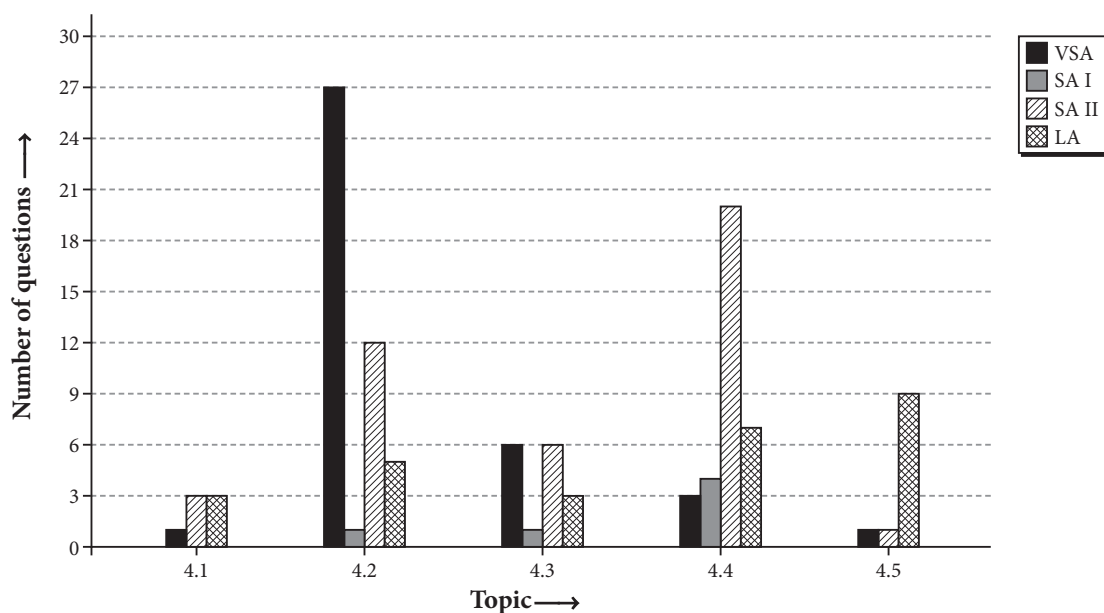


Carbon and its Compounds

4.1 Bonding in Carbon - The Covalent Bond

4.2 Versatile Nature of Carbon[#]4.3 Chemical Properties of Carbon Compounds^{*}4.4 Some Important Carbon Compounds - Ethanol and Ethanoic Acid^{*}4.5 Soaps and Detergents^{*}

Topicwise Analysis of Last 10 Years' CBSE Board Questions (2020-2011)



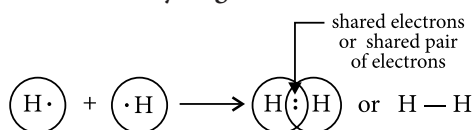
- ▶ Maximum weightage is of *Some Important Carbon compounds– Ethanol and Ethanoic Acid*.
- ▶ Maximum VSA type questions were asked from *Versatile Nature of Carbon*.

- ▶ Maximum SA II type questions were asked from *Some Important Carbon Compounds - Ethanol and Ethanoic Acid*.
- ▶ Maximum LA type questions were asked from *Soaps and Detergents*.

QUICK RECAP

- ▶ **Covalent bond** : A chemical bond formed between two atoms by mutual sharing of valence electrons, so that each atom acquires the stable electronic configuration of the nearest noble gas, is known as *covalent bond*.

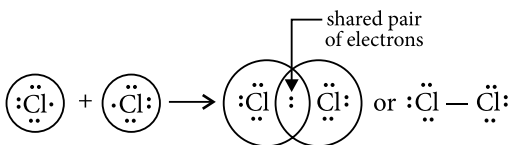
- ▶ **Formation of covalent bonds :**
- ▶ **Formation of hydrogen molecule :**



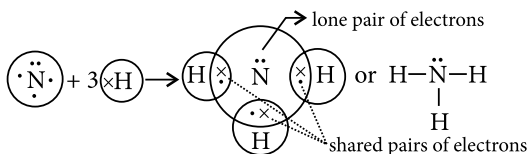
[#]Nomenclature of carbon compounds of the topic "Versatile Nature of Carbon" is not a part of Board Examination 2020-21 syllabus.

^{*}These topics are not a part of the Board Examination 2020-21 syllabus.

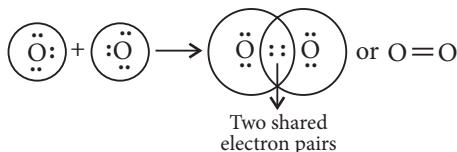
► **Formation of chlorine molecule :**



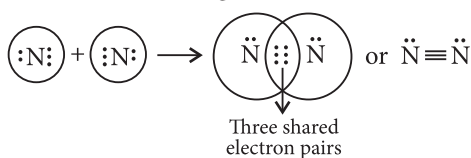
► **Formation of ammonia molecule :**



► **Formation of oxygen molecule :**



► **Formation of nitrogen molecule :**



► **Characteristics of covalent compounds :**

- Covalently bonded molecules are seen to have strong bonds within the molecules, but intermolecular forces are small, resulting in low melting and boiling points.
- Covalent compounds are generally poor conductors of heat and electricity.

► **Covalency :** The number of electrons contributed by each atom for sharing is known as *covalency*.

► **Covalent bonding in carbon :** It is difficult for carbon to lose or gain four electrons because of the following reasons :

- It cannot gain four electrons to form C^{4-} ion having neon gas (2, 8) configuration because this anion would be highly unstable due to the large amount of energy required to overcome the forces of repulsion between the four electrons being added and the six electrons already present in carbon atom.
- It cannot lose four electrons to form C^{4+} ion having helium gas (2) configuration because this cation would be highly unstable due to the large amount of energy required to remove four electrons from the carbon atom.

- Carbon overcomes this problem by sharing its valence electrons with other atoms, *i.e.*, by forming covalent bonds.

► **Allotropes of carbon :** Carbon occurs in different forms in nature :

- **Diamond :** Each carbon atom is bonded to four other carbon atoms, forming a rigid three-dimensional structure.
- **Graphite :** In graphite, each carbon atom is bonded to three other carbon atoms in the same plane giving a hexagonal array. These hexagonal arrays are placed in layers one above the other. Graphite is smooth and slippery and very good conductor of electricity.
- **Fullerenes :** Fullerenes are another class of carbon allotropes. The first one to be identified was C-60 which has carbon atoms arranged in the shape of a football. Since, this looked like the geodesic dome designed by Buckminster Fuller, the molecule was named fullerene.

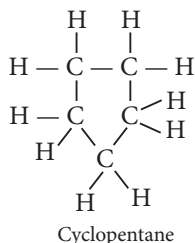
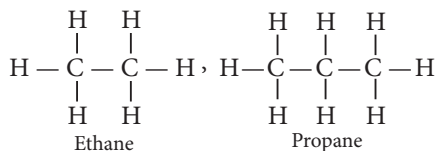
► **Versatile nature of carbon :** Carbon is a versatile element because it shows the following characteristics :

- **Catenation :** The unique property of self-linking of carbon atoms through covalent bonds to form long straight or branched chains or rings of different sizes is called *catenation*. Due to this property, carbon forms a large number of organic compounds.
- **Tetra-covalency of carbon :** Carbon has a covalency of four. It is capable of forming bonds with four other atoms of carbon or atoms of other monovalent elements. Due to the small size of carbon, these compounds are exceptionally stable.
- **Tendency to form multiple bonds :** Due to the small size of carbon atom, it can form multiple bonds with carbon, oxygen, sulphur and nitrogen atoms.
- **Isomerism :** If a molecular formula represents two or more structures having different properties, the phenomenon is called *isomerism*. Isomerism also leads to a huge number of carbon compounds.

► **Hydrocarbons :** The compounds which contain only carbon and hydrogen are called hydrocarbons. These are categorised as :

- **Saturated hydrocarbons** : The compounds in which carbon atoms are linked together with only single covalent bonds, are called *saturated hydrocarbons*.

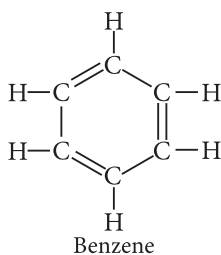
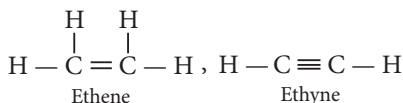
Example :



Since carbon – carbon single bonds are very strong therefore, saturated hydrocarbons are usually not very reactive. Also, saturated hydrocarbons contain the maximum number of hydrogen atoms. Saturated hydrocarbons are called alkanes.

- **Unsaturated hydrocarbons** : The compounds in which one or more (double or triple) bonds are present between carbon atoms are called *unsaturated hydrocarbons*. Unsaturated hydrocarbons with double bonds are called *alkenes* while with triple bonds are called *alkynes*.

Examples :



Unsaturated hydrocarbons are more reactive than saturated hydrocarbons.

- **Functional group** : A functional group can be defined as an atom or a group of atoms present in a molecule which largely determines its chemical properties.

