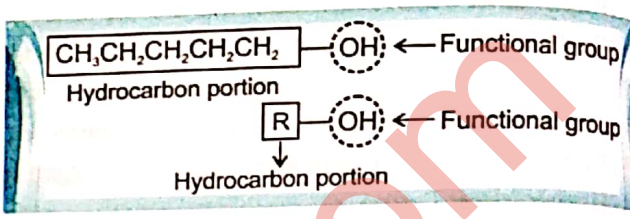
Examples:

Double (=) and triple bonds (≡), - Cl, - Br, - OH, - NH_2 groups etc.

Explanation:

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

We often use the symbol R- to represent the hydrocarbon portion to which the functional group is attached. Thus R- can CH_3 -, CH_3CH_2 -, $(CH_3)_2CH$ - or any other group of C and H atoms with one free valence by which the functional group is attached.



Importance of Functional Group

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

(i) Functional groups serve as basis for nomenclature (naming) of organic compounds.

(ii) Functional groups serve to classify organic compounds into classes/families. All compounds with the sa functional group belong to the same class.

(iii) A functional group is a site of chemical reactivity in a molecule containing the functional group.

Polyfunctional

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

QUICK QUIZ

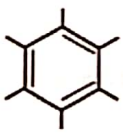
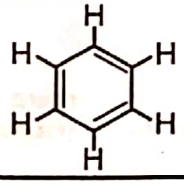
1. What is organic compound?

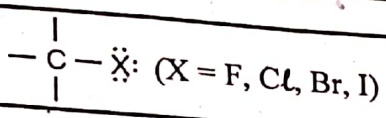
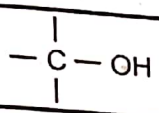
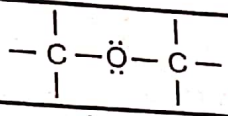
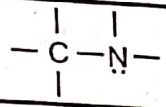
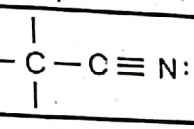
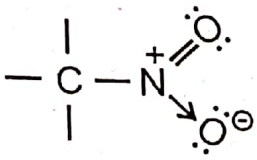
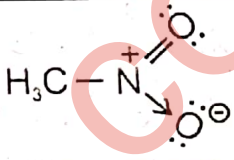
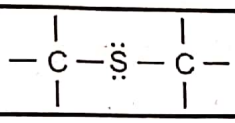
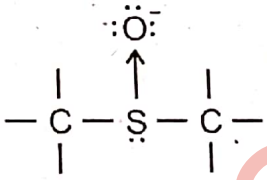
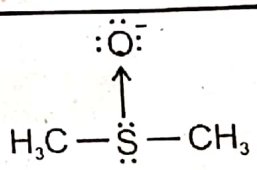
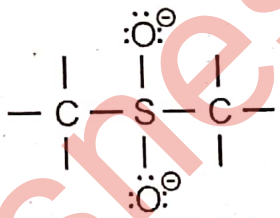
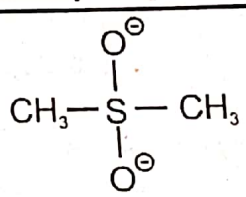
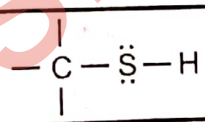
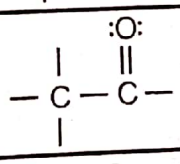
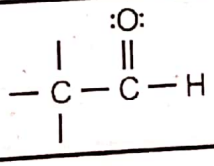
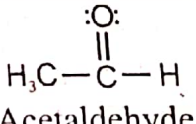
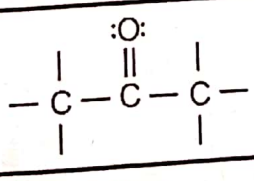
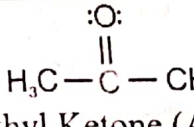
Ans. All those compounds which contain carbon as an essential element along with hydrogen, oxygen, nitrogen, sulphur, phosphorus, halogens, etc. are called organic compounds. e.g., Glucose, methane, benzene etc.

