CARBON AND ITS COMPOUNDS

Introduction

- Symbol C
  At. No. 6
  At. Mass 12u
  E.C. K=2, L=4
  Valency 4
- The term carbon is derived from the word '**Carbo**' which means coal.
- Almost all substances including clothing, food, fuel, plastic, wood etc. contain carbon.
- Forms large no. of compounds.
- 0.02% as minerals in earth crust, 0.03% as CO_2 in air

Covalent Bonding

- Chemical bond: The force of attraction keeping the elements together to form a compound is known as a Chemical Bond.
- Ionic bond: In this type of bond electrons get transferred from a metal to a non metal, forming ions. It is an electrostatic force of attraction between the developed ions.
- **Covalent Bond**: It is the bond formed due to **equal sharing of electrons between two atoms**. It is of three types: Single, Double, triple covalent bonds.
- Covalency in Carbon:
  Carbon does not form Cation C^{4+}as a large amount of energy is required for this due to **large effective nuclear charge.**
  Carbon does not form Anion C^{4-} as large amount of energy is required to overcome **Inter-electronic repulsion** and 6 protons cannot hold 10 electrons.
  Hence Carbon is not able to form any ion so it shares its electrons to form covalent Bond.
- Types of Covalent Bond:
  1) **Single covalent bond**: The bond formed by sharing 1 electron each between two atoms. Eg. Hydrogen molecule, Chlorine molecule, Flourine molecule, HCl, Water, NH_3, CH_4 etc.
  2) **Double covalent bond**: The bond formed by sharing 2 electrons each between two atoms. Eg. Oxygen molecule, CO_2 etc.
  3) **Triple covalent bond**: The bond formed by sharing 3 electrons each between two atoms. Eg. Nitrogen molecule, Ethyne etc.
- Properties of Covalent Compounds:
  1) These compounds have **low melting and boiling point**. The intermolecular force is weak in case of Covalent compound.
  2) No formation of ions.

Occurrence of carbon:

- Carbon exists on earth in combined as well as elemental/free form. Elemental form includes allotropes of Carbon whereas combined form includes Carbonates and Bicarbonates, coal, petroleum.
- **Allotropy:** Existence of an element in more than one form which are physically different but are chemically same. These different forms are known as **Allotropes**.
  Carbon exists as three Allotropes: Diamond, Graphite and Fullerene.

  - **Graphite**:
    1) Graphite crystals are grey coloured, opaque and trigonal.
    2) Each Carbon atom is covalently bonded to 3 other carbon atoms forming hexagonal layers. These layers are stacked one above the other with the help of weak Vander Waals force. This weak bond makes the texture of Graphite soft and slippery.
    3) Since one electron of each Carbon is free, hence it is highly conducting.
  - **Diamond**:
    1) Diamond crystals are transparent, Colorless and octagonal.

2) Each carbon is covalently bonded to 4 other carbon atoms arranged at the corner of a regular tetrahedron. This pattern extends in all 4 directions giving rise to a complex structure thus making it the hardest substance on earth.
3) Since no electron is free hence diamond is non conducting.

- **Fullerene**:
  1) It is also known as Buckminster Fullerene.
  2) It is a C_{60} molecule with each carbon joined to 3 other carbons with one double and 2 single bonds resulting into a cage like structure resembling a soccer ball.
  3) It is basically used in laboratories to trap ions.

Unique nature of Carbon

- **Small size**
- **Tetravalency**: The valency of Carbon is 4 hence it can share all its 4 electrons to form bonds in all 4 directions.
- **Catenation**: Self linking property of atoms is known as Catenation. This property is exhibited by many elements like H_2, N_2, O_2, O_3, P_4, S_8 etc. but it is seen to the maximum extent in carbon as infinite no. of carbon atoms can join together to form large no. of compounds.
- **Multiple bonding**: Carbon can form bonds with all kinds of atoms to complete its valency. It can form single double or triple bond at a time which gives rise to large no. of compounds.

Uses of Carbon

- Graphite: pencil lids, nuclear reactors as moderators, electrode in electrolytic refining of metals, lubricant.
- Diamond: gem, cutting, drilling
- Charcoal: fuel, purify coloured substances
- Coal/Coke: Fuel

Carbon Compounds

The compounds which contain carbon as the main element are known as Carbon or Organic Compounds.

Types of Carbon Compounds:

1) **Long chain:** Carbon compounds containing long chains of Carbon.
2) **Branched Chain:** Carbon compounds containing branches of Carbon.
3) **Cyclic Chain:** Carbon compounds containing rings of Carbon.
4) **Aromatic Compounds:** Benzene and its derivatives are called Aromatic compounds.