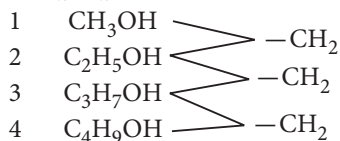
Hetero atom	Functional groups	Formula of functional group
Cl/Br	Halo (chloro/ bromo)	-Cl, -Br Substitutes for hydrogen atom
O	Hydroxyl	-OH
	Aldehyde	$\begin{array}{c} \text{H} \\ \\ -\text{C} \\ \\ \text{O} \end{array}$
	Ketone	$\begin{array}{c} \text{O} \\ \\ -\text{C}- \end{array}$
	Carboxylic acid	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{OH} \end{array}$

- **Homologous series** : A homologous series is defined as a group of compounds having the same functional group, similar chemical properties in which the successive members differ by a $-\text{CH}_2$ group or 14 mass unit.

- **Characteristics of homologous series** :

- All compounds in the series can be represented by a general formula, e.g., for alcohol it is $\text{C}_n\text{H}_{2n+1}\text{OH}$, for alkane $\text{C}_n\text{H}_{2n+2}$, for alkene C_nH_{2n} , and for alkynes $\text{C}_n\text{H}_{2n-2}$, where, $n = 1, 2, 3, \dots$
- Two successive members of homologous series differ by $-\text{CH}_2$ unit.

$$n \text{ C}_n\text{H}_{2n+1}\text{OH}$$

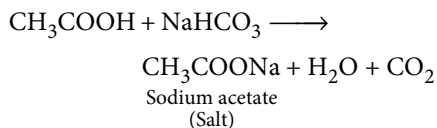
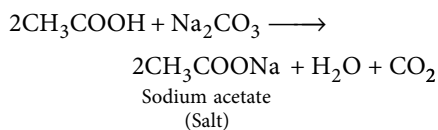


- All compounds in the series have similar chemical properties.
- All members of the series, show a gradual change in their physical properties.
- Physical properties generally increase as the molecular mass increases.

- **Nomenclature of carbon compounds** : Naming a carbon compound can be done by following rules :

- Select the longest possible chain of carbon and number them.
- The functional group present in the organic compound is indicated either by a prefix or a suffix.

- **Reaction with carbonates and hydrogen carbonates :** Ethanoic acid reacts with carbonates and hydrogen carbonates to yield a salt, carbon dioxide and water.



► **Uses :**

- It is used as vinegar in cooking and as preservative in pickles.
- It is used in manufacture of dyes, perfumes, plastics, rubber, etc.
- It is used as a solvent in laboratory and industry.
- It is used as a laboratory reagent for carrying out chemical reactions.

► **Differences between soaps and detergents :**

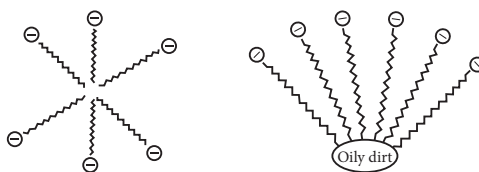
Soaps	Detergents
These are sodium or potassium salts of fatty acids e.g., $\text{C}_{15}\text{H}_{31}\text{COOH}$ (palmitic acid), $\text{C}_{17}\text{H}_{35}\text{COOH}$ (stearic acid) and oleic acid ($\text{C}_{17}\text{H}_{33}\text{COOH}$)	These are ammonium or sulphonate or sulphate salts of long chain hydrocarbons containing 12-18 carbon atoms.
These have $-\text{COONa}$ group.	These have $-\text{NR}_3^+$, $-\text{SO}_3\text{Na}$ or $-\text{SO}_4\text{Na}$ group.
These do not work well with hard water, acidic water and saline water but work well with soft water.	These work well with hard water, acidic water and saline water.
These are biodegradable.	Some detergents having branched hydrocarbon chains are non-biodegradable.
They take time to dissolve in water.	They dissolve faster in water.

► **Cleansing action of soaps and detergents :**

Soaps and detergents consist of a large hydrocarbon tail with a negatively charged head. The hydrocarbon tail is hydrophobic (water-hating or water-repelling) and negatively charged head is hydrophilic (water-loving).

In aqueous solution, water molecules being polar in nature, surround the ions and not the hydrocarbon part of the molecule.

When a soap or detergent is dissolved in water, the molecules associate together as clusters called *micelles*.



Micelle formed by detergent molecules in water.
The hydrocarbon tails stick to the oily dirt.

The tails stick inwards and the heads outwards.

In cleansing, the hydrocarbon tail attaches itself to oily dirt. When water is agitated (shaken vigorously), the oily dirt tends to lift off from the dirty surface and dissociate into fragments. This gives opportunity to other tails to stick to oil. The solution now contains small globules of oil surrounded by detergent molecules. The negatively charged heads present in water prevent the small globules from coming together and form aggregates. Thus, the oily dirt is removed.

In the past, detergents caused pollution in rivers and water bodies. The long carbon chain present in detergents used earlier, contained lots of branching. These branched chain detergent molecules were degraded very slowly by the microorganisms present in sewage discharge, septic tanks and water bodies. Thus, the detergents persisted in water for long time and made water unfit for aquatic life. Nowadays, the detergents are made up of molecules in which branching is kept at minimum. These are degraded more easily than long branched chain detergents.

Previous Years' CBSE Board Questions

4.1 Bonding in Carbon - The Covalent Bond

VSA (1 mark)

1. Covalent compounds have low melting and boiling point. Why? (2020)

SA II (3 marks)

2. What are covalent compounds? Why are they different from ionic compounds? List their three characteristic properties. (Delhi 2016)
3. What are covalent bonds? Show their formation with the help of electron dot structure of methane. Why are covalent compounds generally poor conductors of electricity? (Delhi 2013C)
4. Give reasons for the following :
 (i) Element carbon forms compounds mainly by covalent bonding.
 (ii) Diamond has high melting point.
 (iii) Graphite is a good conductor of electricity. (3/5, Foreign 2011)

LA (5 marks)

5. What is methane? Draw its electron dot structure. Name the type of bonds formed in this compound. Why are such compounds
 (i) poor conductors of electricity and
 (ii) have low melting and boiling points?
 What happens when this compound burns in oxygen? (Delhi 2019)
6. 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. (Foreign 2015, AI 2014)
7. State the reason why carbon can neither form C^{4+} cations nor C^{4-} anions, but forms

covalent compounds. Also state reasons to explain why covalent compounds :

- (i) are bad conductors of electricity?
 (ii) have low melting and boiling points? (Delhi 2014)

4.2 Versatile Nature of Carbon

VSA (1 mark)

8. Name a cyclic unsaturated carbon compound. (2020)
9. **Assertion (A)** : Following are the members of a homologous series :
 CH_3OH , CH_3CH_2OH , $CH_3CH_2CH_2OH$
Reason (R) : A series of compounds with same functional group but differing by $-CH_2$ unit is called homologous series.
 (a) Both (A) and (R) are true and (R) is the correct explanation of the assertion (A).
 (b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion (A).
 (c) (A) is true, but (R) is false.
 (d) (A) is false, but (R) is true. (2020)
10. Write the molecular formula of first two members of homologous series having functional group $-Cl$. (Delhi 2017)
11. Write the molecular formula of first two members of homologous series having functional group $-OH$. (Delhi 2017)
12. Write the molecular formula of the 2nd and 3rd member of the homologous series whose first member is ethene. (AI 2017)
13. Write the molecular formula of the 2nd and 3rd member of the homologous series whose first member is methane. (AI 2017)
14. Write the next homologue of each of the following :
 (i) C_2H_4
 (ii) C_4H_6 (Delhi 2016)
15. Name the following compounds :
 (a) $CH_3 - CH_2 - OH$
 (b) $CH_3 - \overset{H}{\underset{|}{C}} = O$ (Delhi 2016)

