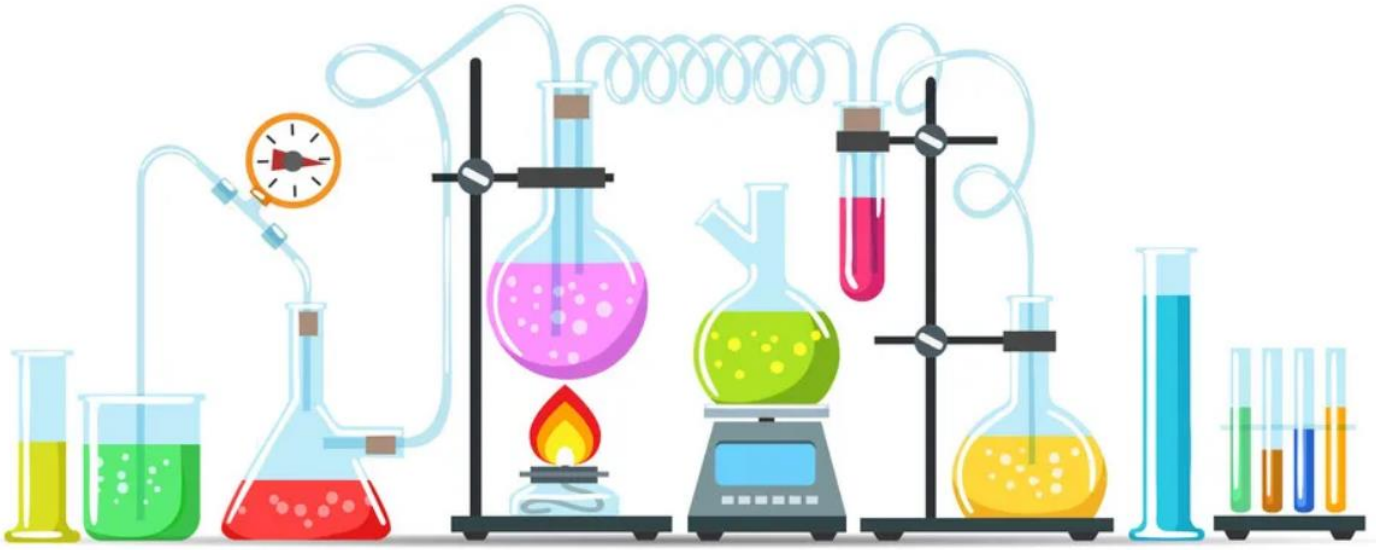
SCIENCE

(Chemistry)

Chapter 4: Carbon and its Compounds



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Carbon and its Compounds

Bonding in Carbon

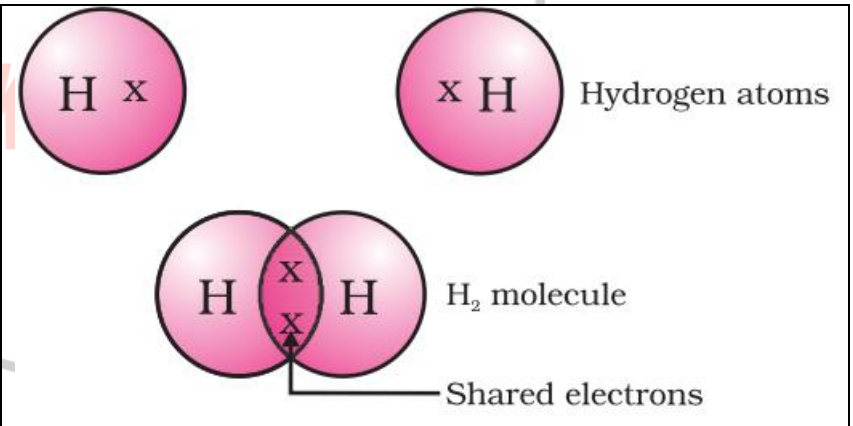
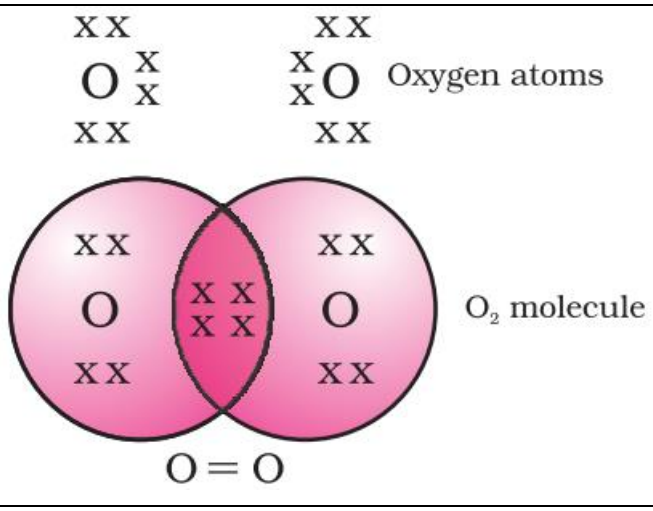
Most carbon compounds are poor conductors of electricity. From the data melting points of the carbon compounds, we find that these compounds have low melting and boiling points as compared to ionic compounds. We can conclude that the forces of attraction between the molecules are not very strong. Since these compounds are largely non-conductors of electricity, we can conclude that the bonding in these compounds does not give rise to any ions.