Hydrocarbons: The carbon compounds containing only carbon and Hydrogen are called Hydrocarbons.
There are two types of Hydrocarbon: Saturated and Unsaturated

Saturated Hydrocarbons: The Hydrocarbons containing all single bonds. Eg. Alkanes
Unsaturated Hydrocarbons: The Hydrocarbons containing atleast one double or triple bond. Eg. Alkenes and Alkynes.

Alkanes

Alkanes are the saturated Hydrocarbons which contain all single covalent bonds. The general formula for alkanes is C_nH_{2n+2} where n denotes the no. of carbons and its values ranges from 1,2,3…….. These are less reactive hydrocarbons and are mostly used as fuel. For eg. Methane (Biogas) and Butane (LPG) are the common household fuels.
Examples of Alkanes:

n=1	C_1H_{2*1+2}	CH_4	Methane
n=2	C_2H_{2*2+2}	C_2H_6	Ethane
n=3	C_3H_{2*3+2}	C_3H_8	Propane
n=4	C_4H_{2*4+2}	C_4H_{10}	Butane
n=5	C_5H_{2*5+2}	C_5H_{12}	Pentane
……			

Alkenes

Alkenes are the Unsaturated Hydrocarbons which contain one double covalent bond. The general formula for alkenes is C_nH_{2n} where n denotes the no. of carbons and its values ranges from 2, 3, 4…….. These are reactive hydrocarbons.
In Alkenes n=1 (Methene) does not exists as one carbon alone cannot form a double bond.
Examples of Alkenes:

n=2	C_2H_{2*2}	C_2H_4	Ethene
n=3	C_3H_{2*3}	C_3H_6	Propene
n=4	C_4H_{2*4}	C_4H_8	Butene
n=5	C_5H_{2*5}	C_5H_{10}	Pentene
……			

Alkynes

Alkynes are the Unsaturated Hydrocarbons which contain one triple covalent bond. The general formula for alkynes is C_nH_{2n-2} where n denotes the no. of carbons and its values ranges from 2,3,4…….. These are highly reactive hydrocarbons.
In Alkynes also n=1 (Methyne) does not exists as one carbon alone cannot form a triple bond.
Examples of Alkynes:

n=2	C_2H_{2*2-2}	C_2H_2	Ethyne
n=3	C_3H_{2*3-2}	C_3H_4	Propyne
n=4	C_4H_{2*4-2}	C_4H_6	Butyne
n=5	C_5H_{2*5-2}	C_5H_8	Pentyne
……			

Functional Group

These are atom or group of atoms which when attached to main chain modifies the properties of the compounds according to them. These groups are known as Functional Groups.

Table 4.3 Some functional groups in carbon compounds

Hetero atom	*Functional group*	*Formula of functional group*
Cl/Br	Halo- (Chloro/bromo)	—Cl, —Br (substitutes for hydrogen atom)
Oxygen	1. Alcohol	—OH
	2. Aldehyde	
	3. Ketone	
	4. Carboxylic acid	

Isomers

The carbon Compounds which have same molecular formula but different structural formula are known as Isomers.

For Example: 1) Butane has 2 isomers.
2) Pentane has 3 isomers.

Homologous series

A series of compounds which follows the following properties is known as Homologous Series.

1) The compounds in a homologous series follow a same general formula.
2) They all have similar chemical properties.
3) They all show gradation in physical properties.
4) The difference between two adjacent compound in a homologous series is of --CH_2--.
5) The difference in the molecular mass of two adjacent compounds in a homologous series is 14u.

For example: H.S. Of Alkanes, H.S. Of Alkenes, H.S. Of Alkynes, H.S. Of Alcohol, H.S. Of Carboxylic Acid etc.

Nomenclature:

The naming of compounds is known as Nomenclature.

There are certain rules followed to assign names to Organic Compounds.

Rule 1. Selection of parent Chain.: Parent Chain is the longest chain of Carbon including double bond, Triple bond and the carbon containing the functional Group. First step of Nomenclature is to select the parent chain.

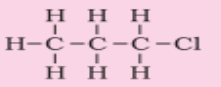
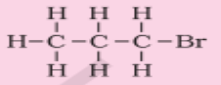
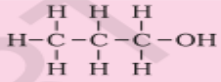
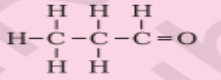
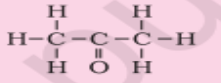
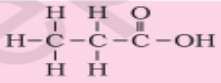
Rule 2. Naming of parent Chain.: The selected parent chain is named based on the number of carbons present in the parent chain. The prefix of the name depends on the no. of carbons in the chain and the suffix of the name depends on the type of bond present in the chain**.('ane' if all single bonds, 'ene' if one double bond and 'yne' if one triple bond)**

No. of C atoms	1	2	3	4	5	6	7	8	9	10
Prefix	Meth	Eth	Prop	But	Pent	Hex	Hept	Oct	Non	Dec

Rule 3. Naming the Branch.: If a branch is present in the compound then this branch is named according to the no. of carbon in the branch with the suffix '**yl**'. The name of the branch is written before the name of the parent chain.