16. Select saturated hydrocarbons from the following : C_3H_6 ; C_5H_{10} ; C_4H_{10} ; C_6H_{14} ; C_2H_4
(Delhi 2016)
17. Write the name and structure of an alcohol with three carbon atoms in its molecule.
(AI 2016)
18. Write the name and structure of an alcohol with four carbon atoms in its molecule.
(AI 2016)
19. Write the name and structure of an aldehyde with four carbon atoms in its molecule.
(AI 2016)
20. Which element exhibits the property of catenation to maximum extent and why?
(Foreign 2016)
21. Write the name and molecular formula of the fourth member of alkane series.
(Foreign 2016)
22. What is homologous series of carbon compounds?
(Foreign 2016)
23. Write the name and formula of the 2nd member of homologous series having general formula C_nH_{2n} .
(Delhi 2015)
24. Write the name and formula of the 2nd member of homologous series having general formula C_nH_{2n+2} .
(Delhi 2015)
25. Write the name and formula of the 2nd member of homologous series having general formula C_nH_{2n-2} .
(Delhi 2015)
26. Write the number of covalent bonds in the molecule of ethane. (AI 2015, Delhi 2014)
27. Write the number of covalent bonds in the molecule of butane, C_4H_{10} . (AI 2015)
28. Write the name of each of the following functional groups :
(a) $-OH$ (b) $\begin{array}{c} -C- \\ || \\ O \end{array}$
(Foreign 2015, Delhi 2013)
29. Write the name and molecular formula of the first member of the homologous series of alkynes. (Foreign 2015)
30. Define the term functional group. Identify the functional group present in
(i) $\begin{array}{c} O \\ || \\ H-C-H \end{array}$ (ii) $\begin{array}{c} H \quad OH \\ | \quad | \\ H-C-C=O \\ | \\ H \end{array}$
(1/3, Foreign 2013)
31. Name the functional group present in each of the following organic compounds :
(i) C_2H_5Cl
(ii) C_2H_5OH (Delhi 2012)
32. Write the name and formula of the second member of the carbon compounds having functional group $-OH$. (AI 2012)
33. Write the name and formula of the first member of the series of carbon compounds having functional group $\begin{array}{c} O \\ || \\ -C-OH \end{array}$.
(Foreign 2012)
34. Butanone is a four-carbon per molecule compound. Name the functional group present in it. (Foreign 2011)
-
- SA I (2 marks)**
35. State two properties of carbon which lead to a very large number of carbon compounds.
(2/5, AI 2011)
-
- SA II (3 marks)**
36. Carbon, a member of group 14, forms a large number of carbon compounds estimated to be about three million. Why is this property not exhibited by other elements of this group? Explain. (2020)
37. (a) Why are most carbon compounds poor conductors of electricity?
(b) Write the name and structure of a saturated compound in which the carbon atoms are arranged in a ring. Give the number of single bonds present in this compound. (2018)
38. An aldehyde as well as a 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. (AI 2016)
39. What is meant by isomers? Draw the structures of two isomers of butane, C_4H_{10} . Explain why we cannot have isomers of first three members of alkane series.
(Delhi 2015, Foreign 2014)
40. Write the molecular formula of the following compounds and draw their electron-dot structures :
(i) Ethane (ii) Ethene
(iii) Ethyne (Foreign 2015)

41. What is meant by functional group in carbon compounds? Write in tabular form the structural formula and the functional group present in the following compounds :
 (i) Ethanol
 (ii) Ethanoic acid (Foreign 2015)
42. Why is homologous series of carbon compounds so called? Write the chemical formula of two consecutive members of any homologous series and state the part of these compounds that determines their (i) physical and (ii) chemical properties.
 (Foreign 2015, AI 2014, Delhi 2013)
43. State the meaning of functional group in a carbon compound. Write the functional group present in (i) ethanol and (ii) ethanoic acid and also draw their structures. (Delhi 2014)
44. 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.
 (Delhi 2014)
45. What is meant by homologous series of carbon compounds? Write the general formula of (i) alkenes, and (ii) alkynes. Draw the structures of the first member of each series to show the bonding between the two carbon atoms.
 (AI 2014)
46. Define the term 'structural isomerism'. Explain why propane cannot exhibit this property. Draw the structures of possible isomers of butane, C_4H_{10} . (AI 2014)
47. (a) What is a homologous series of compounds? List any two of its characteristics. (Foreign 2011)
 (b) What is the next higher homologue of C_3H_7OH ? What is its formula and what is it called? (Foreign 2011)
49. 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 bond with most other elements?
 (Delhi 2015)
50. 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. (Foreign 2014)
51. (a) Define the term 'isomers'.
 (b) Draw two possible isomers of the compound with molecular formula C_3H_6O and write their names.
 (c) Give the electron dot structures of the above two compounds. (Delhi 2013)
52. Explain isomerism. State any four characteristics of isomers. Draw the structures of possible isomers of butane, C_4H_{10} .
 (AI 2011)

4.3 Chemical Properties of Carbon Compounds

VSA (1 mark)

53. Name the process by which unsaturated fats are changed to saturated fats. (Foreign 2015)
54. Write the chemical equation to show what happens when methane is treated with chlorine in the presence of sunlight?
 (1/3, Foreign 2014)
55. Write the respective chemical reaction to show what happens when methane is burnt in presence of oxygen? (1/3, Foreign 2014)
56. Write one chemical equation to represent the following type of reaction of organic substances : substitution.
 (1/3, Foreign 2014)
57. Give reason for the following : Acetylene burns with a sooty flame. (1/5, Foreign 2011)
58. Give reason for the following : Kerosene does not decolourise bromine water while cooking oils do. (1/5, Foreign 2011)

SAI (2 marks)

59. What happens when 5% alkaline $KMnO_4$ solution is added drop by drop to warm

LA (5 marks)

48. (a) State the reason why carbon can neither form C^{4+} cations nor C^{4-} anions, but forms covalent bonds. Also state reasons to explain why covalent compounds
 (i) are bad conductors of electricity
 (ii) have low melting and boiling points.
 (b) Write the structural formula of benzene, C_6H_6 .
 (AI 2019)

ethanol taken in a test tube? State the role of alkaline KMnO_4 solution in this reaction.

(2/3, Foreign 2016)

SA II (3 marks)

60. 3 mL of ethanol is taken in a test tube and warmed gently in a water bath. A 5% solution of alkaline potassium permanganate is added first drop by drop to this solution, then in excess.
- How is 5% solution of KMnO_4 prepared?
 - State the role of alkaline potassium permanganate in this reaction. What happens on adding it in excess?
 - Write chemical equation of this reaction. (2020)
61. Two carbon compounds X and Y have the molecular formula C_4H_8 and C_5H_{12} respectively. Which one of these is most likely to show addition reaction? Justify your answer. Also give the chemical equation to explain the process of addition reaction in this case. (Delhi 2017)
62. The molecular formula of two carbon compounds are C_4H_8 and C_3H_8 . Which one of the two is most likely to show addition reaction? Justify your answer. Also give the chemical equation to explain the process of addition reaction in this case. (Delhi 2017)
63. What is an oxidising agent? What happens when an oxidising agent is added to propanol? Explain with the help of a chemical equation. (Delhi 2016)
64. 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? (AI 2015)
65. 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. (AI 2015, Delhi 2014)

LA (5 marks)

66. Why are certain compounds called hydrocarbons? Write the general formula for homologous series of alkanes, alkenes and alkynes and also draw the structure of the first

member of each series. Write the name of the reaction that converts alkenes into alkanes and also write a chemical equation to show the necessary conditions for the reaction to occur. (AI 2017)

67. What are hydrocarbons? Write the name and general formula of
- saturated hydrocarbons
 - unsaturated hydrocarbons,
- and draw the structure of one hydrocarbon of each type. How can an unsaturated hydrocarbon be made saturated? (AI 2012)
68. (a) With the help of a 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. (Delhi 2015, 2013, Foreign 2012)
- (b) How does a saturated hydrocarbon react with chlorine? Write chemical equation for it. What type of reaction is it called and why? (Foreign 2012)

4.4 Some Important Carbon Compounds - Ethanol and Ethanoic acid

VSA (1 mark)

69. **Assertion (A)** : Esterification is a process in which a sweet smelling substance is produced. **Reason (R)** : When esters react with sodium hydroxide, an alcohol and sodium salt of carboxylic acid are obtained.
- Both (A) and (R) are true and (R) is the correct explanation of the assertion (A).
 - Both (A) and (R) are true, but (R) is not the correct explanation of the assertion (A).
 - (A) is true, but (R) is false.
 - (A) is false, but (R) is true. (2020)
70. **Assertion (A)** : Ethanoic acid is also known as glacial acetic acid. **Reason (R)** : The melting point of pure ethanoic acid is 290 K and hence it often freezes during winters in cold climates.
- Both (A) and (R) are true and (R) is the correct explanation of the assertion (A).
 - Both (A) and (R) are true, but (R) is not the correct explanation of the assertion (A).

- (c) (A) is true, but (R) is false.
 (d) (A) is false, but (R) is true. (2020)

71. Draw the structure for ethanoic acid molecule, CH_3COOH . (AI 2011)

SA I (2 marks)

72. A compound 'X' on heating with excess conc. sulphuric acid at 443 K gives an unsaturated compound 'Y'. 'X' also reacts with sodium metal to evolve a colourless gas 'Z'. Identify 'X', 'Y' and 'Z'. Write the equation of the chemical reaction of formation of 'Y' and also write the role of sulphuric acid in the reaction. (2018)
73. Write the chemical equations to show what happens when
 (i) an ester reacts with a base?
 (ii) ethanol reacts with ethanoic acid in the presence of sulphuric acid? (2/3, Foreign 2014)
74. Write the respective chemical equations to show what happens when
 (i) ethanol is heated with concentrated sulphuric acid at 443 K?
 (ii) ethanol reacts with ethanoic acid in the presence of an acid acting as a catalyst? (2/3, Foreign 2014)
75. Write one chemical equation to represent each of the following types of reactions of organic substances :
 (i) Esterification
 (ii) Saponification (2/3, Delhi 2011)

SA II (3 marks)

76. Complete the following chemical equations :
 (i) $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{NaOH} \longrightarrow$
 (ii) $\text{CH}_3\text{COOH} + \text{NaOH} \longrightarrow$
 (iii) $\text{C}_2\text{H}_5\text{OH} + \text{CH}_3\text{COOH} \xrightarrow{\text{Conc. H}_2\text{SO}_4}$
 (Delhi 2017)
77. Complete the following chemical equations:
 (i) $\text{C}_2\text{H}_5\text{OH} + \text{O}_2 \longrightarrow$
 (ii) $\text{C}_2\text{H}_5\text{OH} \xrightarrow[443\text{ K}]{\text{Conc. H}_2\text{SO}_4}$
 (iii) $\text{CH}_3\text{COOH} + \text{NaHCO}_3 \longrightarrow$
 (Delhi 2017)
78. Write the structural formula of ethanol. What happens when it is heated with excess

of conc. H_2SO_4 at 443 K? Write the chemical equation for the reaction stating the role of conc. H_2SO_4 in this reaction.