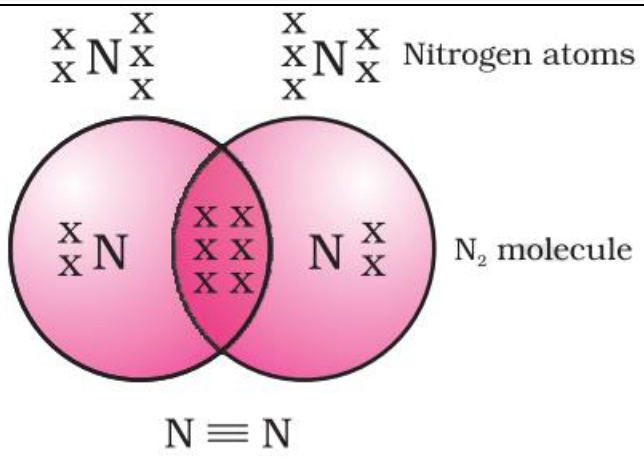
Covalent Bond

A covalent bond is formed when pairs of electrons are shared between two atoms. It is primarily formed between two same nonmetallic atoms or between nonmetallic atoms with similar electronegativity**.**

Noble gas configuration of Carbon

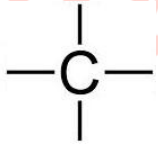
- Carbon is tetravalent, it does not form ionic bond by either losing four electrons (C4+) or by gaining four electrons (C4-). It is difficult to hold four extra electron and would require large amount of energy to remove four electrons. So, carbon can form bond by sharing of its electrons with the electrons of other carbon atom or with other element and attain noble gas configuration.
- The atoms of other elements like hydrogen, oxygen and nitrogen, chlorine also form bonds by sharing of electrons.

H – H single bond between hydrogen atoms (H2)	
O = O double bond between oxygen atoms (O2)	

N ≡ N triple bond between nitrogen atoms	

Carbon atom has four electrons in its outermost shell.

- It requires four electrons to achieve the stable, 8 electron, inert gas configuration.
- Carbon atoms can achieve the inert gas electron arrangement only by sharing their electrons. Hence, carbon always forms covalent bonds.
- The valency of carbon is four since one carbon requires 4 electrons to achieve the nearest inert gas configuration. Thus, we can say that carbon is tetravalent.
- The four valencies of carbon are usually represented by drawing four short lines around the symbol of carbon (C).



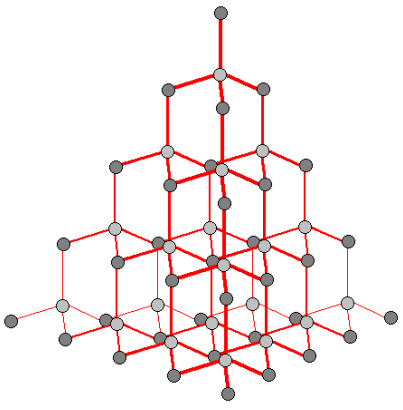
Allotropes of Carbon

The various physical forms in which an element can exist are called the allotropes of that element. Carbon has three allotropes:

- Diamond
- Graphite
- Buckminster fullerene

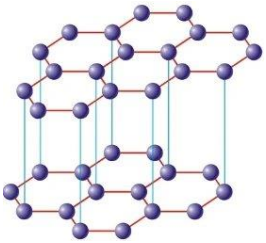
Diamond

- In diamond, each carbon atom is bonded to four other carbon atoms, forming a three dimensional structure.
- The rigid structure of diamond makes it a very hard substance.
- It is a non-conductor of electricity since there are no free electrons in a diamond crystal.
- It can be synthesised by subjecting pure carbon to a very high pressure and temperature.



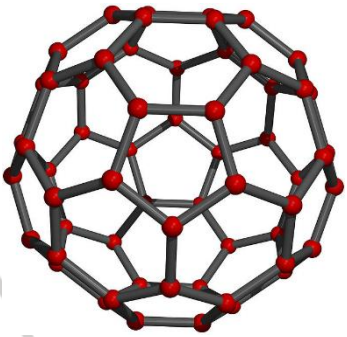
Graphite

- In graphite, each carbon atom is bonded to three other carbon atoms in the same plane, giving a hexagonal array.
- One of the bonds is a double bond and thus the valency of carbon is satisfied.
- Graphite structure is formed by the hexagonal arrays being placed in layers, one above another.
- Graphite is smooth and slippery.
- It is a very good conductor of electricity due to the presence of free electrons.



Fullerene

- It is an allotrope of carbon containing clusters of 60 carbon atoms joined together to form spherical molecules.
- There are 60 carbon atoms in a molecule of buckminsterfullerene, so its formula is C_{60}.
- The allotrope was named buckminsterfullerene after the American architect Buckminster Fuller.



Versatile Nature of Carbon

The two characteristic properties of the element carbon which leads to the formation of a very large number of organic compounds are:

i. **Catenation**: The property of the element carbon due to which its atoms can join one another to form long carbon chains is called catenation.

Types of Chains

a) Straight chain of carbon atoms

b) Branched chain of carbon atoms

c) Closed or ring chain of carbon atoms

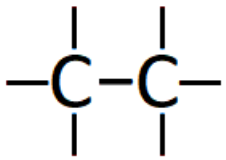
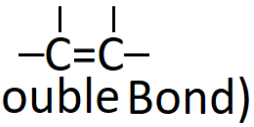
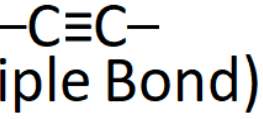
ii. **Tetravalency**: Carbon has a valency of four. So, it is capable of bonding with four other atoms of carbon or atoms of some other monovalent element.

Compounds of carbon are formed with oxygen, nitrogen, hydrogen, sulphur, chlorine and many other elements, giving rise to compounds with specific properties which depend on the elements other than the carbon present in the molecule.

Classification of Hydrocarbons

Comparison of Saturated and Unsaturated Hydrocarbons

Saturated hydrocarbons	Unsaturated hydrocarbons
1. All the four valencies of each carbon atom are satisfied by forming single covalent bonds with carbon and with hydrogen atoms.	1. The valencies of at least two carbon atoms are not fully satisfied by hydrogen atoms.

2. Carbon atoms are joined by a single covalent bond.  (Single Bond)	2. Carbon atoms are joined by double covalent bonds.  (Double Bond) or by triple covalent bonds.  (Triple Bond)
3. They are less reactive due to the non-availability or electrons in the single covalent bond, and therefore, they undergo substitution reaction.	3. They are more reactive due to the presence of electrons in the double or triple bond and therefore undergo addition reaction.

