

Chapter 4 Carbon and its Compounds

Very Short Answer Type Question [1 Mark]

Question. Give the names of the following functional groups:

(i) —OH (ii) —COOH

Answer. (i) Alcohol group (ii) Carboxylic acid group

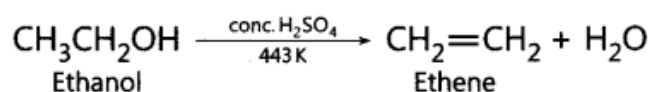
Question. What is the difference in the molecular formula of any two consecutive members of a homologous series of organic compounds?

Answer. $\text{—CH}_2\text{—}$ is the difference in the molecular formula of any two consecutive members of a homologous series of organic compounds.

Question. Name the carbon compound which on heating with excess of concentrated sulphuric acid at 443 K gives ethene.

Answer.

$\text{CH}_3\text{CH}_2\text{OH}$, ethanol



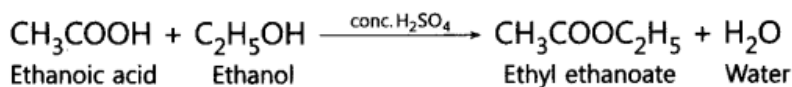
Question. What is meant by a saturated hydrocarbon?

Answer. Those hydrocarbons in which valency of carbon is satisfied by single bonds only are called saturated hydrocarbons.

Question. Name the compound formed when ethanol is warmed with ethanoic acid in the presence of a few drops of conc. H_2SO_4

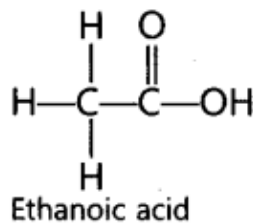
Answer.

Ethyl ethanoate is formed.



Question. Draw the structure of CH_3COOH molecule.

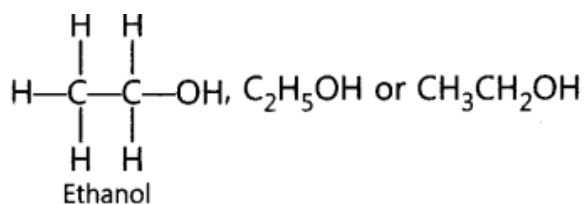
Answer.



Question. Draw the structure of ethanol molecule.

Answer.

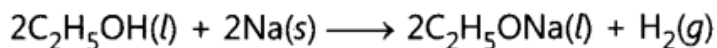




Question. What happens when a small piece of sodium is dropped into ethanol?

Answer. Hydrogen gas will be evolved.

Hydrogen gas will be evolved.

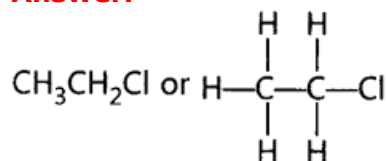


Question. State two characteristic features of carbon which when put together give rise to large number of carbon compounds.

Answer. (i) Catenation (ii) Tetravalency of carbon

Question. Write the structural formula of chloroethane.

Answer.

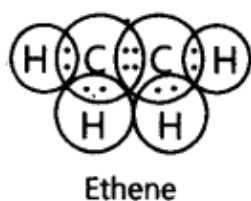


Question. How many covalent bonds are there in a molecule of ethane (C_2H_6)?

Answer. There are 7 covalent bonds in a molecule of ethane.

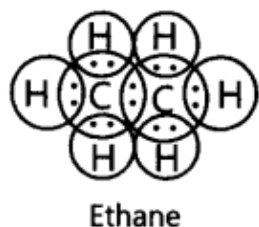
Question. Write the electron dot structure of ethene molecule (C_2H_4).

Answer.



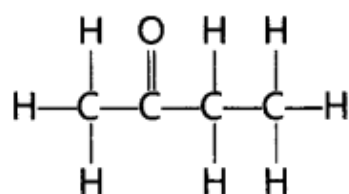
Question. Write the electron dot structure of ethane molecule (C_2H_6).

Answer.



Question. Draw the structure of butanone molecule, $\text{CH}_3\text{COC}_2\text{H}_5$.

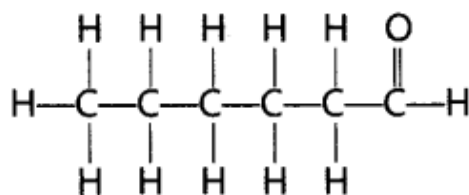
Answer.



Butanone

Question. Draw the structure of the hexanal molecule, $\text{C}_5\text{H}_{11}\text{CHO}$.

Answer.