Rule 4. Naming the functional Group.: If any functional group is present in the compound it is given name according to the following notation

Table 4.4 Nomenclature of functional groups

Functional group	Prefix/Suffix	Example	
1. Halogen	Prefix-chloro, bromo, etc.		Chloropropane
			Bromopropane
2. Alcohol	Suffix - ol		Propanol
3. Aldehyde	Suffix - al		Propanal
4. Ketone	Suffix - one		Propanone
5. Carboxylic acid	Suffix - oic acid		Propanoic acid

Rule 5. Numbering.: The position at which the double bond, triple bond, Branch or functional group is attached is mentioned in the name. The lowest position of carbon from the either side is the assigned position. In case of double or triple band the lowest position from the either side of carbon after which this bond is present is the assigned position.

Reactions :

The various reactions undergone by Carbon Compounds are **Oxidation, Combustion, Addition & Substitution.**

1) **Oxidation:** Addition of oxygen is known as Oxidation. The oxidizing agents required for the oxidation are:
   Alkaline potassium permanganate (Alk. $KMnO_4$): Purple in Colour
   Acidified potassium Dichromate (Acid. $K_2Cr_2O_7$): Yellow in Colour
   The oxygen produced from these oxidizing agents is in the form of nascent Oxygen [O].

For. Eg. Ethanol on oxidation forms ethanoic acid:

CH_3CH_2OH + [O] → CH_3COOH
Ethanol From Oxidizing Agents Ethanoic acid

2) **Combustion:** Burning a compound in presence of air/oxygen is termed as Combustion. Almost all the organic compounds undergo combustion, hence most of the organic compounds act as a good fuel. When combustion takes place, CO_2 and H_2O are formed along with the liberation of high amount of heat and light energy.

$C + O_2 \xrightarrow{\text{From Air}} CO_2 + \text{Heat} + \text{Light}$

$CH_4 + O_2 \xrightarrow{\text{From Air}} CO_2 + H_2O + \text{Heat} + \text{Light}$

$CH_3CH_2OH + O_2 \xrightarrow{\text{From Air}} CO_2 + H_2O + \text{Heat} + \text{Light}$

a) **Combustion in Saturated Hydrocarbons**: Since the percentage of Carbon is less in Saturated Hydrocarbons, hence less amount of oxygen can lead to complete combustion of the hydrocarbons. Therefore the atmospheric oxygen is enough for the saturated hydrocarbons, hence on burning they produce a blue fame indicating complete combustion. Eg. LPG used as household fuel (Butane).
*** Blocked air holes of the gas burner leads to a yellow flame as the air supply is reduced.**

b) Combustion in Unsaturated Hydrocarbons: Since the percentage of Carbon is more in unsaturated hydrocarbons, hence more amount of oxygen is required for the complete combustion of the hydrocarbons. Therefore, unsaturated hydrocarbons always burn with a yellow flame.

* Increased Supply of Oxygen can result into complete combustion of even unsaturated hydrocarbons which leads to releasing of a large amount of energy. For Eg: Oxy-Acetylene Flame(Oxygen & Ethyne) is used for welding.

* Drawbacks of Incomplete Combustion: H.W.

3) **Addition:** This reaction is a characteristic property of Unsaturated Hydrocarbons. During this reaction, unsaturated hydrocarbons converts into saturated hydrocarbons.
For Eg. Hydrogenation of Ethene: When Hydrogen is added to Ethene in presence of catalyst Ni/Pt, Addition reaction takes place and Ethane is formed.

$CH_2{=}CH_2 + H_2 \xrightarrow{Ni/Pt} CH_3\text{-}CH_3$
Ethene Ethane
(Unsaturated Hydrocarbons) (Saturated Hydrocarbons)

Applications of Addition reaction:

a) Conversion of vegetable oil into vegetable ghee
Vegetable oils are unsaturated hydrocarbons which can be converted into vegetable ghee by Hydrogenation (addition of Hydrogen). Vegetable ghee are saturated hydrocarbons.

Vegetable Oil Vegetable Ghee

Q. Which is better for health, Vegetable Oil or Vegetable ghee??

b) Test for unsaturation
When Bromine(Brown Coloured Liquid) is added to any unsaturated compound, it **decolourises** indicating the presence of unsaturation.