Cyclic Hydrocarbons

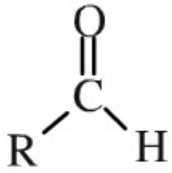
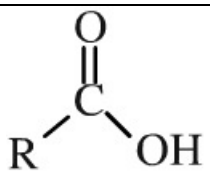
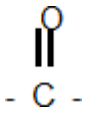
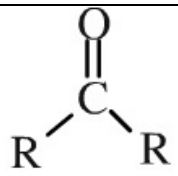
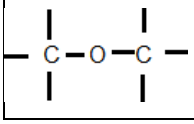
- Hydrocarbons in which the carbon atoms are arranged in the form of a ring are called cyclic hydrocarbons.
- Cyclic hydrocarbons may be saturated or unsaturated.

Saturated cyclic hydrocarbon	Unsaturated cyclic hydrocarbon
• Cyclohexane is an example of a saturated cyclic hydrocarbon. • Formula: C_6H_{12} • Cyclohexane contains 6 carbon atoms arranged in a hexagonal ring, with each carbon atom attached to 2 hydrogen atoms.	• Benzene is an example of an unsaturated cyclic hydrocarbon. • Formula: C_6H_6 • Benzene is made up of 6 carbon atoms and 6 hydrogen atoms.

Functional Groups

- **Functional group**: An atom or a group of atoms present in the molecules, which determines the characteristics property of the organic compounds, is called the functional group.

Functional group	General formulae	Organic compound	Suffix	Examples with common & IUPAC name
Halide-X (F,Cl,Br,I)	R-X	Haloalkanes	-ane	CH_3Cl Common name: Methyl chloride IUPAC name: Chloromethane
Hydroxyl-OH	R-OH	Alcohols	-ol	C_2H_5OH Common name : Ethyl alcohol IUPAC name: Ethanol

Aldehyde- CHO		Aldehydes	-al	CH_3CHO Common name: Acetaldehyde IUPAC name: Ethanal
Carboxyl- COOH		Carboxylic acids	-oic acid	$CH_3CH2COOH$ Common name: Propionic acid IUPAC name: Propanoic acid
Keto 		Ketones	-one	$CH_3COC_2H_5$ Common name: Diethyl ketone IUPAC name: Pentanone
Ethers 	R-O-R’	Ethers	-oxy	$CH_3 – O – C_2H_5$ Common name: Ethyl methyl ether IUPAC name: Methoxy ethane

Homologous Series

It is a group of organic compounds having a similar structure and chemical properties in which the successive compounds differ by a -**CH2** group.

Characteristics of a Homologous Series

- Each member of the series differs from the preceding one by the addition of a -CH2 group and by 14 a.m.u.
- All members of a homologous series have the same general formula.
- The physical properties of the members show a gradation in properties as their molecular mass increases.
- All members of a homologous series can be prepared by the same general method of preparation.

Nomenclature of Carbon Compounds:

The system of designating a suitable name to a particular carbon compound based on certain rules is known as nomenclature. of the basic carbon chain modified by a “prefix” “phrase before” or “suffix” “phrase after” indicating the nature of the functional group.

Suffix: The suffix refers to the sort of bond or functional group that exists in the carbon chain.

Prefix: This indicates the presence and position of other functional groups

Most carbon compounds have one of two names:

- **Trivial Names:** The common names for carbon compounds are known as trivial names. They are typically derived from the compound's source, such as the name formic acid, which comes from the Greek term "formicus," which means "red ants." The names that

came this way were unclear and repetitive.

- **IUPAC Names:** As the number of carbon compounds increased, it became necessary to name them in a more methodical manner. The International Union for Pure and Applied Chemistry (IUPAC) proposed a system for naming carbon-based compounds with valid scientific names. The names derived from their rules are known all throughout the world and are referred to as IUPAC names.

Chemical Properties of Carbon Compounds

The majority of carbon-containing molecules connected with hydrogen, i.e. hydrocarbons, are fuels that emit heat when burned. Natural gas, petrol, gasoline, kerosene, heavy oils, and, more broadly, wood, biogas, charcoal, and coke are all rich sources of carbon molecules that are utilised as fuels.

Combustion

The process of burning a carbon compound in air to give carbon dioxide, water, heat and light is known as combustion.

Flame Characteristics: Saturated hydrocarbons give clean flame while unsaturated hydrocarbons give smoky flame. In the presence of limited oxygen, even saturated hydrocarbons give smoky flame.

For example:

$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)}$ + Heat and Light

Oxidation

Carbon undergoes oxidation when it meets oxygen at a higher temperature, resulting in the formation of oxides such as carbon monoxide (CO) and carbon dioxide (CO_2). When carbon or carbon-containing fuels are burned incompletely, carbon monoxide is produced.

$$CH_3 - CH_2OH \xrightarrow[\text{Or acidified } K_2Cr_2O_7 + \text{Heat}]{\text{Alkaline } KMnO_4 + \text{Heat}} CH_3COOH$$

We see that some substances are capable of adding oxygen to others. These substances are known as oxidising agents.

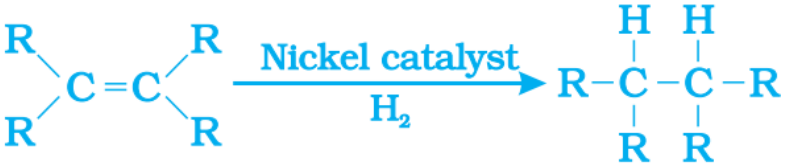
Alkaline potassium permanganate or acidified potassium dichromate are oxidising alcohols to acids, that is, adding oxygen to the starting material. Hence they are known as oxidising agents.

- Carbon compounds can be oxidised.
- Alcohols on oxidation are converted to carboxylic acids.
- Alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$ are used as oxidising agents.