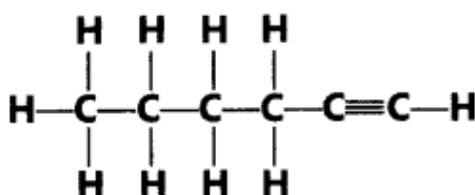


Hexanal ($\text{C}_5\text{H}_{11}\text{CHO}$)

Question. Butanone is a four carbon per molecule compound. Name the functional group present in it.

Answer. Ketone

Question.30 Name the following compound:



Answer. 1-Hexyne is IUPAC name of the compound

Question. Name the functional group present in each of the following organic compounds:

(i) $\text{C}_2\text{H}_5\text{Cl}$

(ii) $\text{C}_2\text{H}_5\text{OH}$

Answer.

(i) ($-\text{Cl}$) Halogen (Chloro)

(ii) ($-\text{OH}$) Alcohol

Question. Name the functional group present in each of the following compounds:

(i) HCOOH

(ii) $\text{C}_2\text{H}_5\text{CHO}$

Answer.

(i) $-\text{COOH}$ (Carboxylic acid)

(ii) $-\text{CHO}$ (Aldehyde)

Question. Name the functional group present in each of the following organic compounds:

(i) CH_3COCH_3

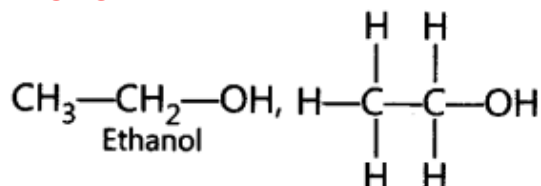
(ii) $\text{C}_2\text{H}_5\text{COOH}$

Answer.

- (i) Ketone ($\text{—}\overset{\text{O}}{\parallel}{\text{C}}\text{—}$)
(ii) Carboxylic acid (—COOH)

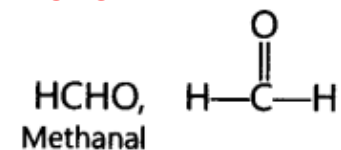
Question. Write the name and formula of the second member of the carbon compounds having functional group —OH .

Answer.



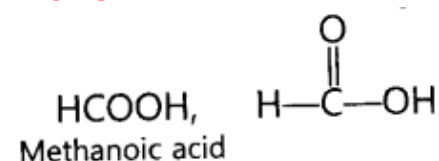
Question. Write the name and formula of the first member of the carbon compounds having functional group —CHO .

Answer.



Question. Write the name and formula of the first member of the carbon compounds having functional group —COOH .

Answer.



Question. Write the name and formula of the 2nd member of the series of carbon compounds whose general formula is $\text{C}_n\text{H}_{2n+1}\text{OH}$

Answer. Ethanol, $\text{C}_2\text{H}_5\text{OH}$ or $\text{CH}_3\text{CH}_2\text{OH}$

Question. Write the name and formula of the 2nd member of the series of carbon compounds whose general formula is C_nH_{2n} .

Answer.

C_3H_6 , $\text{H}_2\text{C=CH—CH}_3$
Propene is second member of series whose general formula is C_nH_{2n} .

Short Answer Type Questions [2 Marks]

Question.

- (a) Give a chemical test to distinguish between saturated and unsaturated hydrocarbons.
(b) (i) Name the products formed when ethanol burns in air. '
(ii) What two forms of energy are liberated on burning alcohol?
(c) Why is the reaction between methane and chlorine considered a substitution reaction?

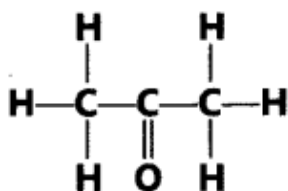


Answer.

- (a) Add bromine water. Saturated hydrocarbons do not react whereas unsaturated hydrocarbon will decolourise bromine water.
- (b) (i) CO_2 and H_2O are formed.
 $\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l}) + \text{Heat} + \text{Light}$
- (ii) Heat energy and light energy
- (c) It is because 'Cl' atom substitutes 'H' atom of methane to form chloromethane and hydrogen chloride.
- $$\begin{array}{ccccccc} \text{CH}_4(\text{g}) & + & \text{Cl}_2(\text{g}) & \xrightarrow{\text{Sunlight}} & \text{CH}_3\text{Cl}(\text{g}) & + & \text{HCl}(\text{g}) \\ \text{Methane} & & \text{Chlorine} & & \text{Chloromethane} & & \end{array}$$

Question.