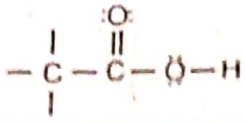
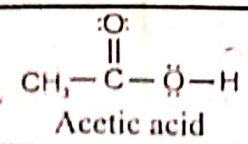
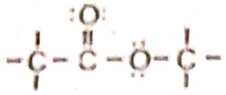
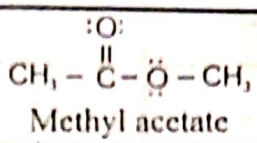
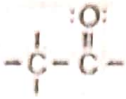
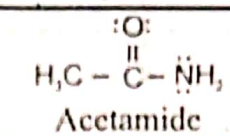
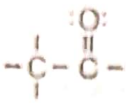
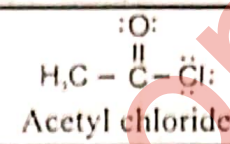
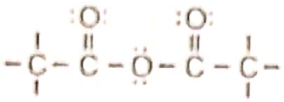
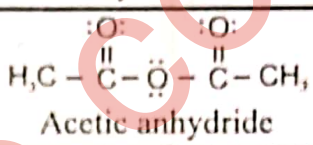
2. What is meant by a functional group?

Ans. A functional group is an atom or group of atoms in a molecule that gives the molecule its characteristic chemical properties. e.g. - OH, - NH_2, - CHO, - COOH etc.

Some common functional groups

Family	Structure of Functional Group	Simple example
Alkane	Containing only C - H and C - C single bond contain no functional group	$CH_3 - CH_3$ Ethane
Alkene	$>C=C<$	$H_2C = CH_2$ (Ethene)
Alkyne	- C ≡ C -	H - C ≡ C - H Ethyne (Acetylene)
Arene		 Benzene

Halide	 (X = F, Cl, Br, I)	$H_3C - Cl$ Methyl chloride
Alcohol		$H_3C - OH$ Methanol (Methyl alcohol)
Ether		$H_3C-\ddot{O}-CH_3$ Dimethyl ether
Amine		$H_3C-\ddot{N}H_2$ Methyl amine
Nitrile		$H_3C - C \equiv N$ Methyl Cyanide (Methyl nitrile)
Nitro		 Nitromethane
Sulphide		$H_3C-\ddot{S}-CH_3$ Dimethyl sulphide
Sulphoxide		 Dimethyl sulphoxide
Sulphone		 Dimethyl sulphone
Thiol		$H_3C-\ddot{S}H$ Methane thiol (Methylthiol)
Carbonyl		Aldehydes, ketones, acids and derivatives of acids.
Aldehyde		 Acetaldehyde
Ketone		 Dimethyl Ketone (Acetone)

Carboxylic Acid		 Acetic acid
Ester		 Methyl acetate
Amide		 Acetamide
Carboxylic acid chloride		 Acetyl chloride
Carboxylic acid anhydride		 Acetic anhydride

Homologous Series

"A homologous series is a series of compounds in which adjacent members differ by a CH_2 unit."

- The individual members are called Homologs

Example: General formula of alcohols is ROH or $C_nH_{2n+1}OH$. Their homologous series can be represented as:

n (No. of C-atom)	R (alkyl)	Formula
1	CH_3-	CH_3OH
2	CH_3CH_2-	CH_3CH_2OH
3	$CH_3CH_2CH_2-$	$CH_3CH_2CH_2OH$
4	$CH_3CH_2CH_2CH_2-$	$CH_3CH_2CH_2CH_2OH$

General Characteristics of a homologous series

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. For example; the general formula for Alkane is C_nH_{2n+2}, for alkene C_nH_{2n} and for alkyne C_nH_{2n-2}.
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. They have same set of properties.
6. There is a gradual variation in physical properties with increasing molecular weight

QUICK QUIZ

1. What are general formulas for alkanes, alkenes and alkyne

Ans. The general formula for Alkane is C_nH_{2n+2}, for alkene C_nH_{2n} and for alkyne C_nH_{2n-2}.

2. What are homologs?

Ans. The individual members in a homologs series are called Homologs. e.g. methane (CH_4), ethane (C_2H_6), propane(C_3H_8) are homologs of alkane family.

3. Why do we arrange compounds in homologous series?

Ans. There exists a close relationship between different organic compounds. This is exemplified by the existence of homologous series. This similarity in behaviour has reduced the study of millions of compounds to only a few homologous series. That is why we arrange compounds in homologous series.

Exercise: Q.3(v) Give the chemical tests for the detection of elements in organic compounds.

DETECTION OF ELEMENTS IN ORGANIC COMPOUNDS

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, halogen, oxygen, phosphorus and metals.

(A) Detection of Carbon and Hydrogen

Carbon and hydrogen can be detected by heating small amount of organic compound with CuO in a glass test tube. 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.