Addition Reaction

Addition reactions are those in which an unsaturated hydrocarbon reacts with another chemical to generate a single product.

Unsaturated hydrocarbon add hydrogen in the presence of catalyst palladium or nickel. Vegetable oils are converted into vegetable ghee using this process.



- This reaction occurs only in unsaturated compounds, where there are double or triple bonds.
- The addition of hydrogen to an unsaturated hydrocarbon to obtain a saturated hydrocarbon is called hydrogenation.
- The process of hydrogenation is used in industries to prepare vegetable ghee (or vanaspati ghee) from vegetable oils.

Substitution Reaction

The reaction in which an atom or group of atoms in a molecule is replaced or substituted by different atoms or group of atoms is called substitution reaction. In alkanes, hydrogen atoms are replaced by other elements.

$CH_4 + Cl_2 + \text{Sunlight} \longrightarrow CH_3Cl + HCl$

- The reaction in which one or more hydrogen atoms of a hydrocarbon are replaced by atoms of other elements is called a substitution reaction.
- Substitution reactions are a characteristic property of saturated hydrocarbons.

Some Important Carbon Compounds – Ethanol & Ethanoic Acid

Properties of Alcohols

- **Reaction with Sodium**: Sodium reacts steadily with ethanol to form sodium ethoxide along with the evolution of hydrogen gas.

$$\underset{\text{Ethanol}}{2C_2H_5OH} + \underset{\text{Sodium}}{2Na} \longrightarrow \underset{\text{Sodium ethoxide}}{2C_2H_5ONa} + \underset{\text{Hydrogen}}{H_2\uparrow}$$

- **Dehydration:** Ethanol, on heating with excess of conc. H_2SO_4 at 170°C gets dehydrated to form ethene.

$$C_2H_5OH \xrightarrow{conc.\ H2SO4\ at\ 170°C} CH_2 = CH_2 + H_2O$$

Reactions of Ethanoic acid

- **Esterification:** Ethanoic acid reacts with alcohols in the presence of a little conc. sulphuric acid to form esters.

$$C_2H_5OH + CH_3COOH \xrightarrow{conc.\ H2SO4} CH_3COOC_2H_5 + H_2O$$

The ester, on treating with a base such as NaOH is converted back to alcohol and sodium salt of carboxylic acid. This reaction is known as saponification because it is used in the

manufacture of soap.

$CH_3COOC_2H_5 + NaOH \rightarrow C_2H_5OH + CH_3COONa$

- **Reaction with a base:** Ethanoic acid reacts with a base such as sodium hydroxide to form a salt and water.

$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$
Acetic acid — Sodium acetate — Water

- **Reaction with Carbonates & bicarbonates:** Acetic acid reacts with carbonates and bicarbonates to form salt, water and carbon dioxide.

$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$
Acetic acid — Sodium acetate

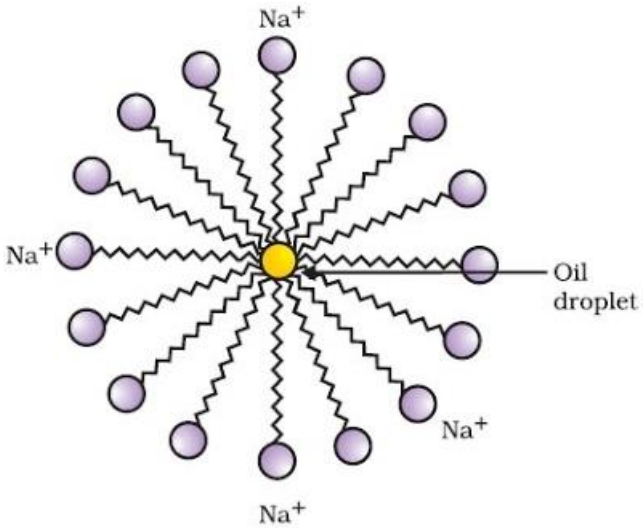
$CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$
Acetic acid — Sodium acetate

Soaps & Detergents

The molecules of soap are sodium or potassium salts of long-chain carboxylic acids. The ionic-end of soap interacts with water while the carbon chain interacts with oil. The soap molecules, thus form structures called micelles where one end of the molecules is towards the oil droplet while the ionic-end faces outside. This forms an emulsion in water. The soap micelle thus helps in pulling out the dirt in water and we can wash our clothes clean.

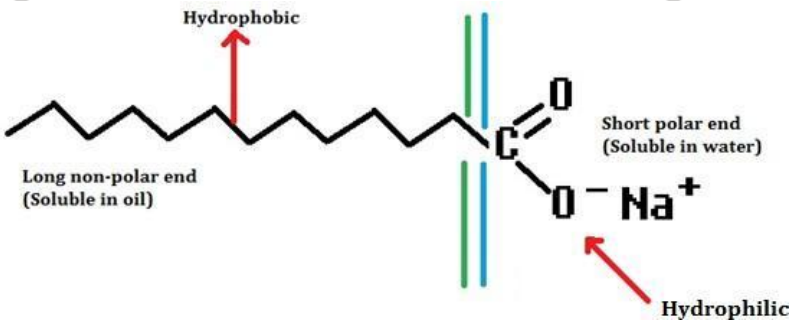
Micelles

Soaps are molecules in which the two ends have differing properties, one is hydrophilic, that is, it interacts with water, while the other end is hydrophobic, that is, it interacts with hydrocarbons. When soap is at the surface of water, the hydrophobic 'tail' of soap will not be soluble in water and the soap will align along the surface of water with the ionic end in water and the hydrocarbon 'tail' protruding out of water. Inside water, these molecules have a unique orientation that keeps the hydrocarbon portion out of the water. Thus, clusters of molecules in which the hydrophobic tails are in the interior of the cluster and the ionic ends are on the surface of the cluster. This formation is called a micelle.