(AI 2017, Delhi 2015, 2013)

79. What happens when (write chemical equation in each case)
 (a) ethanol is burnt in air?
 (b) ethanol is heated with excess conc. H_2SO_4 at 443 K?
 (c) a piece of sodium is dropped into ethanol? (AI 2017)
80. Distinguish between esterification and saponification reaction with the help of the chemical equations for each. State one use of each (i) esters, and (ii) saponification process. (AI 2017, Foreign 2012)
81. Explain esterification reaction with the help of a chemical equation. Describe an activity to show esterification. (AI 2017)
82. 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. (Delhi 2016)
83. Name the compound formed when ethanol is heated in excess of conc. sulphuric acid at 443 K. Also write the chemical equation of the reaction stating the role of conc. sulphuric acid in it. What would happen if hydrogen is added to the product of this reaction in the presence of catalyst such as palladium or nickel? (Delhi 2016, Foreign 2015)
84. 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. (AI 2016)
85. On dropping a small piece of sodium in a test tube containing carbon compound 'X' with molecular formula $\text{C}_2\text{H}_6\text{O}$, 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. (AI 2016)

86. Write three different chemical reactions showing the conversion of ethanoic acid to sodium ethanoate. Write balanced chemical equation in each case. Write the name of the reactants and the products other than ethanoic acid and sodium ethanoate in each case. (AI 2016)
87. 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. (Foreign 2016)
88. An organic compound 'P' is a constituent of wine. 'P' on reacting with acidified $\text{K}_2\text{Cr}_2\text{O}_7$ 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. (Foreign 2016)
89. List two tests for experimentally distinguishing between an alcohol and a carboxylic acid and describe how these tests are performed. (AI 2015)
90. What are esters? How are they prepared? List two uses of esters. (Delhi 2014)
91. A carboxylic acid (molecular formula, $\text{C}_2\text{H}_4\text{O}_2$) 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 $\text{C}_2\text{H}_4\text{O}_2$. Write the name and structure of (i) carboxylic acid, (ii) alcohol and (iii) the compound 'X'. (AI 2014)
92. Write the chemical equation to explain what happens when ethanol is heated with alkaline solution of potassium permanganate. Mention two physical properties and two uses of ethanol. (Foreign 2014)
93. Write chemical equations to describe two examples of different oxidations of ethanol. List two uses of ethanol. (Foreign 2014)
94. Write the chemical equations to show what happens when
(i) sodium hydroxide is added to ethanoic acid?
(ii) solid sodium hydrogen carbonate is added to ethanoic acid?
(iii) ethanol reacts with sodium? (Foreign 2014)
95. Write chemical equations for what happens when
(i) sodium metal is added to ethanoic acid?
(ii) solid sodium carbonate is added to ethanoic acid?
(iii) ethanoic acid reacts with a dilute solution of sodium hydroxide? (AI 2011)

LA (5 marks)

96. (a) What is a homologous series? Explain with an example.
(b) Define the following terms giving one example of each.
(i) Esterification (ii) Addition reaction (2020)
97. (a) Carry out following conversions :
(i) Ethanol to ethene
(ii) Ethanol to ethanoic acid
(b) Differentiate between addition reaction and substitution reaction. Give one example of each. (2020)
98. Write the chemical formula and name of the compound which is the active ingredient of all alcoholic drinks. List its two uses. Write chemical equation and name of the product formed when this compound reacts with
(i) sodium metal
(ii) hot concentrated sulphuric acid. (Delhi 2019)
99. (a) Define the term isomer.
(b) Two compounds have same molecular formula $\text{C}_3\text{H}_6\text{O}$. Write the name of these compounds and their structural formula.
(c) How would you bring the following conversions :
(i) Ethanol to ethene
(ii) Propanol to propanoic acid? (AI 2019)
100. A carbon compound 'P' on heating with excess conc. H_2SO_4 forms another carbon compound 'Q' which on addition of

hydrogen in the presence of nickel catalyst forms a saturated carbon compound 'R'. One molecule of 'R' on combustion forms two molecules of carbon dioxide and three molecules of water. Identify P, Q and R and write chemical equations for the reactions involved. (AI 2016)

101. List in tabular form three physical and two chemical properties on the basis of which ethanol and ethanoic acid can be differentiated. (Delhi 2012)
102. (a) In a 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. (Delhi 2011)

4.5 Soaps and Detergents

VSA (1 mark)

103. Several factories were pouring their wastes in rivers A and B. Water samples were collected from these two rivers. It was observed that sample collected from river A was acidic while that of river B was basic. The factories located near A and B are
 (a) Soaps and detergents factories near A and alcohol distillery near B.
 (b) Soaps and detergents factories near B and alcohol distillery near A.
 (c) Lead storage battery manufacturing factories near A and soaps and detergents factories near B.
 (d) Lead storage battery manufacturing factories near B and soaps and detergents factories near A. (2020)

SA II (3 marks)

104. Why does micelle formation take place when soap is added to water? Why are micelles not formed when soap is added to ethanol? (3/5, AI 2011)

LA (5 marks)

105. Soaps and detergents are both, types of salts. State the difference between the two. Write the mechanism of the cleansing action of soaps. Why do soaps not form lather (foam) with hard water? Mention any two problems

that arise due to the use of detergents instead of soaps. (Delhi 2017, AI 2015)

106. What are micelles? Why does it form when soap is added to water? Will a micelle be formed in other solvents such as ethanol also? State briefly how the formation of micelles help to clean the clothes having oily spots. (Foreign 2016)
107. (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. (Foreign 2016)
108. What is the difference between the molecules of soaps and detergents, chemically? Explain the cleansing action of soaps. (Delhi 2015)
109. 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? (Delhi 2012)
110. 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. (AI 2012)
111. What are soaps and detergents chemically? Explain the action of cleaning by soaps. State the reason why we can wash our clothes even in hard water using detergents. (Foreign 2012)
112. (a) What is a soap? Why are soaps not suitable for washing clothes when the water is hard?
 (b) Explain the action of soap in removing an oily spot from a piece of cloth. (Delhi 2011)
113. (a) What is a detergent? Name one detergent.
 (b) Write two advantages and two disadvantages of using detergents over soaps.
 (c) Why, by using a detergent, can we wash clothes even in hard water? (Foreign 2011)

Detailed Solutions

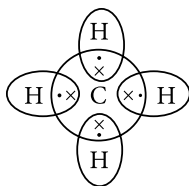
1. Covalent compounds have low melting and boiling points because the forces of attraction between molecules of covalent compounds are very weak. On applying a small amount of heat these molecular forces break.

2. Covalent compounds are those compounds which are formed by sharing of valence electrons between the atoms *e.g.*, hydrogen molecule is formed by mutual sharing of electrons between two hydrogen atoms.

They are different from ionic compounds as ionic compounds are formed by the complete transfer of electrons from one atom to another *e.g.*, NaCl is formed when one valence electron of sodium gets completely transferred to outer shell of chlorine atom. The characteristic properties of covalent compounds are :

- (i) They are generally insoluble or less soluble in water but soluble in organic solvents.
- (ii) They have low melting and boiling points.
- (iii) They do not conduct electricity as they do not contain ions.

3. Covalent bonds are those bonds which are formed by sharing of the valence electrons between two atoms. Electron dot structure of methane is shown in the figure.



Covalent compounds are generally poor conductors of electricity because they do not have free electrons or ions.

4. (i) As carbon has four valence electrons and it can neither lose nor gain four electrons thus, it attains noble gas configuration only by sharing of electrons. Thus, it forms covalent compounds.

(ii) In diamond, each carbon atom is bonded to four other carbon atoms forming a rigid three-dimensional structure. This makes diamond the hardest known substance. Thus, it has high melting point.

(iii) In graphite, each carbon atom is bonded to three other carbon atoms by covalent bonds in the same plane giving a hexagonal array. Thus, only three valence electrons are used for bond formation and hence, the fourth valence electron

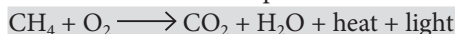
is free to move. As a result, graphite is a good conductor of electricity.

5. Methane is the first member of alkane series having formula CH_4 .

Refer to answer 3.

(ii) *Refer to answer 1.*

When methane is burnt in presence of oxygen then carbon dioxide will be produced.