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

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

Lime water

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

$$CuSO_4 + 5H_2O \longrightarrow CuSO_4.5H_2O$$

anhydrous (white) Hydrous (blue)

(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) Heat the fusion tube in a flame to melt sodium metal.
(4) When sodium metal is melted, then add a small amount of powdered organic compound into fusion tube.
(5) Then Heat the fusion tube again till its bottom become red hot.
(6) Break this fusion tube in a China dish containing $20cm^3$ of distilled water.
(7) Mixed, boil and then filter the solution.
(8) The filtrate obtained is called Lassaigne's solution or sodium extract.
(9) Divide this filtrate into three portion and test, the presence of N, S and X (halogens) respectively.

Reactions:

$$2Na + S \longrightarrow Na_2S$$

$$Na + N + C \longrightarrow NaCN$$

$$Na + X \longrightarrow NaX \quad \text{where } X = C\ell, Br, I$$

Nitrogen Test

To one portion of Lassaigne's filtrate a few drops of NaOH is added to make it alkaline, then freshly prepared ($FeSO_4$) solution is added to it. The solution is boiled and a few drops of $FeC\ell_3$ solution and $HC\ell$ 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.

$$Na + C + N \dashrightarrow NaCN$$

$$6NaCN + FeSO_4 \longrightarrow Na_4[Fe(CN)_6] + Na_2SO_4$$

Sodium ferrocyanide

$$3Na_4[Fe(CN)_6] + 4FeCl_3 \longrightarrow Fe_4[Fe(CN)_6]_3 + 12NaCl$$

Ferric ferrocyanide

(Prussian blue colour)

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.

$$2Na + 2C + N_2 + 2S \longrightarrow 2NaSCN$$

$$6NaSCN + FeSO_4 \longrightarrow Na_4[Fe(CNS)_6] + Na_2SO_4$$

$$3Na_4[Fe(CNS)_6] + 4FeCl_3 \longrightarrow Fe_4[Fe(CNS)_6] + 12NaCl$$

Blood red ppt.

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.

$$S^{2-} + 2CH_3COOH \longrightarrow H_2S + 2CH_3COO^-$$

$$H_2S + 2CH_3COO^- + Pb \longrightarrow PbS + 2CH_3COOH$$

Black ppt.

Halogen Test (Silver Nitrate Test)

A third portion of Lassaigne's solution is boiled with nitric acid to expel cyanide ions and sulphide ions and $AgNO_3$ solution is added. The formation of precipitate shows the presence of a halogens, 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.

$$NaX + AgNO_3 \longrightarrow AgX + NaNO_3 \ (X^- = Cl^-, Br^-, I^-)$$

(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 hydroxyl (OH), carboxyl (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 acid, and then a hot solution of ammonium molybedate 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 tested for the presence of metallic radical by the usual scheme employed for inorganic salts.

SHORT QUESTIONS

- How can you prepare Lassaigne's extracts?
- CO_2 turns lime water milky. Justify.
- How can you detect halogens in an organic compound?

Society Science Technology

ORGANIC COMPOUNDS OBTAINED FROM PLANTS AND ANIMALS

Most Sugars, Some alkaloids (a naturally occurring nitrogenous organic molecule), Some terpenoids (a large class of natural products consisting of isoprene (C_5) units) Certain nutrients such as vitamins, Antigens, Carbohydrates, Enzymes, Hormones, Lipids and fatty acids, fats and oils, Neurotransmitters, Nucleic acids, Proteins, peptides and amino acids, Lectins (sugar-binding proteins)

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).

KEY POINTS

- Coal, petroleum and natural gas are important sources of organic compounds.
- The study of organic chemistry organized around functional groups. Each functional group defines as organic family.
- Organic chemistry is concerned with the chemistry of living material or substances which were at one time alive. It is therefore concerned with living plants or animals or substances like coal and oil which are derived from living plants (coal), or from microscopic sea organisms (oil).
- 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.
- The word petroleum is derived from the Latin words "Petra" meaning rock and "Oleum" meaning oil. It is also called mineral oil.
- Bacterial decay at high pressure with little oxygen changed the organic matter into crude oil and natural gas.
- 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.
- The clothes we wear, the dyes that color 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.