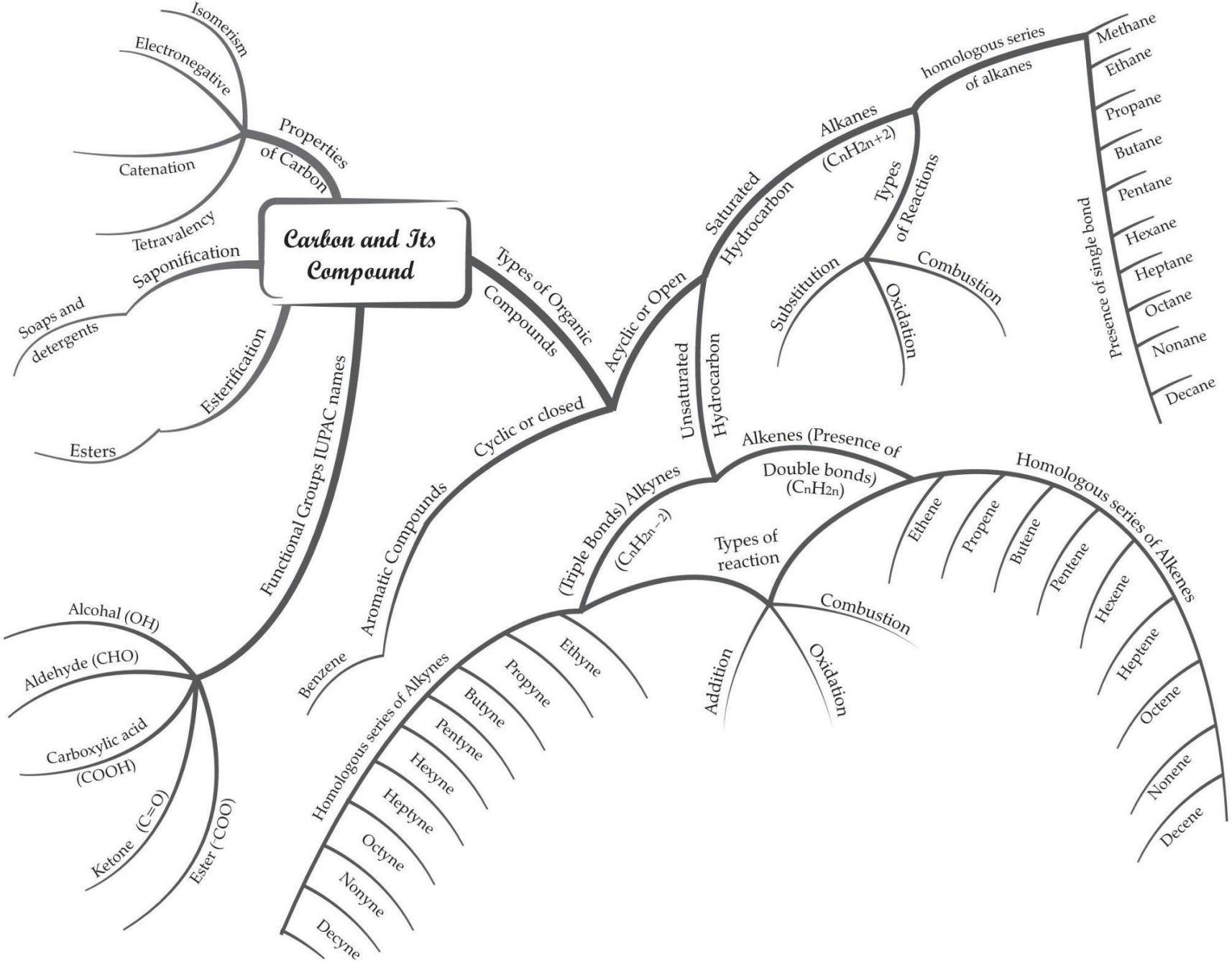
Soap in the form of a micelle is able to clean, since the oily dirt will be collected in the centre of the micelle. The micelles stay in solution as a colloid and will not come together to precipitate because of ion-ion repulsion. Thus, the dirt suspended in the micelles is also easily rinsed away. The soap micelles are large enough to scatter light. Hence a soap solution appears cloudy.

- Soaps are cleansing agents capable of reacting with water and dislodging the unwanted particles from clothes or skin.
- The molecules of soap are sodium or potassium salts of long chain carboxylic acids.
- A soap molecule has a tadpole shaped structure.
- At one end (long non-polar end) of the soap molecule is a hydrocarbon chain which is insoluble in water but soluble in oil.
- At the other end (short polar end) of the soap molecule, there is a carboxylate ion which is hydrophilic i.e. water soluble but insoluble in oil.



MIND MAP : LEARNING MADE SIMPLE

Chapter-4



Important Questions

➢ Multiple Choice Questions:

1. Which of the following statements are correct for carbon compounds?

(i) Most carbon compounds are good conductors of electricity.

(ii) Most carbon compounds are poor conductors of electricity.

(iii) Force of attraction between molecules of carbon compounds is not very strong.

(iv) Force of attraction between molecules of carbon compounds is very strong.

(a) (ii) and (iv)

(b) (ii) and (iii)

(c) (i) and (iv)

(d) (i) and (iii)

2. C_3H_8 belongs to the homologous series of

(a) Alkynes

(b) Alkenes

(c) Alkanes

(d) Cyclo alkanes

3.

The IUPAC name of $CH_3 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}} - CH_2 - CH_3$ is

(a) 2-ethyl-2-methyl propane

(b) 2, 2-demethyl butane

(c) 1,1,1-trimethyl propane

(d) 2, 2-methyl butane

4. Which of the following is the formula of Butanoic acid?

(a) $CH_3CH_2CH_2CH_2COOH$

(b) $COOH-CH_2-CH_2-CH_2-CH_3$

(c) $CH_3 - \underset{\displaystyle COOH}{\overset{|}{CH}} - CH_2 - CH_3$

(d) $CH_2 - CH_2 - CH_2 - COOH$

5. The number of isomers of pentane is

(a) 2

(b) 3

(c) 4

(d) 5

6. Which of the following will undergo addition reactions?

(a) CH_4

(b) C_3H_8

(C) C_2H_6

(d) C_2H_4

7. When ethanoic acid is treated with NaHCO^ the gas evolved is

(a) H_2

(b) CO_2

(c) CH_4

(d) CO

8. Ethanol on complete oxidation gives

(a) acetic acid/ ethanoic acid

(b) CO_2 and water

(c) ethanal

(d) acetone/ ethanone

9. Which of the following will give a pleasant smell of ester when heated with ethanol and a small quantity of sulphuric acid?