$CH_2=CH_2$ + Br_2 → $Br\text{-}CH_2\text{-}CH_2\text{-}Br$

Ethene | Bromine liquid | Di bromo ethene

(Unsaturated Hydrocarbon) | (Brown Colour) | (Saturated Compound)

4) **<u>Substitution:</u>** This reaction is the characteristic property of Saturated Hydrocarbons.
For eg. Chlorination of Methane.

$CH_4 + Cl_2 \xrightarrow{hv} CH_3Cl + HCl$

Methane | Chlorine gas | Chloro Methane

$CH_3Cl + Cl_2 \xrightarrow{hv} CH_2Cl_2 + HCl$

Chloro Methane | DiChloro Methane

$CH_2Cl_2 + Cl_2 \xrightarrow{hv} CHCl_3 + HCl$

DiChloro Methane | TriChloro Methane (Chloroform)

$CHCl_3 + Cl_2 \xrightarrow{hv} CCl_4 + HCl$

TriChloro Methane | TetraChloro Methane (Carbon Tetra Chloride)

Overall reaction: $CH_4 + 4Cl_2 \xrightarrow{hv} CCl_4 + 4HCl$

<u>Ethanol</u>

1) Physical Properties
   a) Ethanol is the second member of the homologous series of alcohols with the formula **C_2H_5OH** and molecular mass as 46u.
   b) It is liquid in state at room temperature, colorless and is soluble in water at all proportions.
   c) 100% ethanol is known as Absolute alcohol whereas 5% ethanol in water is called as Rectified Spirit.
   d) It is a good solvent and is widely used in medicinal industry as well as it is a chief ingredient of all hard drinks.

2) Chemical Properties
   a) Oxidation: Same as before
   b) Combustion: Ethanol easily burns in the presence of atmospheric oxygen produce CO2, H2O, heat and light. Since a large amount of energy is released during this combustion reaction hence ethanol acts as a good fuel. It is a Clean fuel as combustion of Ethanol does not produce any toxic gas. In some countries ethanol is used along with petrol to run cars.

      $CH_3CH_2OH + O_2 \rightarrow CO_2 + H_2O + Heat + Light$

   c) Reaction with Sodium Metal: When ethanol reacts with sodium metal, hydrogen gas is released along with the formation of Sodium Ethoxide. The Sodium metal displaces hydrogen from ethanol.
      *Since Hydrogen gas can be easily tested in the laboratory, hence this reaction is used to test the presence of alcohol in the laboratory.

      $2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2ONa + H_2$

      Sodium Ethoxide

   d) **Dehydration**: Dehydration means removal of water. When alcohol is heated with Conc. H_2SO_4, corresponding alkene is formed along with removal of a water molecule.

$$CH_3CH_2OH \xrightarrow{\text{Conc. } H_2SO_4} CH_2{=}CH_2 + H_2O$$

Ethene
(unsaturated Hydrocarbon)

3) Preparation of Ethanol: Ethanol is prepared by the fermentation of Molasses. Molasses is dark brown liquid left after the extraction of sugar from sugarcane juice.

Ethanoic acid

1) Physical Properties
   a) Ethanoic Acid is the second member of the homologous series of Carboxylic Acids with the formula **CH_3COOH** and molecular mass as 60u. It is commonly called as Acetic Acid.
   b) It is colorless and is soluble in water at all proportions and has vinegar like odour. It is a weak acid.
   c) 100% ethanoic acid is known as Glacial acetic acid as its crystals resemble like ice whereas 5% ethanoic acid in water is called as Vinegar.
   d) It is used as a preservative for jams and pickles.

2) Chemical Properties
   a) Reaction with a base: Ethanoic acid reacts with a base to produce corresponding salt and water.

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

Sodium Ethanoate

   b) Reaction with metal Carbonate/ bicarbonate : Ethanoic acid reacts with a metal carbonates or bicarbonates to produce corresponding salt, CO_2 and water. Since liberation of CO_2 can easily be tested in laboratory using limewater test, hence this reaction is used as a test for Carboxylic Acids.

$$CH_3COOH + Na_2CO_3/NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$$

   c) **Esterification reaction**: This reaction is used to prepare esters. Esters are fruity/sweet smelling organic compounds with general formula RCOOR'. These are prepared when any alcohol reacts with carboxylic acids in presence of Sulphuric acid.

$$\underset{\text{Ethanoic Acid}}{CH_3COOH} + \underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow{\text{Conc. } H_2SO_4} \underset{\text{Ethyl Ethanoate}}{CH_3COO\,CH_2CH_3} + H_2O$$

*Esters can be easily converted back into corresponding carboxylic acids and alcohol just by treating esters with acid or base. The reaction in which esters are reacted with a base to give back the corresponding Carboxylic acid and alcohol is called as **SAPONIFICATION REACTION**.