6. Ionic compounds are formed either by gaining or losing electrons from the outermost shells, but carbon which has four electrons in its outermost shell cannot form ionic bonds because

– If carbon forms ionic bonds by gaining four electrons to attain a noble gas configuration then it would be difficult for six protons in the nucleus to hold ten electrons.

– If carbon forms ionic bonds by loss of four electrons then it would require a lot of energy to remove these electrons from outermost shell.

Due to these reasons carbon forms covalent bonds by sharing the valence electrons.

Type of bonds formed in ionic compounds are called electrovalent bonds and the type of bonds formed in carbon compounds are called covalent bonds.

Refer to answer 3.

7. *Refer to answer 6.*

(i) *Refer to answer 3.*

(ii) *Refer to answer 1.*

8. Benzene,  is a cyclic unsaturated carbon compound.

9. (a) : The given compounds are members of homologous series of alcohol.

10. The molecular formula of first two members of homologous series having $-\text{Cl}$ functional group are CH_3Cl and $\text{CH}_3\text{CH}_2\text{Cl}$.

11. The molecular formula of first two members of homologous series having $-\text{OH}$ functional group are CH_3OH and $\text{CH}_3\text{CH}_2\text{OH}$.

12. Homologous series of alkenes have general formula, C_nH_{2n} whose first member is ethene.

2nd member of homologous series of alkenes is C_3H_6 *i.e.*, propene.

3rd member of homologous series of alkenes is C_4H_8 *i.e.*, butene.

13. Methane, CH_4 is an alkane. Alkanes have general formula, C_nH_{2n+2} .

2nd member of homologous series of alkanes is C_2H_6 *i.e.*, ethane.

3rd member of homologous series of alkanes is C_3H_8 *i.e.*, propane.

14. (i) C_2H_4 belongs to alkene series having general formula, C_nH_{2n} .

Thus, next homologue will be $C_3H_{2 \times 3} = C_3H_6$

(ii) C_4H_6 belongs to alkyne series having general formula, C_nH_{2n-2} .

Thus, next homologue will be $C_5H_{2 \times 5 - 2} = C_5H_8$

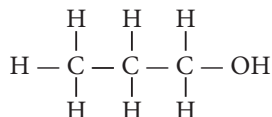
15. (a) $CH_3 - CH_2 - OH$: Ethanol

(b) $CH_3 - \overset{\overset{O}{\parallel}}{C} - H$: Ethanal

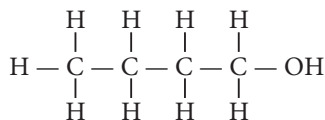
16. Saturated hydrocarbons have general formula, C_nH_{2n+2} .

Among the given compounds only C_4H_{10} and C_6H_{14} satisfy the above formula. Thus, these are saturated hydrocarbons.

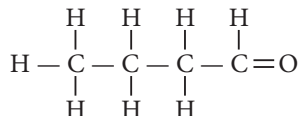
17. An alcohol with three carbon atoms in its molecule is propanol. The structure of propanol is



18. An alcohol with four carbon atoms is butanol and its structure is :



19. An aldehyde with four carbon atoms is butanal and its structure is.



20. Carbon has the unique ability to form bonds with other atoms of carbon, giving rise to large molecules. This property is called catenation. Carbon shows catenation due to its small size and stronger carbon-carbon bond strength.

21. The general formula of the alkane series is C_nH_{2n+2} . For fourth member of alkane series, $n = 4$

$\therefore C_4H_{2 \times 4 + 2} = C_4H_{10}$ *i.e.*, butane.

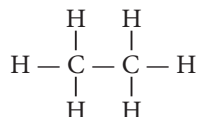
22. A homologous series is the family of organic compounds having the same functional group, similar chemical properties but the successive (adjacent) members of the series differ by a $-CH_2$ unit or 14 mass units.

23. Refer to answer 12.

24. Refer to answer 13.

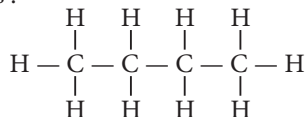
25. General formula, C_nH_{2n-2} belongs to alkyne series. The second member of this series is propyne *i.e.*, (C_3H_4) or $CH_3 - C \equiv CH$.

26. The structural formula of ethane (C_2H_6) is



There are total 7 covalent bonds. Six C — H covalent bonds and one C — C covalent bond.

27. Butane (C_4H_{10}) has the following structural formula as :



Total number of covalent bonds is 13 in which there are 10 C — H and 3 C — C covalent bonds.

28. (a) $-OH$: Alcohol

(b) $-\overset{\overset{O}{\parallel}}{C}-$: Ketone

29. General formula for alkyne is C_nH_{2n-2} .

First member of homologous series of alkyne has the formula, $C_2H_{2 \times 2 - 2} = C_2H_2$ *i.e.*, ethyne.

30. An atom or a group of atoms present in a molecule which largely determines its chemical properties, is called functional group.

(i) $H - \overset{\overset{O}{\parallel}}{C} - H$ contains aldehydic functional group. $\left[-\overset{\overset{H}{\diagup}}{C} = \overset{\overset{O}{\parallel}}{C} \right]$

(ii) $H - \overset{\overset{H}{|}}{C} - \overset{\overset{OH}{|}}{C} = O$ contains carboxylic acid functional group.

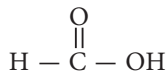
$\left(-\overset{\overset{O}{\parallel}}{C} - OH \right)$ functional group.

31. (i) C_2H_5Cl contains $-Cl$ (chloro) group which belongs to halo functional group.

(ii) C_2H_5OH contains $-OH$ group which belongs to alcoholic functional group.

32. Those having $-OH$ as functional group belong to alcohol family. Second member of this family is ethanol, C_2H_5OH .

33. Carbon compound containing $-\overset{\overset{O}{\parallel}}{C}-OH$ group is called carboxylic acid. The first member of this family is methanoic acid ($HCOOH$).



34. Butanone is $CH_3 - \overset{\overset{O}{\parallel}}{C} - C_2H_5$.

The functional group $-\overset{\overset{O}{\parallel}}{C}-$ *i.e.*, ketone is present in butanone.

35. Carbon forms a large number of carbon compounds like long chains which may be straight or branched chains or ring of different sizes due to its tetravalency and unique property of catenation. Carbon due to its small size forms exceptionally stable compounds by forming strong bonds.

36. Refer to answer 20.

As we move down the group, the element-element bond energies decrease rapidly. For this reason other elements of this group show little or no catenation property.

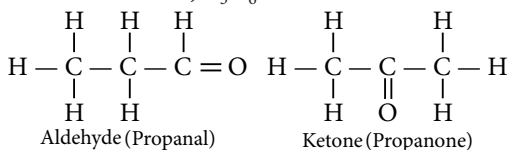
37. (a) Due to catenation, carbon forms covalent bonds with the constituent elements in the carbon compounds, hence it does not have mobile electrons and carbon compounds do not dissociate themselves into ions and hence, they are poor conductor of electricity.



Name : Cyclopentane

Number of single bonds : 15

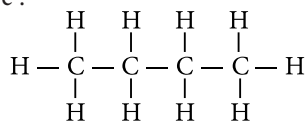
38. The aldehyde and ketone represented by the molecular formula, C_3H_6O .



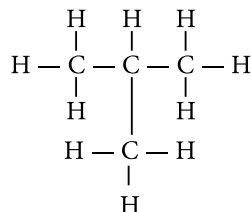
In the language of science, they are called as isomers because both have same molecular formula but different structural formulae (having different functional groups.)

39. Isomers are those molecules which have the same molecular formula but different structural formula *i.e.*, show different properties.

The structures of possible isomers of butane (C_4H_{10}) are :



n-Butane
(I)



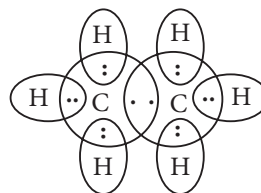
2-Methylpropane
(II)

The first three members of alkane series are :

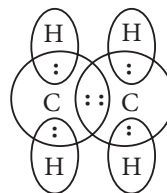
- (i) CH_4 (methane) (ii) C_2H_6 (ethane)
(iii) C_3H_8 (propane)

In the above members of alkane series, it is not possible to have different arrangements of carbon atoms. Thus, we cannot have isomers of first three members of alkane series.

40. (i) Molecular formula of ethane is C_2H_6 . Its electron dot structure is :



(ii) Molecular formula of ethene is C_2H_4 . Its electron dot structure is :



(iii) Molecular formula of ethyne is C_2H_2 . Its electron dot structure is :

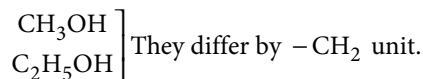


41. Refer to answer 30.

Compound		Structural formula	Functional group
(i)	Ethanol (C ₂ H ₅ OH)	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{OH} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	—OH (alcoholic)
(ii)	Ethanoic acid (CH ₃ COOH)	$\begin{array}{c} \text{H} \quad \text{O} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{OH} \end{array}$ (carboxylic acid)

42. Refer to answer 22.

Consecutive members of the homologous series of alcohols are :



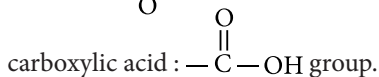
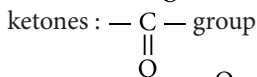
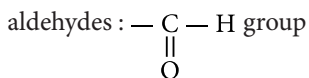
The physical properties are determined by alkyl group/hydrocarbon part/part other than the functional group.