- (a) Why are covalent compounds generally poor conductors of electricity?
- (b) Name the following compound:



- (c) Name the gas evolved when ethanoic acid is added to sodium carbonate. How would you prove the presence of this gas?

Answer.

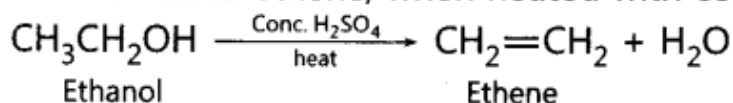
- (a) It is because they do not form ions.
- (b) Propanone
- (c) Carbon dioxide gas. It turns lime water milky.
- $$\begin{array}{l} 2\text{CH}_3\text{COOH}(\text{l}) + \text{Na}_2\text{CO}_3(\text{aq}) \longrightarrow 2\text{CH}_3\text{COONa}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g}) \\ \text{Ca}(\text{OH})_2(\text{aq}) + \text{CO}_2(\text{g}) \longrightarrow \text{CaCO}_3(\text{s}) + \text{H}_2\text{O}(\text{l}) \\ \text{Calcium} \quad \quad \text{Carbon} \quad \quad \text{Calcium} \\ \text{hydroxide} \quad \quad \text{dioxide} \quad \quad \text{carbonate} \end{array}$$

Question. Write the name and molecular formula of an organic compound having its name suffixed with '-ol' and having two carbon atoms in the molecule. With the help of a balanced chemical equation indicate what happens when it is heated with excess of conc. H_2SO_4 .

Answer.

It is ethanol, its molecular formula is $\text{C}_2\text{H}_6\text{O}$.

Ethanol forms ethene, when heated with conc. H_2SO_4 .



Question. Write the names and molecular formula of two organic compounds having functional group suffixed as '-oic acid'. With the help of a balanced chemical equation and explain what happens when any one of them reacts with sodium hydroxide.

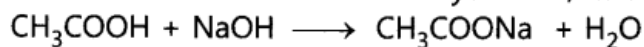
Answer.



Methanoic acid, its molecular formula is CH_2O_2 .

Ethanoic acid, its molecular formula is $\text{C}_2\text{H}_4\text{O}_2$.

When acid reacts with sodium hydroxide, its sodium salt and water is formed.



Ethanoic acid

Sodium ethanoate Water

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

CH_3 , C_2H_6 , $\text{C}_2\text{H}_6\text{O}$, $\text{C}_2\text{H}_6\text{O}_2$, CH_4O

Answer.

Homologous series is a series of organic compounds which have same functional group and similar chemical properties. Each member of this series differs by $-\text{CH}_2-$ in its molecular formula and 14 u in its molecular mass.

$\text{C}_2\text{H}_6\text{O}$ ($\text{C}_2\text{H}_5\text{OH}$) and CH_4O (CH_3OH) belong to same homologous series.

Short Answer Type Questions [3 Marks]

Question. What is meant by a functional group in an organic compound? Name the functional group present in

(i) $\text{CH}_3\text{CH}_2\text{OH}$

(ii) CH_3COOH

(b) State one point of difference between soap and synthetic detergent.

Answer.

(a) Functional group is an atom or group of atoms or reactive part of compound, which determines chemical properties of compounds.

(i) $-\text{OH}$ (Alcohol)

(ii) $-\text{COOH}$ (Carboxylic acid)

(b) Soaps do not work well with hard water, detergents work well with hard water.

Question. Give reasons for the following observations:

(a) The element carbon forms a very large number of compounds.

(b) Air holes of a gas burner have to be adjusted when the heated vessels get blackened by the flame.

(c) Use of synthetic detergents causes pollution of water.

Answer.

(a) Carbon forms large number of compounds since carbon is small in size and can form stable covalent bonds (catenation) and it shows tetravalency.

(b) Air holes of gas burner are made open (adjusted) so that air can pass through, which is needed for complete combustion, so that heated vessels do not get blackened.

(c) Some synthetic detergents are non-biodegradable, therefore, cause pollution of water.

Question. What is ethanoic acid? Write the formula of the functional group present in this acid.

What special name is given to its 5 – 8% solution in water? How does ethanoic acid react with sodium carbonate? Write a chemical equation of the reaction and common name of the salt produced.

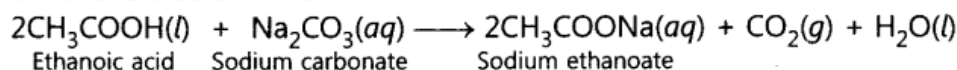
Answer.



CH_3COOH is ethanoic acid. $-\text{COOH}$ is the formula of the functional group present in ethanoic acid.