(a) CH_3COOH

(b) CH_3CH_2OH

(c) CH_3OH

(d) CH_3CHO

10. Name the functional group present in CH_3COCH_3.

(a) Alcohol

(b) Carboxylic acid

(c) Ketone

(d) Aldehyde

➢ Very Short Question:

1. What are the essential constituents of all organic compounds?

2. What is the valency of carbon in its compounds?

3. Why are organic compounds present in such a large number?

4. Which is common in all the members of a family?

5. A family of organic compounds has the functional group 'al'. What is its name?

6. Out of ketonic and aldehydic groups, which is the terminal functional group?

7. Why is candle flame generally yellow?

8. The formula of a hydrocarbon is CnH2n. Name the family to which it belongs and also predict its nature.

9. An unknown compound has the smell of vinegar. Identify it.

10. What do we get when ethanoic acid reacts with ethanol in the presence of concentrated sulphuric acid?

➢ Short Questions:

1. Write the structures of

   (i) Ethanoic acid

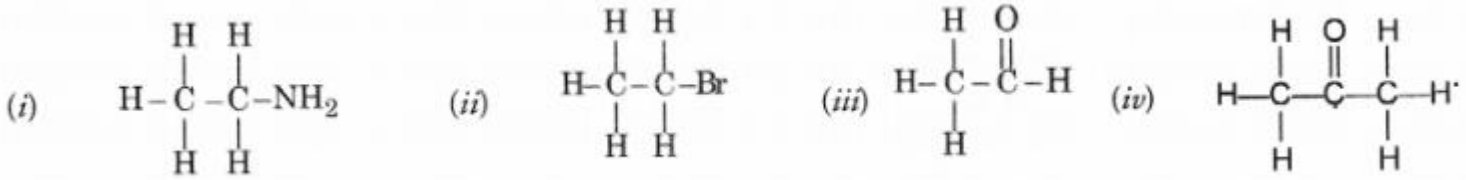
   (ii) Butanone

   (iii) Hexanal

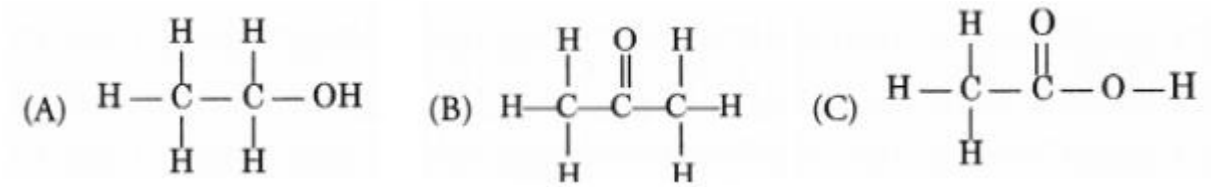
   (iv) But-2-ene.

2. How will you name the following compounds?

3. Identify the name of the functional groups in the following compounds.



4. Write the IUPAC names of the following compounds.



5. Give the electron dot structure and structural formula of first member of alkene and alkyne families.

6. Draw the structural formulae of the possible isomers for the compound with molecular formula C_3H_6O?

7. How will you convert ethene into ethanol? Give the chemical reaction involved.

8. What is an homologous series? Which two of the following organic compounds belong to the same homologous series?

C_2H_6, C_2H_6O, $C_2H_6O_2$,

➢ Long Questions:

1. 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 formulae. What happens when 'A' and 'B' react in the presence of an acid catalyst? Write the chemical equation for the reaction.

2. Give a chemical test to distinguish between:

(i) Ethane and ethene

(ii) Ethanol and ethanoic acid

(iii) Soaps and detergents.

3.

(a) What are homologous series of compounds? List any two characteristics of homologous series.

(b) What would be observed by adding a 5% solution of alkaline potassium permanganate drop by drop to warm ethanol taken in a test tube?

(c) Write the name of the compound formed during the chemical reaction. How would you distinguish experimentally between an alcohol and a carboxylic acid on the basis of a chemical property?

➢ Assertion Reason Questions:

1. For question two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true, but R is false.
   d. A is false, but R is true.

Assertion: Diamond and graphite do not have the same crystal structure.

Reason: Diamond is crystalline while graphite is amorphous.

2. For question two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.
   c. A is true, but R is false.

d. A is false, but R is true.

Assertion: Olefins have the general formula C_nH_{2n+1}.

Reason: There is at least one double bond between two carbon atoms in their molecules.

➢ Case study Question:

1. Read the following and answer any four questions from (i) to (v).

A hydrocarbon (P) has the molecular formula $C_{10}H_{22}$ hydrocarbon (Q) has two carbon atoms less than (P) and belong to the same homologous series. A hydrocarbon (R) has two carbon atoms more than (P) and belong to the same homologous series.

i. What is the molecular formula of (Q)?
   a. $C_{12}H_{26}$
   b. C_8H_{16}
   c. C_8H_{18}
   d. C_8H_{14}

ii. To which homologous series do the compound (P), (Q) and (R) belong?
   a. C_nH_{2n}
   b. C_2H_{2n-2}
   c. C_nH_{2n+2}
   d. C_nH_{2n+1}

iii. What is the molecular formula of (R)?
   a. $C_{12}H_{26}$
   b. $C_{12}H_{24}$
   c. $C_{12}H_{22}$
   d. $C_{12}H_{28}$

iv. Identify the correct statement about compounds (P), (Q) and (R).
   a. They have same melting and boiling points.
   b. They have same chemical properties.
   c. They have different general formula.
   d. They differ by -CH unit.

v. Compounds (P), (Q) and (R) are:
   a. Alkanes.
   b. Alkenes.
   c. Alkynes.

d. None of these.