Soaps and Detergents

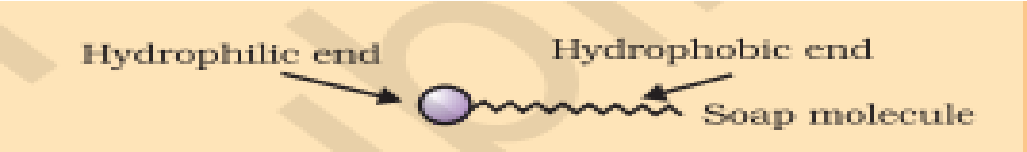
All cleaning reagents are known as Soaps.
Soaps are of two types: Soaps and detergents.

SOAPS: Soaps are **Sodium and potassium salts of long chain Carboxylic acids**. They are prepared by saponification reaction.
Saponification reaction is the alkaline hydrolysis of Animal fats(long chain esters).

RCOOR'	+	NaOH	→	RCOO Na	+	R'OH
Fatty acids		Base		Soap		Glycerol
(Long Chain Esters)				(Carboxylic acid counterpart)		(alcohol counterpart)

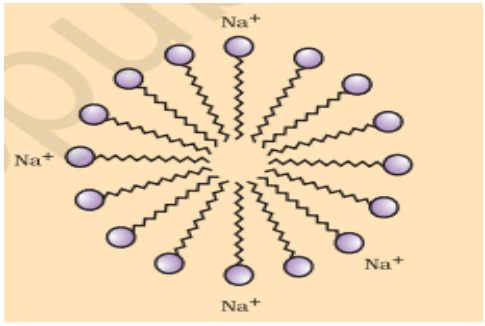
- Egs. of soap: Sodium stearate ($C_{17}H_{35}COONa$)
  Sodium Palmitate ($C_{15}H_{31}COONa$)
  Sodium Oleate ($C_{17}H_{33}COONa$)

- Representation of soap molecule: A soap molecule can be represented as the following.



The tail of the soap molecule represents the covalently bonded long carbon chain. Due to presence of covalent bond, this chain is hydrophobic(insoluble in water) or lipophilic (soluble in oil)in nature. The head of the soap molecule represents the ionic -COONa group. Due to ionic nature, this end of the soap molecule is hydrophilic(soluble in water) or lipophobic (insoluble in oil).
This dual nature of the soap molecule helps it to show cleaning properties.

- Cleaning Mechanism of soap molecule: This involves three steps:
  1) **Formation of a Micelle**: When soap is dissolved in water, it forms a colloidal suspension type of solution. On addition of soap molecules to water, they arrange themselves in a spherical orientation where the heads of the soap molecules are at the surface of the sphere in contact with water and the tails are hanging inside away from the water. This kind of orientation is known as a MICELLE. This formation of micelle is responsible for the cleaning action of soap.



  2) **Cleaning action**: When the dirty cloth is dipped in soapy water, the tails of the micelle get attached to the dirt and surround it. When the cloth is agitated the dirt is pulled from the cloth by the tails of the soap and comes along with the water squeezed out from the cloth. The dirt gets trapped inside the micelles forming globules of oil. This results into cleaning of the cloth.

  3) No formation of Aggregates: The globules of oil formed in water have negative charges at their surface, these charges prevent the globules from coming near to each other to forms aggregates. Therefore no lumps of oil or dirt are formed.

- Disadvantages of Soap:
  1) Soaps are **not effective in hard water**: Hard water is the water containing Mg^{2+} and Ca^{2+}ion. These ions displace Na from soap molecule forming **insoluble white precipitate called SCUM** which does not show cleaning action.

     $2RCOONa + Mg^{2+}/Ca^{2+} \rightarrow (RCOO)_2Mg\ /(RCOO)_2Ca + 2\ Na^{+}$

     Soap — From Hard Water — Scum (White Precipitate)
  2) Soaps are **not suitable for cleaning woolen clothes**: Woolen clothes contain acidic dyes, but soaps are basic salts. So, using soap for cleaning woolen clothes destroys the colour of the cloth.

DETERGENTS: Detergents are **Ammonium or suphonic salts of long chain carboxylic acids**.

- Advantages of Detergents over Soap:
  1) Detergents are effective in hard water: The Sulphonic group present in the detergent molecule has more affinity for Na^{+} ion than Mg^{2+} or Ca^{2+} ion. Hence no reaction takes place and the action of detergent remains as it is.
  2) Detergents are suitable for cleaning woolen clothes: Detergents are neutral molecules, hence the acidic dyes does not get affected by detergents.
  3) Detergents have stronger cleaning action than Soaps.