Its 5 to 8% solution in water is called vinegar.

Sodium ethanoate and brisk effervescence due to carbon dioxide gas are formed on reaction of ethanoic acid with sodium carbonate.

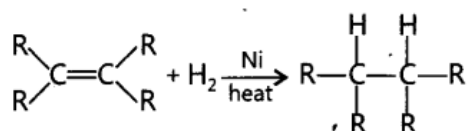


The salt produced has common name sodium acetate.

Question. Name the functional group of organic compounds that can be hydrogenated. With the help of suitable example explain the process of hydrogenation mentioning the conditions of the reaction and any one change in physical property with the formation of the product. Name any one natural source of organic compounds that are hydrogenated.

Answer.

Double bond $=$, Triple bond $\equiv$ are functional groups (reactive part of compounds) which can be hydrogenated.

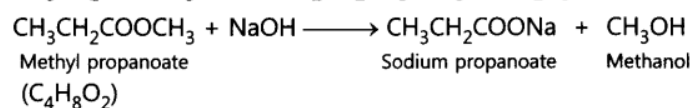


When unsaturated hydrocarbons are heated with hydrogen in the presence of nickel as catalyst, saturated hydrocarbons are formed. If the starting unsaturated hydrocarbons are liquids, they will change into solids. Vegetable oils are hydrogenated to form vegetable ghee. Plants are natural sources of vegetable oils which can be hydrogenated.

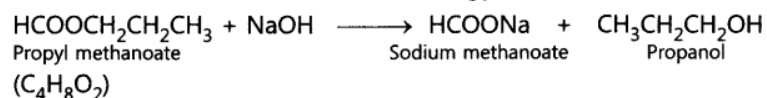
Question. An ester has the molecular formula $\text{C}_4\text{H}_8\text{O}_2$. Write its structural formula. What happens when this ester is heated in the presence of sodium hydroxide solution? Write the balanced chemical equation for the reaction and name the products. What is a saponification reaction?

Answer.

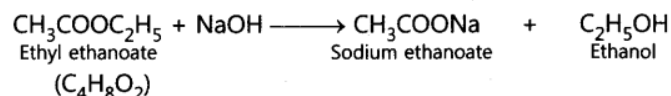
There are three possible structural formulae of ester with molecular formula $\text{C}_4\text{H}_8\text{O}_2$.



Or



Or



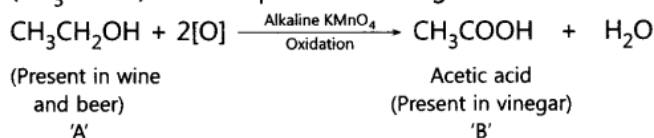
Saponification is the process in which an ester is treated with sodium hydroxide to form sodium salt of acid and alcohol is formed.

Question. An organic compound 'A' is an essential constituent of wine and beer. Oxidation of 'A' yields an organic acid 'B' which is present in vinegar. Name the compounds 'A' and 'B' and write their structural formula. What happens when 'A' and 'B' react in the presence of an acid catalyst? Write the chemical equation for the reaction.

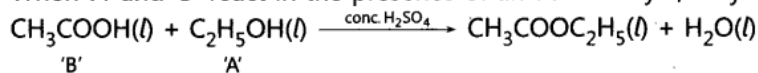
Answer.



'A' is ethanol (C₂H₅OH) which is essential constituent of wine and beer and 'B' is acetic acid (CH₃COOH) which is present in vinegar.



When 'A' and 'B' react in the presence of an acid catalyst, ethyl ethanoate is formed.



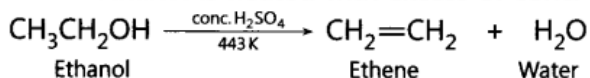
Question. What is ethanol? State its two properties. What happens when it is heated with excess of conc. H₂SO₄ at 443 K? What role does conc. H₂SO₄ play in this reaction? Write chemical equation of the reaction involved and the structural formula of the main product formed.

Answer.

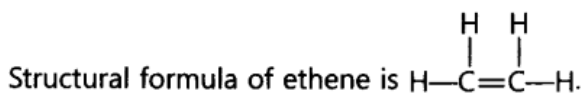
Ethanol is C₂H₅OH.

- (i) It has specific smell.
- (ii) It is soluble in water.

When ethanol is heated with excess of conc. H₂SO₄, ethene is formed along with water.



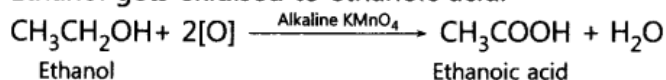
Conc. H₂SO₄ acts as dehydrating agent.