The chemical properties are determined by functional group such as —OH group.

43. Refer to answer 30 and 41.

44. Refer to answer 30.

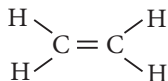
The formulae for different functional groups are :
alcohols : —OH group



45. Refer to answer 22.

The general formula for alkenes is C_nH_{2n} and for alkynes is C_nH_{2n-2}.

First member of alkene is ethene, C₂H₄ and its structure is



First member of alkyne is ethyne, C₂H₂ and its structure is H—C≡C—H

46. Two or more organic compounds having the same molecular formula but different structures, are called structural isomers and the phenomenon is known as structural isomerism.

There is no possible isomers for propane as it contains three carbon atoms and it is not possible to have different arrangements of these carbon atoms.

Refer to answer 39.

47. (a) Refer to answer 22.

Two characteristics of homologous series are :

(i) The successive compounds of the homologous series differ by —CH₂ unit *i.e.* 14 mass units.

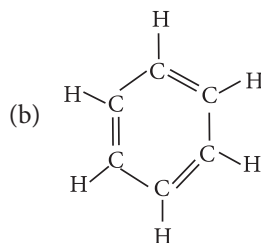
(ii) Each homologous series belongs to similar class of compounds which shows the same chemical properties.

(b) Next higher homologue of C₃H₇OH is C₄H₉OH *i.e.*, butanol.

48. (a) Refer to answer 6.

(i) Refer to answer 3.

(ii) Refer to answer 1.



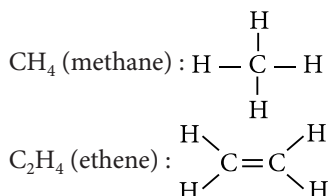
49. Refer to answers 6 and 35.

Due to the small size of carbon atom, its nucleus holds the shared pair of electrons between atoms strongly. Thus, carbon forms strong covalent bonds with elements such as hydrogen, oxygen, nitrogen, sulphur, chlorine and other elements.

50. Hydrocarbons are the compounds of carbon and hydrogen atoms. Those hydrocarbons which contain only single carbon-carbon bonds are called alkanes (saturated hydrocarbons) while those having double and triple bonds are called alkenes and alkynes respectively (unsaturated hydrocarbon).

	Alkanes	Alkenes	Alkynes
1.	General formula = C _n H _{2n+2}	General formula = C _n H _{2n}	General formula = C _n H _{2n-2}
2.	Contain C—C single bonds	Contain C=C double bonds	Contain C≡C triple bonds
3.	<i>e.g.</i> , methane (CH ₄)	<i>e.g.</i> , ethene (C ₂ H ₄)	<i>e.g.</i> , ethyne (C ₂ H ₂)

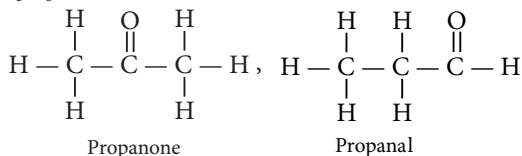
Structures of the above examples are :



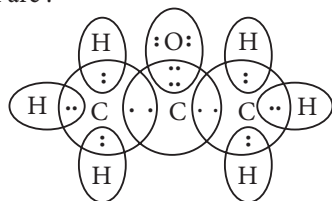
C_2H_2 (ethyne) : $H - C \equiv C - H$

51. (a) Refer to answer 39.

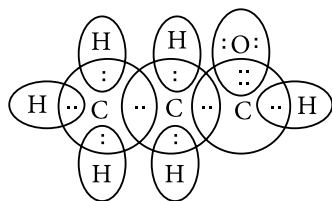
(b) Two possible isomers of the compound, C_3H_6O are :



(c) The electron dot structures of propanone and propanal are :



Propanone



Propanal

52. Isomers are those compounds which have same molecular formula but different structures. The phenomenon of existing these isomers are called isomerism.

Four characteristics of isomers are :

- (i) They have same molecular formula but different structures.
- (ii) For hydrocarbons, isomers is possible only with hydrocarbons having four or more carbon atoms.
- (iii) Due to isomerism, a given molecular formula can represent two or more different compounds.
- (iv) Due to isomerism, the different compounds have different properties.

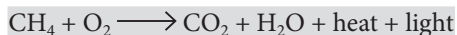
Refer to answer 39.

53. Hydrogenation is the process in which unsaturated fats are changed to saturated fats.

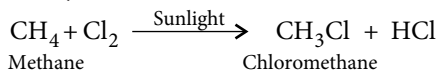
54. When methane is treated with chlorine in the presence of sunlight then substitution reaction takes place. In this, chlorine replaces the hydrogen atom of methane.



55. When methane is burnt in presence of oxygen then carbon dioxide will be produced.



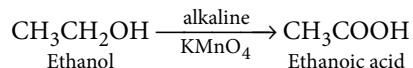
56. **Substitution** : In this type of reaction one or more hydrogen atoms of a hydrocarbon is replaced by some other atoms.



57. The formula of acetylene is $HC \equiv CH$. It is an unsaturated hydrocarbon where carbon content is more than the hydrogen content. Hence, carbon is not completely burnt and the unburnt carbon deposits as a soot.

58. Cooking oils (unsaturated compounds) decolourise bromine water due to formation of addition products whereas kerosene (saturated compound) does not decolourise bromine water.

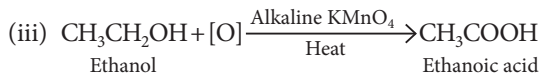
59. When 5% alkaline $KMnO_4$ solution is added drop by drop to warm ethanol then it gets oxidised to ethanoic acid.



Here, alkaline $KMnO_4$ acts as an oxidising agent *i.e.*, the substance which is capable of adding oxygen to others. Thus, alkaline $KMnO_4$ provides oxygen to ethanol to form ethanoic acid.

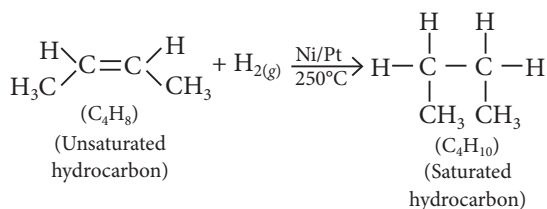
60. (i) 5% solution of $KMnO_4$ is prepared by adding 5 g of $KMnO_4$ in 95 g of water.

(ii) Here alkaline $KMnO_4$ acts as an oxidising agent. It oxidises ethanol to ethanoic acid by donating nascent oxygen. If excess of $KMnO_4$ is added the purple colour will persist indicating no more alcohol is left and there is no reaction.



61. All unsaturated hydrocarbons (containing double or triple bonds) have tendency to get converted to saturated hydrocarbons (single bonds) by adding small molecules such as hydrogen (H_2), halogens (X_2), etc. Such reactions are called addition reactions.

Compound X *i.e.*, C_4H_8 belongs to alkene series (C_nH_{2n}) while compound Y *i.e.*, C_5H_{12} belongs to alkane series (C_nH_{2n+2}). Thus, compound X will undergo addition reaction.

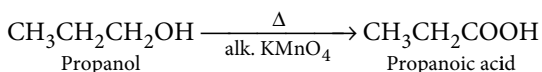


62. C_3H_8 belongs to alkane series ($\text{C}_n\text{H}_{2n+2}$)

Refer to answer 61.

63. The substance that supply oxygen in a reaction for oxidation is called oxidising agent e.g., potassium permanganate, potassium dichromate, etc.

When propanol is heated with alkaline KMnO_4 , it gets oxidised to propanoic acid.



64. The formula for ethyne is C_2H_2 and its electron dot structure is :



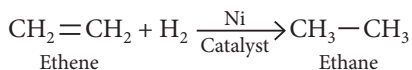
A mixture of ethyne and oxygen is burnt for welding so that complete oxidation of ethyne takes place. If in place of oxygen, air is taken which contains less amount of oxygen then incomplete combustion of oxygen takes place and temperature required for welding will not be attained.

65. Alkenes, having general formula as C_nH_{2n} and alkynes, having general formula as $\text{C}_n\text{H}_{2n-2}$ are the class of hydrocarbons in which addition reaction is possible.

The essential conditions for addition reaction are :

- Presence of unsaturated hydrocarbon.
- Presence of catalyst such as Ni/Pt/Pd.

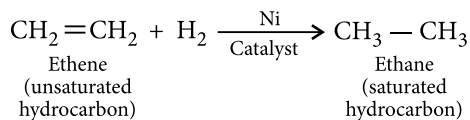
Let us take an example of ethene. It undergoes addition reaction with hydrogen when it is heated in the presence of nickel catalyst to form ethane. The reaction is known as hydrogenation.