- Difference between Soaps and detergents: H.W.

ASSIGNMENT

1. Write the electron dot structure of ethene molecule (C_2H_4).
2. Write the electron dot structure of ethane molecule (C_2H_6).
3. State two properties of carbon which lead to a very large number of carbon compounds.
4. Carbon has four electrons in its valence shell. How does carbon attain stable electronic configuration.
5. Write the number of covalent bonds in the molecule of ethane.
6. Write the number of covalent bonds in the molecule of propane, C_3H_8.
7. Write the number of covalent bonds in the molecule of butane, C_4H_{10}
8. Write the general formula of hydrocarbon alkene. Write the name of simplest alkene.
9. Write the molecular formula of benzene and state the number of double bonds in its structure.
10. State two characteristic features of carbon which when put together give rise to large number of carbon compounds.
11. Select saturated hydrocarbons from the following:
    C_3H_6, C_5H_{10}, C_4H_{10}, C_6H_{14}, C_2H_4.
12. Which element exhibits the property of catenation to maximum extent and why?
13. Name the functional group present in each of the following organic compounds:
    (i) C_2H_5Cl (ii) C_2H_5OH (iii) HCOOH
    (iv) C_2H_5CHO (v) CH_3COCH_3 (vi) C_2H_5COOH
14. Why does micelle formation take place when soap is added to water? Why are micelles not formed when soap is added to ethanol?
15. What is a soap? Why are soaps not suitable for washing clothes when the water is hard?
16. Write the name and formula of the second member of the carbon compounds having functional group —OH.
17. Write the name and formula of the first member of the carbon compounds having functional group —COOH.
18. Write the name and formula of the first member of the carbon compounds having functional group —CHO.
19. Write the name and formula of the 2nd member of the series of carbon compounds whose general formula is $C_nH_{2n+1}OH$.
20. Write the name and formula of the 2nd member of the series of carbon compounds whose general formula is C_nH_{2n}.
21. Draw the structure for ethanoic acid molecule, CH_3COOH.
22. Draw the structure of butanone molecule, $CH_3COC_2H_5$.
23. Draw the structure of the hexanal molecule, $C_5H_{11}CHO$.
24. Butanone is a four carbon per molecule compound. Name the functional group present in it.
25. Explain the action of soap in removing an oily spot from a piece of cloth.
26. Explain why carbon generally forms compounds by covalent bonds.
27. With the help of a suitable example explain in brief the process of hydrogenation mentioning the conditions for the reaction and also state any one physical property of substances which changes due to hydrogenation.
28. Select alkene and alkyne from the following : C_6H_{12}, C_3H_4, C_2H_4, CH_4, C_4H_8, C_5H_8
29. Write the name and molecular formula of an organic compound having its name suffixed with '–ol' and having two carbon atoms in the molecule. With the help of a balanced chemical equation indicate what happens when it is heated with excess of conc. H_2SO_4.
30. Write the names and molecular formula of two organic compounds having functional group suffixed as '–oic acid'. With the help of a balanced chemical equation and explain what happens when any one of them reacts with sodium hydroxide.
31. What is a homologous series? Which two of the following organic compounds belong to the same homologous?
    C_2H_6, C_2H_6O, $C_2H_6O_2$, CH_4O.
32. What is the IUPAC name of
    (i) $CH_3—CH_2—CH=CH_2$ (ii) CH_3CHO (iii) $CH_3COCH_2CH_3$
    (iv) HCOOH (v)CH_3COOCH_3
33. What are detergents chemically? List two merits and two demerits of using detergents for cleansing. State the reason for the suitability of detergents for washing, even in the case of water having calcium and magnesium ions.
34. Atom of an element contains five electrons in its valence shell. This element is major component of air. It exists as a diatomic molecule.
    (i) Identify the element.
    (ii) Show the bond formed between two atoms of this element.
    (iii) Write the nature of the bond between the two atoms.
35. Give reason why carbon neither forms C^{4+} cations nor C^{4-} anions, but forms covalent compounds which are bad conductor of electricity and have low melting and low boiling points.