2. Read the following and answer any four questions from (i) to (v).

The table given below shows six organic compounds A, B, C, D, E and F having different molecular formula:

Organic compound	Molecular formula
A	C_7H_{16}
B	C_8H_{16}
C	C_4H_6
D	C_6H_{10}
E	C_5H_{10}
F	C_9H_{20}

i. Which of the following compounds belong to same homologous series?
   a. E and F
   b. B and C
   c. A and B
   d. C and D

ii. Which of the following is the member of the same homologous series as E?
   a. D
   b. A
   c. F
   d. B

iii. Identify the correct statements.
   a. A and Fare saturated hydrocarbons while all others are unsaturated hydrocarbons.
   b. C and D belong to a homologous series having general formula C_nH_{2n}.
   c. B and E are alkynes.
   d. All the compounds have same physical and chemical properties.

iv. Compound B is:
   a. An alkane.
   b. An alkene.
   c. An alkyne.
   d. None of these.

v. Compound (F) has a general formula:

a. C_nH_{2n-2}

b. C_nH_{2n}

c. C_nH_{2n+4}

d. C_nH_{2n+2}

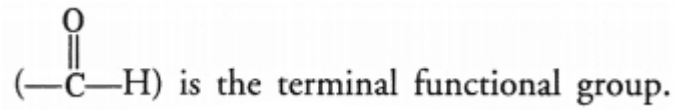
Answer Key-

➢ Multiple Choice Answers:

1. (b) (ii) and (iii)
2. (c) Alkanes
3. (b) 2, 2-demethyl butane
4. (d)
5. (b) 3
6. (d) C_2H_4
7. (b) CO_2
8. (b) CO_2 and water
9. (a) CH_3COOH
10. (c) Ketone

➢ Very Short Answers:

1. Answer: Carbon and hydrogen are the essential constituents of all organic compounds. However, carbon tetrachloride (CCl_4) is an exception.
2. Answer: Carbon is tetravalent in its compounds.
3. Answer: This is due to the self-linking property of carbon known as catenation.
4. Answer: They have the common functional group.
5. Answer: The family is of aldehydes also called alkanals.
6. Answer: Aldehydic group

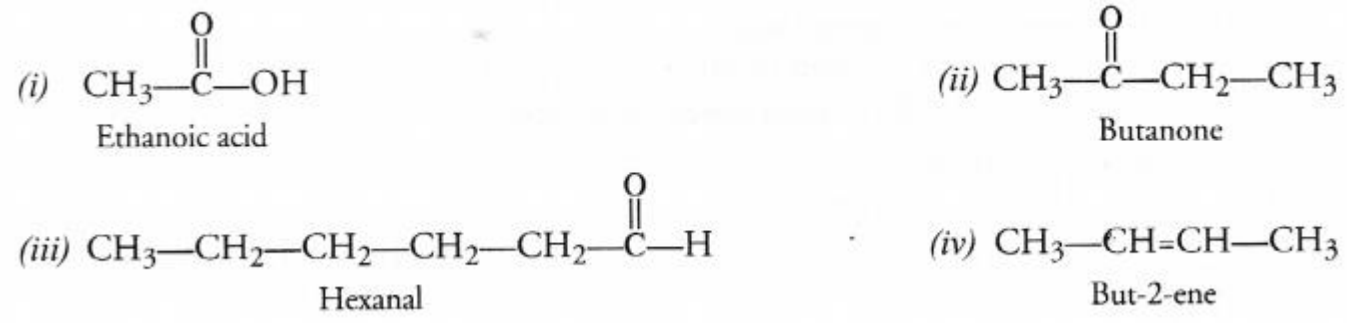


7. Answer: Candle flame is generally yellow due to the presence of unburnt carbon particles. When light falls on these particles, they scatter yellow colour. This shows that the combustion of hydrocarbons present in wax or candle is not complete.
8. Answer: The hydrocarbon belongs to alkene family. It is unsaturated in nature.
9. Answer: The compound is ethanoic acid also called acetic acid.

10. Answer: Ethyl ethanoate ($CH_3COOC_2H_5$) is formed by esterification reaction. It has fruity smell.

➢ Short Answer:

1. Answer:



2. Answer:

   (a) Ethanal

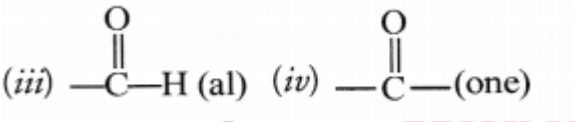
   (b) Ethanol

   (c) Methanal

   (d) Chloroethane.

3. Answer:

   (i) —NH_2 (amino) (ii) —Br (bromo)



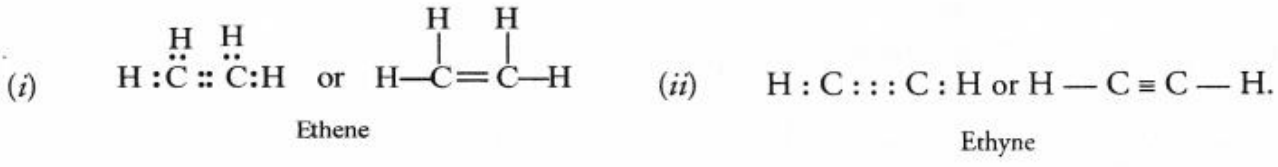
4. Answer:

   (A) Ethanol

   (B) Propanone

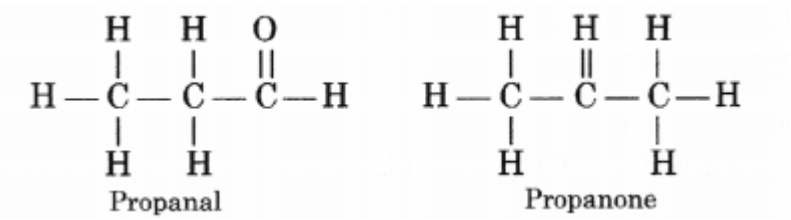
   (C) Ethanoic acid.