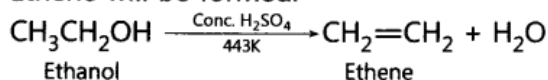
Question. With the help of balanced chemical equations explain what happens when ethanol is heated with (i) alkaline solution of potassium permanganate, (ii) excess concentrated sulphuric acid at 443 K. Mention any two uses of ethanol.

Answer.

- (i) Ethanol gets oxidised to ethanoic acid.



- (ii) Ethene will be formed.



Uses:

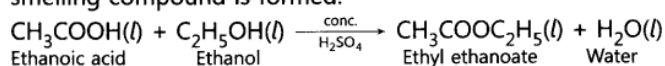
- (i) It is used in tonics and cough syrups.
 - (ii) It is used as fuel.
 - (iii) It is used as solvent.
 - (iv) It is used in wine, beer and whisky.
- (any two)

Question. What is an 'esterification' reaction? Describe an activity to show esterification.

Answer.

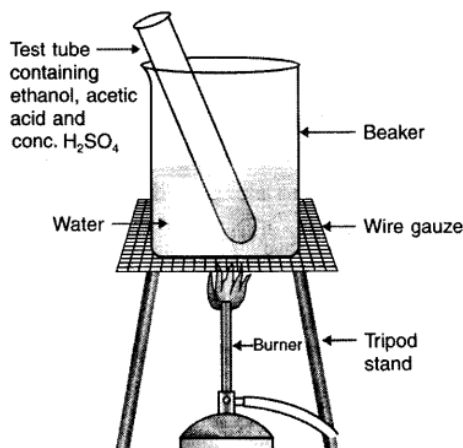


When carboxylic acid reacts with alcohol in the presence of conc. H_2SO_4 , pleasant fruity smelling compound is formed.



Activity:

- Take 1 ml of ethanol in a test tube. Add 1 ml of acetic acid in this test tube.
- Add few drops of conc. H_2SO_4 in the mixture.
- Heat the content on water bath for 5 minutes.
- Smell the resulting mixture formed.



Result: Pleasant fruity smelling ester is formed.

Question. Out of HCl and CH_3COOH , which one is a weak acid and why? Describe an activity to support your answer.

Answer. Acetic acid (CH_3COOH) is a weaker acid because it does not dissociate completely into its ions in aqueous solution. .

Activity: Add zinc metal in HCl and CH_3COOH respectively. The hydrogen gas will be evolved faster in HCl and slowly in CH_3COOH . It shows acetic acid is a weak acid.

Alternative Method:

If we use pH paper, the colour of pH paper will be dark red in HCl and light red in CH_3COOH which shows HCl is a strong acid and CH_3COOH is a weak acid.

Question. Write chemical equations for what happens when

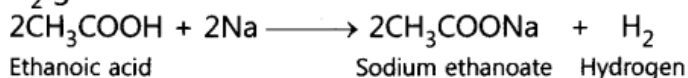
(i) sodium metal is added to ethanoic acid.

(ii) solid sodium carbonate is added to ethanoic acid.

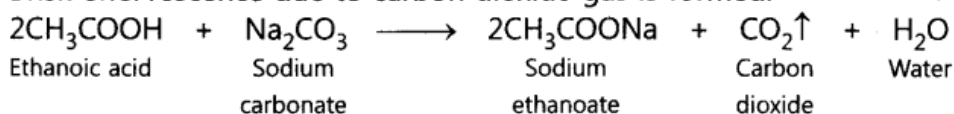
(iii) ethanoic acid reacts with a dilute solution of sodium hydroxide.

Answer.

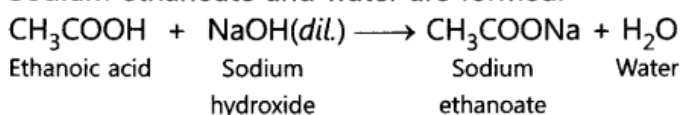
(i) H_2 gas is evolved.



(ii) Brisk effervescence due to carbon dioxide gas is formed.



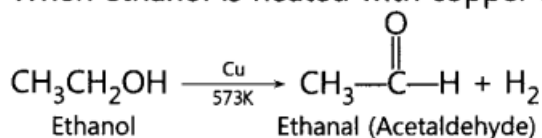
(iii) Sodium ethanoate and water are formed.



Question. Describe two examples of different oxidations of ethanol. Name the products obtained in each case.

Answer.

(i) When ethanol is heated with copper at 573 K, ethanal is formed.