36. Write the name and general formula of a chain of hydrocarbons in which an addition reaction with hydrogen can take place. Stating the essential conditions required for an addition reaction to occur. Write the chemical equation giving the name of the reactant and the product of such a reaction.
37. What are covalent compounds? Why are they different from ionic compounds? List their three characteristic properties.
38. What is the difference between the chemical composition of soaps and detergents? State in brief the action of soaps in removing an oily spot from a shirt. Why are soaps not considered suitable for washing where water is hard.
39. Draw the electron-dot structure for ethyne. A mixture of ethyne and oxygen is burnt for welding. In your opinion, why cannot we use a mixture of ethyne and air for this purpose?
40. What happens when 5% alkaline $KMnO_4$ solution is added drop by drop to warm ethanol taken in a test tube? State the role of alkaline $KMnO_4$ solution in this reaction.
41. Write the name and general formula of a chain of hydrocarbons in which an addition reaction with hydrogen is possible. State the essential condition for an addition reaction. Stating this condition, write a chemical equation giving the name of the reactant and the product of the reaction.
42 (a) In tabular form, differentiate between ethanol and ethanoic acid under the following heads:
(i) Physical state (ii) Taste (iii) $NaHCO_3$ test (iv) Ester test
(b) Write a chemical reaction to show the dehydration of ethanol.
43. (a) What are isomers? Draw the structures of two isomers of butane, C_4H_{10}.
(b) Differentiate between alkenes and alkynes.
44. Elements forming ionic compounds attain noble gas electronic configuration by either gaining or losing electrons from their valence shells. Explain giving reason why carbon cannot attain such a configuration in this manner to form its compounds. Name the type of bonds formed in ionic compounds and in the compounds formed by carbon. Also explain with reason why carbon compounds are generally poor conductors of electricity.
45. What are isomers? Why can't we have isomers of first three members of alkane series? Draw the possible structures of isomers of butane, C_4H_{10}.
46. Write the name and molecular formula of an organic compound having its name suffixed with 'ol' and having two carbon atoms in its molecule. Write balanced chemical equation to indicate what happens when this compound is heated with excess conc. H_2SO_4 and the name of main product formed. Also state the role of conc. H_2SO_4 in the reaction.
47. An aldehyde as well as ketone can be represented by the same molecular formula, say C_3H_6O. Write their structures and name them. State the relation between the two in the language of science.
48. C_3H_6, C_4H_8 and C_5H_{10} belong to the same homologous series.
(i) Define homologous series.
(ii) Why the melting and boiling points of C_5H_{10} is higher than C_4H_8?
(iii) Arrange these hydrocarbons in order of increasing boiling points.
49. What is meant by homologous series of carbon compounds? Classify the following carbon compounds into two homologous series and name them. C_3H_4, C_3H_6, C_4H_6, C_4H_8, C_5H_8, C_5H_{10}
50. When ethanoic acid reacts with sodium hydrogen carbonate a salt X is formed along with a gas Y. Name X and Y. Describe an activity and draw the diagram of the apparatus used to prove that the gas Y is one which you have named. Also write the chemical equation for the reactions involved.
51. Give reasons for the following:
(i) Element carbon forms compounds mainly by covalent bonding.
(ii) Diamond has a high melting point.
(iii) Graphite is a good conductor of electricity.
(iv) Acetylene burns with a sooty flame.
(v) Kerosene does not decolourise bromine water while cooking oils do.
52. State the meaning of the functional group in an organic compound. Write the formula of the functional group present in alcohols, aldehydes, ketones and carboxylic acids.
53. What are hydrocarbons? Distinguish alkanes from alkenes and each of them from alkynes, giving one example of each. Draw the structure of each compound cited as example to justify your answer.
54. What are homologous series of carbon compounds? Write the molecular formula of two consecutive members of homologous series of aldehydes. State which part of these compounds determines their (i) physical and (ii) chemical properties.
55. What is meant by isomers? "We cannot have isomers of first three members of alkane series." Give reason to justify this statement. Draw the structures of two isomers of pentane, C_5H_{12}.
56. (a) You have three unlabelled test tubes containing ethanol, ethanoic acid and soap solution. Explain the method you would use to identify the compounds in different test tubes by chemical tests using litmus paper and sodium metal.
(b) Give the reason of formation of scum when soaps are used with hard water.
57. An organic compound 'X' on heating with conc. H_2SO_4 forms a compound 'Y' which on addition of one molecule of hydrogen in the presence of nickel forms a compound 'Z'. One molecule of compound 'Z' on combustion forms two