EXERCISE

Q1. Multiple Choice Questions. Encircle the correct answer:

- ✪ *Read the question carefully.*
- ✪ *Try to answer the question yourself before reading the answer choices.*
- ✪ *Guess only if you can eliminate one or more answer choices.*
- ✪ *Drawing a picture can help.*
- ✪ *Don't spend too much time on any one question.*
- ✪ *In-depth calculations are not necessary; approximate the answer by rounding.*

(i) **The major portion of natural gas is**
(a) ethane (b) propane (c) butane (d) methane

(ii) **In organic compounds, carbon atoms form;**
(a) ionic bond (b) metallic bond (c) covalent bond (d) none of these

(iii) **Which of the following is an aromatic compound?**
(a) propanol (b) cyclohexane (c) acetone (d) benzene

(iv) **There are a few homologous series of compounds. The existence of homologous series is due to;**
(a) functional group (b) cracking (c) isomerism (d) polymerization

(v) **Which of the following compound is heterocyclic?**
(a) pyridine (b) pyrrole (c) thiophene (d) all of the above

(vi) **Select from the following one, which is alcohol;**
(a) $CH_3 - CH_2 - OH$ (b) $CH_3 - O - CH_3$ (c) CH_3COOH (d) $CH_3 - CH_2 - Br$

(vii) **Lassaigne's solution is prepared in the detection of elements of organic compound. Which metal is used for the reaction with organic compound?**
(a) aluminium (b) sodium (c) iron (d) copper

(viii) **When $AgNO_3$ is added to the Lassaigne's solution which colour is formed for Iodine?**
(a) blue (b) violet (c) green (d) deep yellow

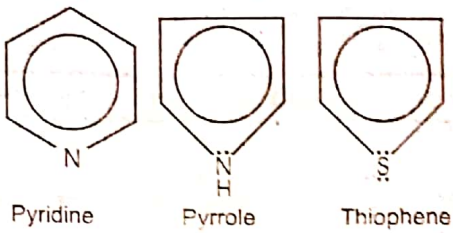
(ix) **When water vapours are passed over white anhydrous copper sulphate, which colour is formed?**
(a) white (b) deep blue (c) yellow (d) brown

(x) **The simplest molecule of Bucky Ball contains carbon atoms;**
(a) 20 (b) 8 (c) 60 (d) 100

(xi) **If a molecule contains more than one functional groups, it is known as;**
(a) derivative (b) polyfunctional (c) heterocyclic (d) isomer

SOLVED EXERCISE MCQs

Q. No	Answer	Reason
(i)	(d) methane	Major portion of the natural gas is methane. Others are ethane, propane and butane. A small amount of CO_2, N_2, H_2S and He are also present in natural gas.
(ii)	(c) covalent bond	Organic compounds are generally covalent compounds, because organic compounds contain carbon. Carbon belongs to fourth group of the periodic table and forms bonds by sharing.
(iii)	(d) benzene	Aromatic compounds include benzene and all those compounds that are structurally related to benzene. Benzene has characteristics structural features. It has a regular planar hexagonal structure.
(iv)	(a) functional group	Functional groups serve to classify organic compounds into classes/families.

		All compounds in the same homologous series contain the same elements and the functional group.
(v)	(d) all of the above	The compounds in which the ring consists of atoms of more than one kind are called heterocyclic compounds or heterocycles.  Pyridine Pyrrole Thiophene
(vi)	(a) $CH_3 - CH_2 - OH$	The compounds containing –OH as functional group are called alcohols.
(vii)	(b) sodium	Sodium metal is used for the preparation of Lassaigne's solution. Therefore, it is also called sodium extract.
(viii)	(d) deep yellow	When Lassaigne's solution is boiled with nitric acid to expel cyanide ions and sulphide ions and $AgNO_3$ solution is added. The formation of a deep yellow ppt. insoluble in NH_4OH indicated iodine.
(ix)	(b) deep blue	When water vapours are passed over white anhydrous copper sulphate, it changes into deep blue solid copper (II) sulphate pentahydrate which is called blue vitriol.
(x)	(c) 60	The simplest form of Bucky Ball is C_{60} and its molecule is made up of sixty carbon atoms.
(xi)	(b) polyfunctional	A molecule may contain more than one functional groups. It is then said to be **Polyfunctional**, and the properties of each functional group may be modified by the presence of the others.

SHORT ANSWERS QUESTIONS

2. Give brief answers for the following questions.

(i) What is functional group?

Ans. Functional Group:

A functional group is an atom or group of atoms in a molecule that gives the molecule its characteristic chemical properties.

Examples: – OH, – NH_2, – CHO, – COOH etc.

(ii) What is the difference between partial and total synthesis of organic compounds?

Ans. Partial Synthesis:

In partial synthesis, already present natural compound is converted to the new useful organic compound. Such as dyes, rubber, fibres, plastics etc.

Total Synthesis:

In total synthesis, the new organic compounds are synthesized in labs, such as ether, alcohol drugs, glycol etc.

(iii) How organic compounds are derived by fermentation process?

Ans. Many organic compounds (alcohols, acids, vitamins and antibiotics) are derived by fermentation process. It happens in the absence of oxygen and presence of microorganisms. Big compounds are broken down into simpler compounds.