(ii) When ethanol is oxidised with alkaline potassium permanganate solution, ethanoic acid is formed.



Question. Write a chemical equation in each case to represent the following types of chemical reactions of organic compounds:

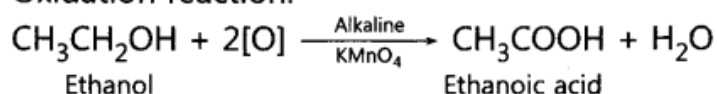
(i) Oxidation reactions

(ii) Addition reactions

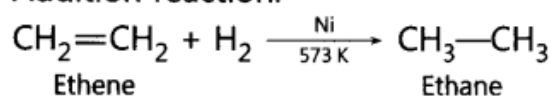
(iii) Substitution reactions

Answer.

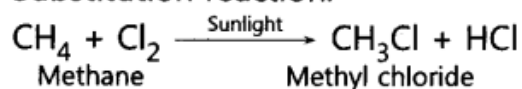
(i) Oxidation reaction:



(ii) Addition reaction:

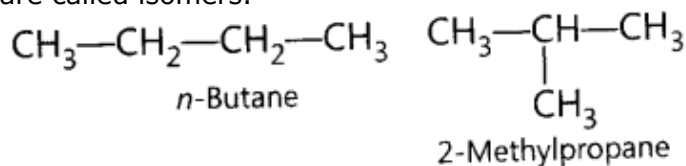


(iii) Substitution reaction:



Question. What are isomers? Draw the structures of two isomers of butane, C₄H₁₀. Why can't we have isomers of first three members of alkane series?

Answer. Those compounds, which have same molecular formula but different structural formulae are called isomers.



In first three members of alkane series, branching is not possible. Therefore, we cannot have isomers.

Question. Define homologous series of organic compounds. List its two characteristics. Write the name and formula of the first member of the series of alkenes.

Answer. The series of organic compounds having same functional group and similar chemical properties is called homologous series.

Each member differs from successive member by —CH₂— group. The difference in molecular weight between two successive members is 14 u.

Characteristics:

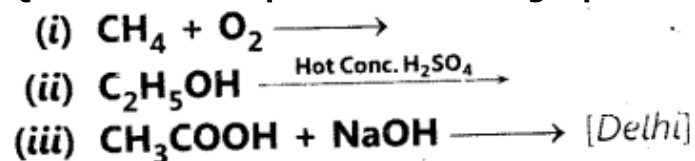
(i) It has same general formula, from which, all members can be derived.

(ii) They have similar chemical properties.

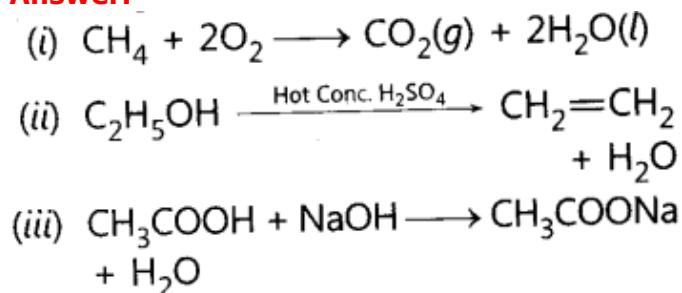
C₂H₄, CH₂=CH₂, Ethene is first member of alkene series.



Question.50 Complete the following equations:



Answer.



Question. Why homologous series of carbon compounds are so called? Write chemical formula of two consecutive members of a homologous series and state the part of these compounds that determines their

(i) physical properties, and (ii) chemical properties.

Answer. The series consists of members of same family with similar physical and chemical properties, therefore, called homologous series

(i) CH_3OH , and (ii) $\text{CH}_3\text{CH}_2\text{OH}$ are two consecutive members of homologous series.

Alkyl group $-\text{CH}_3$ and $-\text{CH}_3\text{CH}_2$ part determines physical properties. Functional group $-\text{OH}$ determines chemical properties of the compounds.

Question. Name the oxidising agent used for the conversion of ethanol to ethanoic acid. Distinguish between ethanol and ethanoic acid on the basis of (i) litmus test, (ii) reaction with sodium hydrogencarbonate.

Answer. Alkaline potassium permanganate or Acidified potassium dichromate.

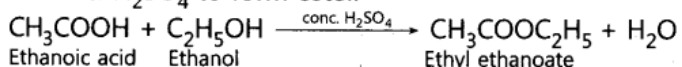
(i) Ethanol will not affect litmus paper. Ethanoic acid will turn blue litmus ` paper red.