5. Answer:



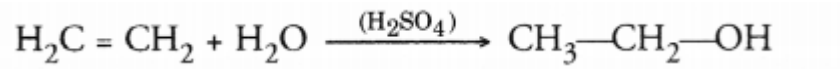
6. Answer:

   The given organic compounds represents two structural isomers which are actually functional isomers in nature.



7. Answer:

   Ethene is converted into ethanol by passing its vapours through water in the presence of sulphuric acid. This reaction is called hydration of ethene.



8. Answer:

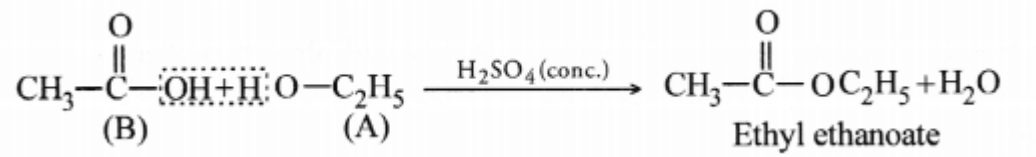
Homologous series represent different families of organic compounds into which these are divided. Two characteristics of homologous series are listed.
The compounds CH_4O and C_2H_6O belong to the same homologous series known as alkanols.

➢ Long Answer:

1. Answer:

   The available information suggests that the compound 'A' is ethanol and the compound 'B' formed by the oxidation of 'A' is ethanoic acid. Their structural formulae are:

   When 'A' and 'B' react in the presence of an acid like cone. H2SO4, the compound is ethyl ethanoate (ester) with a pleasant smell.



2. Answer:

   (i) Ethene decolorizes the yellow colour of bromine water while ethane does not.

   (ii) Ethanoic acid gives a brisk effervescence with sodium hydrogen carbonate while ethanol does not.

   (iii) Soaps form curdy white precipitate or scum with hard water while detergents do not form any precipitate.

3. Answer:

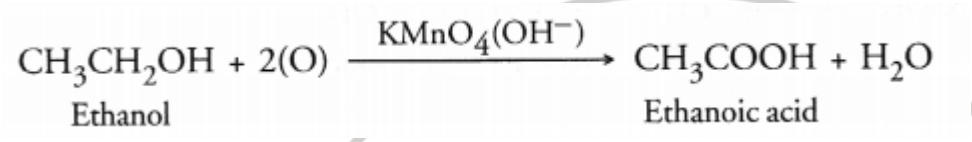
(a) Homologous series represent different families of organic compounds into which

these are divided. Two characteristics of homologous series are listed.

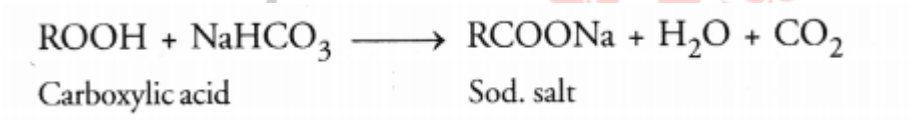
- All the members in a particular homologous series of family have the same characteristic functional group. For example, in organic acids, the functional group is carboxyl group (—COOH).
- Any two consecutive members in a particular family have the same common difference of CH_2 in their molecular formulae. For example, the first three members of the family of alkanes are: CH_4 (methane), C_2H_6 (ethane) and propane (C_3H_8).

(b) On adding a 5% solution of alkaline potassium permanganate to ethanol, it will be oxidized to ethanoic acid.

The pink colour of the solution will get discharged upon warming.



(c) A carboxylic acid gives a brisk effervescence when an aqueous solution of sodium hydrogen carbonate ($NaHCO_3$) is added to it. This is due to the evolution of CO_2 gas. However, alcohol will not give any reaction.



➢ Assertion Reason Answer:

1. (c) A is true, but R is false.

Explanation:

In diamond, C-atoms are sp^3 hybridized while in graphite, they are sp^2 hybridized. Diamond and graphite both are crystalline forms of carbon.

2. (d) A is false, but R is true.

Explanation:

Olefins are unsaturated hydrocarbons. There is at least one double bond between two carbon atoms in their molecules and they have the general formula C_nH_{2n}.

➢ Case Study Answer:

1. i (c) C_8H_{18}

Explanation:

Molecular formula of (Q) is C_8H_{18} as it has two carbon atoms less than (P).

ii. (c) C_nH_{2n+2}

Explanation:

Compounds (P), (Q) and (R) are alkanes having general formula C_nH_{2n+2}.

iii. (a) $C_{12}H_{26}$

Explanation:

Molecular formula of (R) is $C_{12}H_{26}$ as it has two carbon atoms more than (P).

iv. (b) They have same chemical properties.

Explanation:

Compound (P), (Q) and (R) belong to same homologous series So they have different physical properties but similar chemical properties. They have same general formula C_nH_{2n+2}. They differ by 2 carbon atoms and 4 hydrogen atoms.

v. (a) Alkanes.

2. i (d) C and D

Explanation:

A and Fare alkanes; B and E are alkenes; C and Dare alkynes.

ii. (d) B

Explanation:

B is an alkene having general formula C_nH_{2n} the homologous series to which E belongs.

iii. (a) A and Fare saturated hydrocarbons while all others are unsaturated hydrocarbons.

Explanation:

C and D belong to a homologous series having general formula C_nH_{2n-2} B and E are alkenes. All the compounds have different physical and chemical properties.

iv. (b) An alkene.

Explanation:

(B) is alkene.

v. (d) C_nH_{2n+2}

Explanation:

(F) is an alkane.