molecules of CO_2 and three molecules of H_2O. Identify giving reasons the compounds 'X', 'Y' and 'Z'. Write the chemical equations for all the chemical reactions involved.
58. (a) What is a homologous series of compounds? List any two of its characteristics.
(b) What is the next higher homologue of C_3H_7OH? What is its formula and what is it called?
59. (a) What are hydrocarbons? Give examples.
(b) Give the structural differences between saturated hydrocarbons and unsaturated hydrocarbons with two examples each.
(c) What is a functional group? Give examples of two different functional groups.
60. Name the functional group of organic compounds that can be hydrogenated. With the help of suitable example explain the process of hydrogenation mentioning the conditions of the reaction and any one change in physical property with the formation of the product. Name any one natural source of organic compounds that are hydrogenated.
61. An ester has the molecular formula $C_4H_8O_2$. Write its structural formula. What happens when this ester is heated in the presence of sodium hydroxide solution? Write the balanced chemical equation for the reaction and name the products. What is a saponification reaction?
62. An organic compound 'A' is an essential constituent of wine and beer. Oxidation of 'A' yields an organic acid 'B' which is present in vinegar. Name the compounds 'A' and 'B' and write their structural formula. What happens when 'A' and 'B' react in the presence of an acid catalyst? Write the chemical equation for the reaction.
63. What is ethanol? State its two properties. What happens when it is heated with excess of conc. H_2SO_4 at 443 K ? What role does conc. H_2SO_4 play in this reaction? Write chemical equation of the reaction involved and the structural formula of the main product formed.
64. With the help of balanced chemical equations explain what happens when ethanol is heated with (i) alkaline solution of potassium permanganate, (ii) excess concentrated sulphuric acid at 443 K. Mention any two uses of ethanol.
65. When ethanol reacts with ethanoic acid in the presence of conc. H_2SO_4, a substance with fruity smell is produced. Answer the following:
(i) State the class of compounds to which the fruity smelling compounds belong. Write the chemical equation for the reaction and write the chemical name of the product formed.
(ii) State the role of conc. H_2SO_4 in this reaction.
66. Write chemical equation of the reaction of ethanoic acid with the following:
(a) Sodium;(b) Sodium hydroxide; (c) Ethanol.
Write the name of one main product of each reaction.
67. (a) Give chemical tests to detect the presence of (i) Ethanol (ii) Ethanoic acid
(b) Why ethanoic acid is called glacial acetic acid?
68. List two tests for experimentally distinguishing between an alcohol and a carboxylic acid and describe how these tests are performed.
69. An organic compound 'P' is a constituent of wine. 'P' on reacting with acidified $K_2Cr_2O_7$ forms another compound 'Q'. When a piece of sodium is added to 'Q' a gas 'R' evolves which burns with a pop sound. Identify P, Q and R and write the chemical equations of the reactions involved.
70. A carboxylic acid (molecular formula $C_2H_4O_2$) reacts with an alcohol in the presence of an acid catalyst to form a compound 'X'. The alcohol on oxidation with alkaline $KMnO_4$ followed by acidification gives the same carboxylic acid $C_2H_4O_2$. Write the name and structure of (i) carboxylic acid, (ii) alcohol and (iii) the compound 'X'.
71. On dropping a small piece of sodium in a test tube containing carbon compound 'X' With molecular formula C_2H_6O, a brisk effervescence is observed and a gas 'Y' is produced, On bringing a burning splinter at the mouth of the test tube the gas evolved burns with a pop sound. Identify 'X' and 'Y'. Also write the chemical equation for the reaction. Write the name and structure of the product formed, when you heat 'X' with excess conc. sulphuric acid.
72. A carbon compound X turns blue litmus to red and has a molecular formula $C_2H_4O_2$. Identify X and draw its structure. Write chemical equation for the reaction and name of the product formed in each case when X reacts with
(a) ethanol in the presence of conc. H_2SO_4 (b) sodium carbonate.
73. (i) Chemical properties of ethanol is different from methyl ethanoate. Justify the statement with proper reason.
(ii) Methyl ethanoate is used in making perfumes. Justify.
(iii) Ethanol is converted into ethene with excess of hot concentrated H_2SO_4. Justify with the help of chemical equation.
74. Describe the structure of a soap molecule with the help of a diagram.
75. Why is scum formed only with hard water ? Mention the disadvantages of the formation of scum.
76. What is the difference between the molecules of soaps and detergents, chemically? Explain the cleansing action of soaps.
77. Explain why carbon forms compounds mainly by covalent bond. Explain in brief two main reasons for carbon forming a large number of compounds. Why does carbon form strong bonds with most other elements?
78. State reasons to explain why covalent compounds:
(i) are bad conductors of electricity? (ii) have low melting and boiling points?
79. (a) Give a chemical test to distinguish between saturated and unsaturated hydrocarbon.

(b) Name the products formed when ethane burns in air. Write the balanced chemical equation for the reaction showing the types of energies liberated.
(c) Why is reaction between methane and chlorine in the presence of sunlight considered a substitution reaction?
80. Give two examples of covalent compounds which you have studied. State any four properties in which covalent compounds differ from ionic compounds.