(ii) Ethanol will not react with sodium hydrogen carbonate. Ethanoic acid will give brisk effervescence due to colourless, odourless carbon dioxide gas.

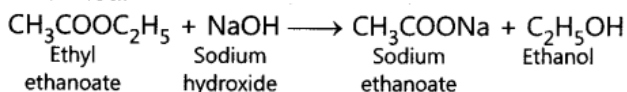
Question. Distinguish between esterification and saponification reactions of organic compounds with the help of the chemical equation for each. What is the use of (i) esters and (ii) saponification process?

Answer.

Esterification: It is a process in which alcohol and carboxylic acid combine in the presence of conc. H_2SO_4 to form ester.



Saponification: When an ester reacts with sodium hydroxide, sodium salt of acid and alcohol is formed.



Uses:

- (i) Esters are used in cold drinks, ice creams, perfumes and as artificial flavouring agents.
- (ii) Saponification process is used in the manufacture of soaps.



Long Answer Type Questions [5 Marks]

Question. (a) In tabular form, differentiate between ethanol and ethanoic acid under the following heads:

(i) Physical state (ii) Taste

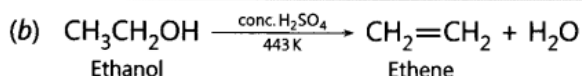
(iii) NaHCO₃ test (iv) Ester test

(b) Write a chemical reaction to show the dehydration of ethanol.

Answer.

(a)

Properties	Ethanol	Ethanoic acid
(i) Physical state	It is liquid with specific smell.	It is also liquid with vinegar like smell.
(ii) Taste	It has burning taste.	It has sour taste.
(iii) NaHCO ₃ test	It does not react.	It gives brisk effervescence due to CO ₂ .
(iv) Ester test	Add acetic acid and conc. H ₂ SO ₄ , pleasant fruity smelling compound, ester is formed.	Add ethyl alcohol and conc. H ₂ SO ₄ , pleasant fruity smelling compound, ester is formed.



Question. (a) State two properties of carbon which lead to a very large number of carbon compounds.

(b) Why does micelle formation take place when soap is added to water? Why are micelles not formed when soap is added to ethanol?

Answer.

(a) (i)-Catenation (ii) Tetravalency

(b) It is because large number of molecular ions of soaps get aggregated and form colloidal solution. Soap has hydrophobic tail (hydrocarbon) which dissolves in hydrocarbon part and hydrophilic part dissolves in water. Ethanol is non-polar solvent therefore micelles are not formed because hydrocarbon part gets attracted towards ethanol and ionic end will not dissolve in alcohol.

Question. Explain isomerism. State any four characteristics of isomers. Draw the structures of possible isomers of butane, C₄H₁₀

Answer. Isomerism is a phenomenon due to which some compounds have same molecular formula but different structural formulae.

Characteristics:

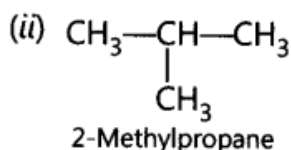
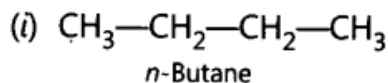
(i) They differ in structural formula.

(ii) They differ in melting point.

(iii) They differ in boiling point.

(iv) They differ in solubility in same solvent.

There are two isomers of butane, C₄H₁₀.



Question. Give reasons for the following:

(i) Element carbon forms compounds mainly by covalent bonding.

(ii) Diamond has a high melting point.



(iii) Graphite is a good conductor of electricity.

(iv) Acetylene burns with a sooty flame.

(v) Kerosene does not decolourise bromine water while cooking oils do.

Answer.

(i) It is because carbon has four valence electrons, it cannot gain or lose four electrons because high energy is needed. It can only share four electrons.

(ii) It is due to strong covalent bonds and compact structure of diamond.

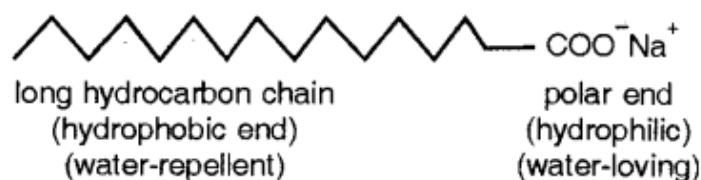
(iii) It is due to presence of free electrons in graphite because each carbon is linked to three more carbon atoms.

(iv) It is due to high percentage of carbon, it burns with sooty or smoky flame.

(v) Kerosene oil is mixture of saturated hydrocarbons therefore does not decolourise bromine water.

Question. 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?