66. Refer to answers 50 and 65.

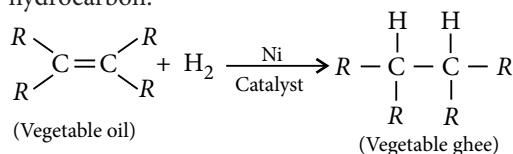
67. Refer to answer 50.

Unsaturated hydrocarbons can be made to saturated hydrocarbons by hydrogenation reaction using nickel (Ni) as a catalyst.



68. (a) >C=C< and $-\text{C}\equiv\text{C}-$ are functional groups that can be hydrogenated.

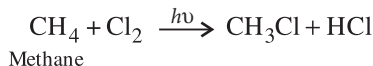
Hydrogenation is the addition of hydrogen to an unsaturated hydrocarbon to obtain a saturated hydrocarbon.



Here R can be any alkyl group.

There is the change of unsaturated compound from the liquid state to saturated compound in the solid state thus, melting point increases.

(b) Saturated hydrocarbon reacts with chlorine to form a substituted product. e.g.,

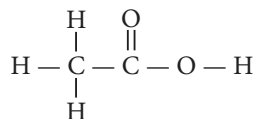


This reaction is called substitution reaction as here one hydrogen of methane is substituted by one chlorine atom.

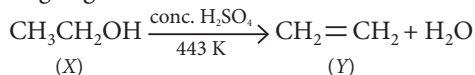
69. (b): When an ester reacts with the base saponification reaction occurs.

70. (a): Pure ethanoic acid or acetic acid freezes below room temperature into white crystals that resemble glaciers.

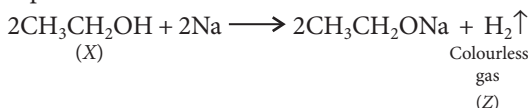
71. Structure of ethanoic acid is



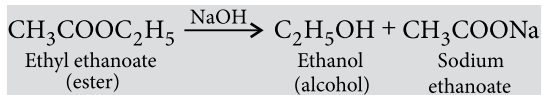
72. As X reacts with conc. H_2SO_4 to give an alkene so it should be an alcohol as conc. H_2SO_4 acts as a dehydrating agent. The reaction of X with Na also confirms that it is an alcohol because alcohols react with Na metal to evolve colourless hydrogen gas.



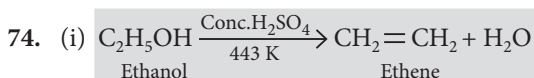
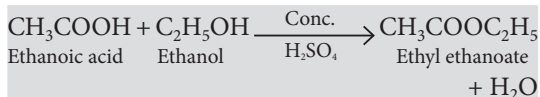
Here, conc. H_2SO_4 acts as a dehydrating agent i.e., helps in the removal of water.



73. (i) When an ester reacts with the base then it gives sodium salt of carboxylic acid and an alcohol. It is known as saponification reaction.



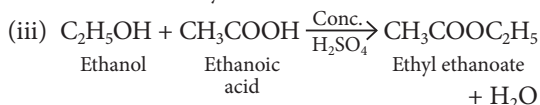
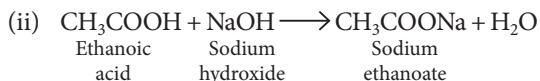
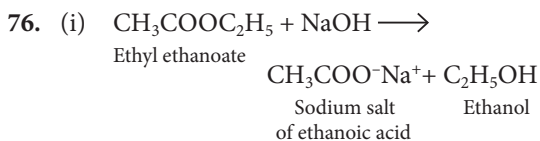
(ii) Carboxylic acids react with alcohols in the presence of a little concentrated sulphuric acid to form pleasant smelling esters. This reaction is called esterification reaction.



(ii) Refer to answer 73(ii).

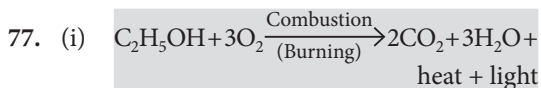
75. (i) Refer to answer 73(ii).

(ii) Refer to answer 73(i).

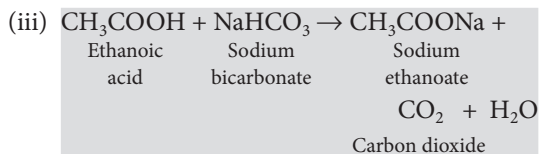


80.

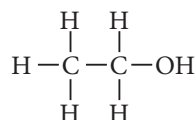
S. No.	Esterification	Saponification
1.	When alcohol is added to carboxylic acid in the presence of acid catalyst then a fruity smelling ester is formed. This process is called esterification.	Oils or fats when treated with sodium hydroxide solution gets converted into sodium salts of fatty acids and glycerol. This reaction is called saponification.
2.	<p>Chemical reaction :</p> $\text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3\text{COOH} \xrightarrow[\text{H}_2\text{SO}_4]{\text{Conc.}} \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$ <p style="text-align: center;">Ester</p>	<p>Chemical reaction :</p> $\begin{array}{ccc} \text{CH}_2\text{OCOC}_{17}\text{H}_{35} & & \text{CH}_2\text{OH} \\ & & \\ \text{CHOCOC}_{17}\text{H}_{35} + 3\text{NaOH} \longrightarrow & & \text{CHOH} \\ & & \\ \text{CH}_2\text{OCOC}_{17}\text{H}_{35} & & \text{CH}_2\text{OH} \\ \text{(Oil or Fat)} & & \text{Glycerol} \end{array}$ <p style="text-align: right;">+ $3\text{C}_{17}\text{H}_{35}\text{COONa}$</p> <p style="text-align: right;">Sodium stearate (Soap)</p>



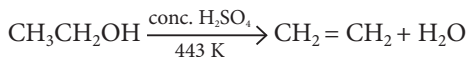
(ii) Refer to answer 74(i).



78. The structural formula of ethanol ($\text{C}_2\text{H}_5\text{OH}$) is



When ethanol is heated with conc. H_2SO_4 at 443 K then it loses a water molecule to form unsaturated alkene (ethene) as a product.

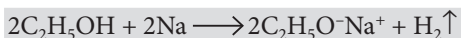


Here conc. H_2SO_4 acts as a dehydrating agent *i.e.*, helps in the removal of water.

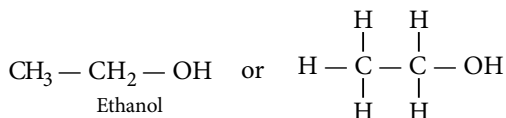
79. (a) Refer to answer 77(i).

(b) Refer to answer 74(i).

(c) When a small piece of sodium is dropped into ethanol then hydrogen gas is liberated which burns with a pop sound.

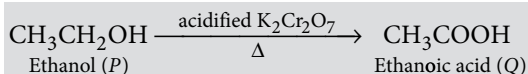


87. Those organic compounds having suffix 'ol' are alcohols. As the alcohol is having two carbon atoms in its molecule so, it is ethanol.

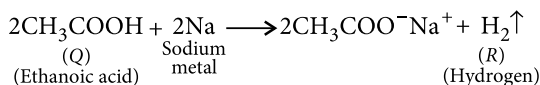


Refer to answer 78.

88. 'P' is ethanol which is a constituent of wine. Ethanol on reacting with acidified potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) solution gives ethanoic acid 'Q'.



When a piece of sodium is added to ethanoic acid then sodium salt of ethanoic acid is formed with the liberation of hydrogen gas which burns with a pop sound.



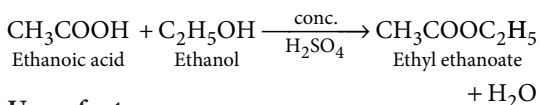
89. Tests for distinguishing between an alcohol and a carboxylic acid are :

(i) **Litmus test** : When we place a drop of carboxylic acid on blue litmus paper it turns red while alcohol will not change the colour of blue litmus paper.

(ii) **Sodium hydrogen carbonate test/sodium carbonate test** : If a pinch of NaHCO_3 or Na_2CO_3 is added to two test tubes containing alcohol and carboxylic acid respectively, then test tube containing carboxylic acid will show the evolution of colourless gas with brisk effervescence while test tube containing alcohol does not show any reaction.

90. Esters are generally volatile liquids which have pleasant fruity smell.

Esters are prepared when a carboxylic acid reacts with an alcohol in the presence of small amount of concentrated H_2SO_4 . For example, when ethanoic acid reacts with ethanol it forms an ester (*i.e.* ethyl ethanoate).

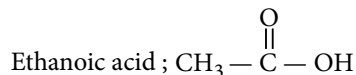


Uses of ester :

1. It is used in making perfumes.

2. It is used in making artificial flavours and essences used in ice-creams, sweets and cold drinks.

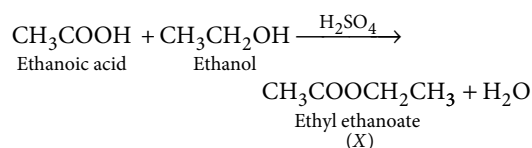
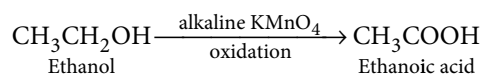
91. The molecular formula of carboxylic acid is $\text{C}_2\text{H}_4\text{O}_2$. Thus, it should be acetic acid (ethanoic acid).