(iv) What is coal? How is coal used as source of organic compounds?

Ans. Coal:

Coal is a combustible black or brownish-black sedimentary rock usually occurring in rock strata.

It is one of major source of organic compounds. It yields coke, coal gas and coal-tar on pyrolysis or destructive distillation. More than 200 organic compounds have been directly isolated from coal-tar.

(v) What is name of new allotropic form of carbon? Give its definition?

Ans.

- The new allotropic form of carbon is Bucky balls.
- Bucky balls have carbon atoms ranging from forty to hundred. The carbon atoms are arranged in a hollow cage like structure.

(vi) What is Homologous series?

Ans. Homologous series

A group of chemical compounds which are structurally alike and have same chemical properties. In a homologous series two successive members of the group differ from each other by a ($-CH_2-$) group or a mass of 14 amu.

The members of a homologous series generally have same;

(i) General formula

(ii) Methods of preparation

(iii) Chemical properties

(iv) A gradual change in physical properties

Examples: Alkanes, Alcohols, Ketones, etc.

(vii) How sulphur can be detected in organic compounds?

Ans. Prepare Lassaigne's solution by using sodium metal. Lassaigne's solution 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.

$$S^{2-} + 2CH_3COOH \longrightarrow H_2S + 2CH_3COO^-$$

$$H_2S + 2CH_3COO^- + Pb \longrightarrow PbS + 2CH_3COOH$$

Black ppt.

3. Give detailed answers for the following questions.

(ii) Write down the characteristics of organic compounds different from inorganic compounds.

Ans:

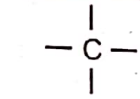
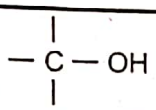
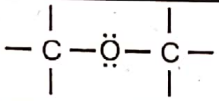
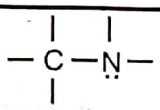
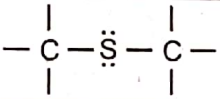
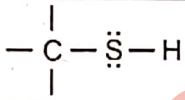
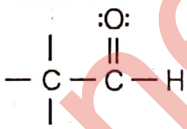
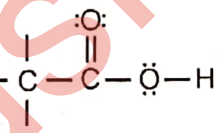
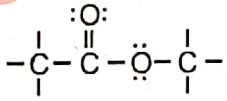
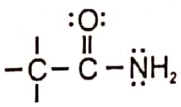
Organic Compounds	Inorganic Compounds
Have lower melting and boiling points and usually decompose on heating.	Have higher melting and boiling points and usually do not decompose on heating.
Low solubility in water and high solubility in nonpolar solvents.	Freely soluble in water but insoluble in nonpolar solvents.
They exhibit covalent bonding in their molecules and are nonconductors of electricity.	They exhibit electrovalent bonding and are good conductors of electricity in molten and dissolved state.
Reactions in organic compounds take place slowly.	Reactions in inorganic compounds take place fast.

Organic compounds are inflammable; they catch fire easily.	Inorganic compounds are usually non inflammable; they do not burn easily.

(iv) Write down any ten functional groups of organic compounds? Give reasons for the importance of organic chemistry.

Ans:

Some common functional groups

Family	Structure of Functional Group	Simple example
Halide	 (X = F, Cl, Br, I)	$H_3C - Cl$ Methyl chloride
Alcohol		$H_3C - OH$ Methanol (Methyl alcohol)
Ether		$H_3C-\ddot{O}-CH_3$ Dimethyl ether
Amine		$H_3C - NH_2$ Methyl amine
Sulphide		$H_3C-\ddot{S}-CH_3$ Dimethyl sulphide
Thiol		$H_3C-\ddot{S}H$ Methane thiol (Methylthiol)
Aldehyde		$H_3C-C(=O)-H$ Acetaldehyde
Carboxylic Acid		$CH_3-C(=O)-\ddot{O}-H$ Acetic acid
Ester		$CH_3-C(=O)-\ddot{O}-CH_3$ Methyl acetate
Amide		$H_3C-C(=O)-\ddot{N}H_2$ Acetamide

Importance of Functional Group

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:

(i) Functional groups serve as basis for nomenclature (naming) of organic compounds.

(ii) Functional groups serve to classify organic compounds into classes/families. All compounds with t same functional group belong to the same class.

(iii) A functional group is a site of chemical reactivity in a molecule containing the functional group.

Skill Activity

Bleaching powder is used as disinfectant for swimming pool water, take sample of swimming pool water a determine the best pH of water for clean swimming pool.