Answer. Soaps are sodium or potassium salts of fatty acids having —COONa group. Detergents are sodium or potassium salts of sulphonic acids having $\text{—SO}_3\text{Na}$ and $\text{—SO}_4\text{Na}$ group. Cleansing action of soap: Soap molecules consist of a large hydrocarbon tail which is hydrophobic (water-hating or water repelling) with a negatively charged head which is hydrophilic (water-loving) as shown in figure.



When a soap is dissolved in water, the molecules associate together as clusters called micelles in which water molecules, being polar in nature, surround the ions and the hydrocarbon part of the molecule attracts grease, oil and dirt.

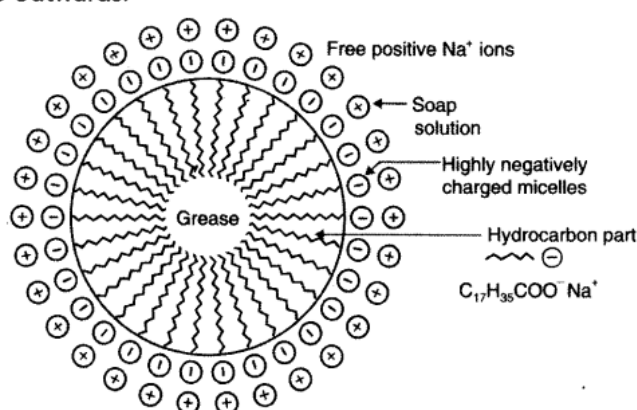
The tails stick inwards and the heads outwards.

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 soap molecules.

The negatively charged heads present in water prevent the small globules from coming together and form aggregates. Thus, the oily dirt is removed.

Hard water has Ca^{2+} and Mg^{2+} ions. When it reacts with soap, it forms insoluble compound and the soap goes waste.



Question. List in tabular form three physical and two chemical properties on the basis of which ethanol and ethanoic acid can be differentiated

Answer.

Physical properties:

Ethanol	Ethanoic acid
1. It has specific smell.	1. It has vinegar like smell.
2. It has burning taste.	2. It is sour in taste.
3. It does not freeze in winters.	3. It freezes in winters.

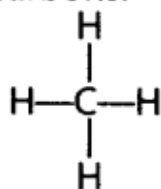
Chemical properties:

Ethanol	Ethanoic acid
1. It does not react with NaHCO_3 .	1. It gives CO_2 with NaHCO_3 .
2. It burns with blue flame.	2. It does not burn with blue flame.
3. It does not affect blue litmus.	3. It turns blue litmus red.

Question. What are the hydrocarbons write the name and general formula of (i) saturated hydrocarbons, (ii) unsaturated hydrocarbons, and draw the structure of one hydrocarbon of each type. How can an unsaturated hydrocarbon be made saturated?

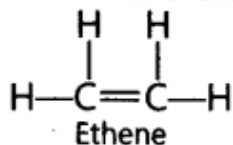
Answer.

(i) Alkanes, $\text{C}_n\text{H}_{2n+2}$ are saturated hydrocarbons.

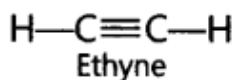


Methane
(Saturated hydrocarbon)

(ii) Alkenes, C_nH_{2n} and Alkynes, $\text{C}_n\text{H}_{2n-2}$ are unsaturated hydrocarbons.

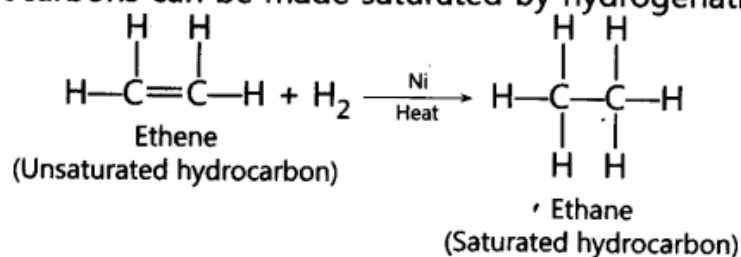


(Unsaturated hydrocarbon)



(Unsaturated hydrocarbon)

Unsaturated hydrocarbons can be made saturated by hydrogenation.



Question. 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.

Answer. Detergents chemically are sodium or potassium salts of sulphonic acid of benzene or alkene.

Merits:

- (i) They work well with hard water.
- (ii) They are more effective than soaps.

Demerits:

- (i) They are expensive.
- (ii) Some of them having branching are non-biodegradable, therefore create water pollution.

Detergents are suitable for hard water having Mg^{2+} and Ca^{2+} ions because they do not form insoluble salts with Mg^{2+} and Ca^{2+} ions.