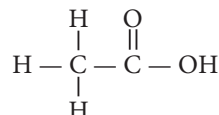
It reacts with alcohol in presence of acid catalyst to give compound 'X'.

As alcohol on oxidation with alkaline KMnO_4 gives the same acid *i.e.* ethanoic acid, hence alcohol must contain two carbon atoms. Thus, formula for alcohol is $\text{CH}_3\text{CH}_2\text{OH}$ *i.e.* ethanol.

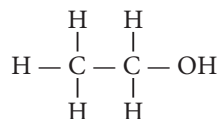
Reactions involved are :



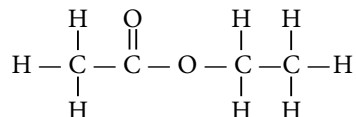
(i) Structure of ethanoic acid :



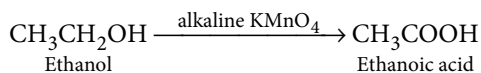
(ii) Structure of ethanol :



(iii) Structure of ethyl ethanoate (X) :



92. When ethanol is heated with alkaline solution of potassium permanganate then oxidation of ethanol takes place to form ethanoic acid.



Two physical properties of ethanol are :

1. It is liquid at room temperature.
2. It is soluble in water in all proportions.

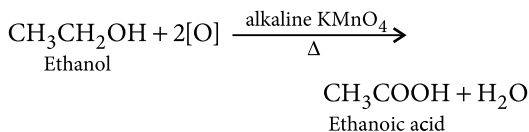
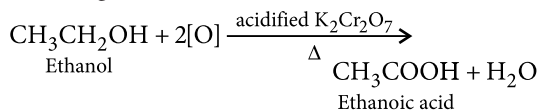
Two uses of ethanol are :

1. It is used as a liquor for drinking purpose.

2. It is a good solvent and hence, it is used in medicines such as tincture of iodine, cough syrup and many tonics.

93. Addition of oxygen to any substance is called oxidation.

Ethanol gets oxidised to ethanoic acid as :



Refer to answer 92.

94. (i) Refer to answer 76(ii).

(ii) Refer to answer 77(iii).

(iii) Refer to answer 79(c).

95. (i) Refer to answer 84(a).

(ii) Refer to answer 86.

(iii) Refer to answer 76(ii).

96. (a) Refer to answer 22.

For example, alkane series has general formula $\text{C}_n\text{H}_{2n+2}$.

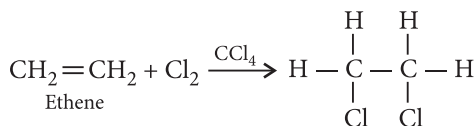
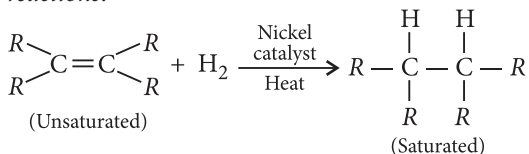
First member of homologous series of alkane is methane, i.e., CH_4 .

Second member of homologous series of alkane is ethane, i.e., C_2H_6 .

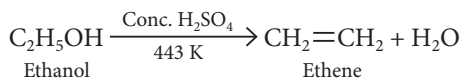
Third member of homologous series of alkane is propane i.e., C_3H_8 .

(b) (i) Refer to answer 73(ii).

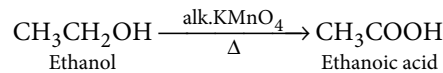
(ii) **Addition reactions** : Those reactions in which atoms or group of atoms are simply added to a double or triple bond without the elimination of any atom or molecule, are known as *addition reactions*.



97. (a) (i) When ethanol is heated with conc. H_2SO_4 at 443 K, ethene is obtained due to dehydration of ethanol.



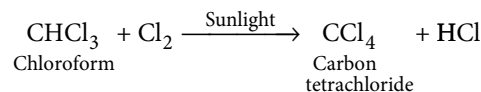
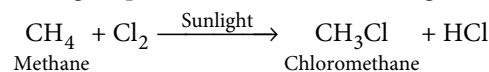
(ii) When 5 % alkaline KMnO_4 solution is added drop by drop to warm ethanol then it gets oxidised to ethanoic acid.



(b) Refer to answer 96(ii).

Substitution reactions : The reactions which involve the displacement or substitution of an atom or a group of atoms in an organic compound by another atom or group of atoms, are known as *substitution reactions*.

Saturated hydrocarbons are fairly unreactive and inert in the presence of most of the reagents. However, in presence of sunlight, hydrocarbons undergo rapid substitution reactions. e.g.,



98. Ethanol having chemical formula $\text{C}_2\text{H}_5\text{OH}$ is the active ingredient of all alcoholic drinks.

Uses of ethanol :

1. Ethanol is widely used in industry as a solvent.

2. Ethanol is used as an antiseptic for wounds in the form of rectified spirit.

Chemical equations :

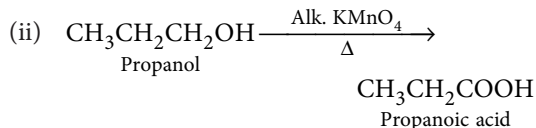
(i) Refer to answer 79(c).

(ii) Refer to answer 74(i).

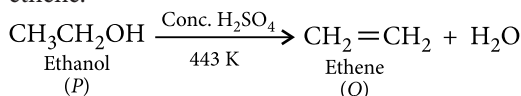
99. (a) Refer to answer 39.

(b) Refer to answer 51(b).

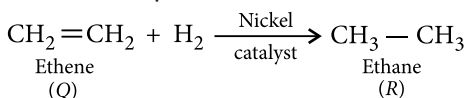
(c) (i) Refer to answer 97(a)(i).



100. When ethanol is heated with excess of concentrated H_2SO_4 it gets dehydrated to form ethene.



When ethene is heated with hydrogen in presence of nickel catalyst it forms ethane.



Ethane on oxidation gives two moles of carbon dioxide and three moles of water.



101.

Ethanol (Physical properties)		Ethanoic acid (Physical properties)	
(i)	It has very low melting point (156 K) and low boiling point (351 K).	(i)	It has moderate melting point (290 K) and boiling point (391 K).
(ii)	It has a burning taste.	(ii)	It has a sour taste.
(iii)	It has a distinct smell.	(iii)	It has a pungent smell.
Chemical properties		Chemical properties	
(i)	It is neutral in nature and thus, it does not turn blue litmus to red or vice-versa.	(i)	It is acidic in nature and turns blue litmus to red.
(ii)	Ethanol does not react with Na_2CO_3 or NaHCO_3 . $\text{C}_2\text{H}_5\text{OH} + \text{Na}_2\text{CO}_3 \rightarrow \text{No reaction}$	(ii)	Ethanoic acid reacts with Na_2CO_3 or NaHCO_3 to give brisk effervescence of CO_2 gas. $2\text{CH}_3\text{COOH} + \text{Na}_2\text{CO}_3 \rightarrow 2\text{CH}_3\text{COONa} + \text{CO}_2\uparrow + \text{H}_2\text{O}$

102. (a)

Tests	Ethanol ($\text{C}_2\text{H}_5\text{OH}$)	Ethanoic acid (CH_3COOH)
(i) Physical state	In liquid state	In liquid state
(ii) Taste	Burning	Sour
(iii) NaHCO_3	$\text{C}_2\text{H}_5\text{OH} + \text{NaHCO}_3 \rightarrow \text{No reaction}$	$\text{CH}_3\text{COOH} + \text{NaHCO}_3 \rightarrow \text{CH}_3\text{COONa} + \text{CO}_2\uparrow + \text{H}_2\text{O}$ (CO_2 gas is evolved with a brisk effervescence.)
(iv) Ester	When ethanol is heated with ethanoic acid in presence of 2-3 drops of conc. H_2SO_4 fruity smelling ester is formed. $\text{C}_2\text{H}_5\text{OH} + \text{CH}_3\text{COOH} \xrightarrow[\text{H}_2\text{SO}_4]{\text{Conc.}} \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$	When ethanoic acid is heated with ethanol in presence of 2-3 drops of conc. H_2SO_4 then fruity smelling ester is formed. $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} \xrightarrow[\text{H}_2\text{SO}_4]{\text{Conc.}} \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$

(b) Refer to answer 97(a)(i).

103. (c)

104. A soap molecule has two ends with different properties, one end is polar *i.e.*, water soluble or hydrophilic while other end is non-polar *i.e.*, water insoluble or hydrophobic. When soap is added to water, the polar ends get dissolve in water and non-polar ends get dissolved in each other and directed towards the centre. As a result, a spherical ionic molecule known as micelles, formation takes

place. Since, soaps are soluble in ethanol, therefore, micelles formation does not occur.

105. Soaps are the sodium or potassium salts of higher fatty acids. The ionic group in soaps is $-\text{COO}^- \text{Na}^+$.

On the other hand, synthetic detergents are the sodium salts of a long chain alkylbenzenesulphonic acids or long chain alkyl hydrogen sulphates. The ionic group in synthetic detergents is

