4 Carbon and its Compounds

Carbon is an extremely common element and can be found in many forms, in both living and non-living things. Today's printer ink is made of carbon black, a pigment that is used to color a surface to produce an image, text, or design.

Topic Notes

- *Covalent Bonding in Carbon*
- *Versatile Nature of Carbon*
- *Hydrocarbons*
- *Functional Groups*
- *Homologous Series*
- *Chemical Properties of Carbon Compounds*
- *Some Important Carbon Compounds*
- *Soaps and Detergents*

TOPIC 1

COVALENT BONDING IN CARBON

The amount of carbon present in the earth's crust and in the atmosphere is very less. The earth's crust has only 0.02% carbon in the form of minerals (like carbonates, hydrogencarbonates,coal and petroleum) and the atmosphere has 0.03% of carbondioxide. Yet, we find that a large number of things that we use in our daily life are made of carbon compounds. Food, clothes, medicines, books and many other things are some examples.

The presence of carbon in a material can be tested by burning the substance in air and passing the gas formed through lime water. If the lime water turns milky, then the given material contains carbon.

Most carbon compounds are poor conductors of electricity and have low boiling and melting points, from which it can be concluded that the forces of attraction between these 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.

In the case of carbon, it has four electrons in its outermost shell and in order to attain noble gas configuration, it needs to either gain four electrons or lose four electrons.

(1) It could gain four electrons forming C^{4-} anion. But as the nucleus contains only six protons, it would be difficult for the nucleus to hold on to ten electrons.

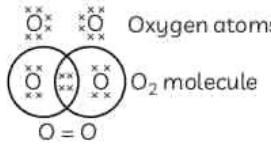
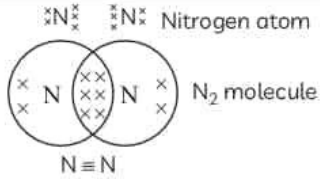
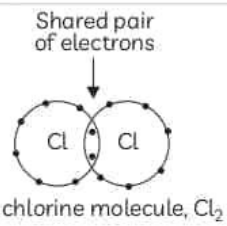
(2) It could lose four electrons forming C^{4+} cation. But a large amount of energy would be required to remove four electrons leaving behind a carbon cation with six protons in its nucleus holding on to just two electrons.

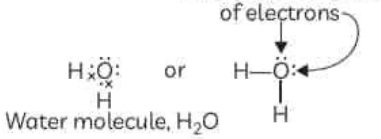
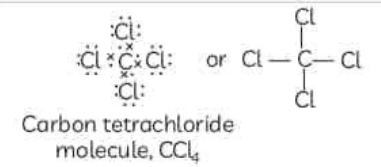
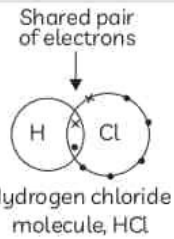
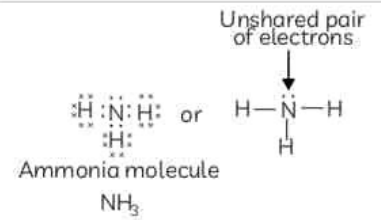
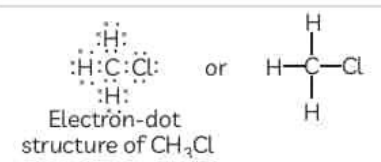
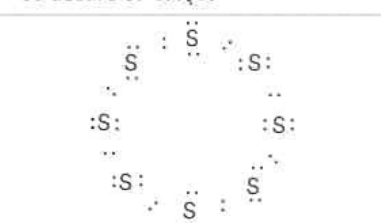
Carbon overcomes this problem by sharing its valence electrons with other atoms of carbon or with atoms of other elements. Apart from carbon, there are many other elements also which form molecules by sharing electrons in this manner. The shared electrons 'belong' to the outer shells of both the atoms and lead to both atoms attaining the noble gas configuration.

Covalent Bond: The types of bonds which are formed by the sharing of an electron pair between two atoms are known as covalent bonds.

Depending upon the number of pairs of electrons shared between atoms, there can be single, double or triple covalent bonds.

Some Examples of Covalent Compounds

Compound	Description	Covalent Bonding
Hydrogen (H_2)	Hydrogen has one electron in its K shell and it requires one more electron to fill the K shell. So two hydrogen atoms share their electrons to form a molecule of hydrogen, H_2.	
Oxygen (O_2)	A double bond is formed between two oxygen atoms. Each atom of oxygen shares two electrons with another atom of oxygen. The two electrons contributed by each oxygen atom give rise to two shared pairs of electrons. This is said to constitute a double bond between the two atoms.	
Nitrogen (N_2)	In order to attain an octet, each nitrogen atom in a molecule of nitrogen contributes three electrons giving rise to three shared pairs of electrons. This is said to constitute a triple bond between the two atoms.	
Chlorine (Cl_2)	Two chlorine atoms share one electron each to form a chlorine molecule thus attaining the nearest inert gas configuration of Argon (2, 8, 8).	

(H_2O)	two hydrogen atoms.	
Carbon Tetrachloride (CCl_4)	The carbon atom shares its four valence electrons with four chlorine atoms to form carbon tetrachloride molecule.	
Hydrogen Chloride (HCl)	Hydrogen and chlorine atom share one electron each to form a hydrogen chloride molecule.	
Ammonia (NH_3)	One atom of nitrogen shares its three valence electrons with three hydrogen atoms and forms ammonia molecule.	
Methyl chloride (CH_3Cl)	Carbon shares its 4 valence electrons with three hydrogen atoms and one chlorine atom	
Sulphur molecule (S_8)	A sulphur atom has 6 valence electrons. Eight sulphur atoms combine by sharing two electrons among themselves to form a ring like structure.	

Example 1. **Draw the electron dot structures for**

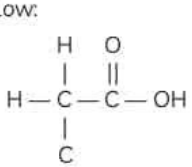
(A) Ethanoic acid. **(B) H_2S**

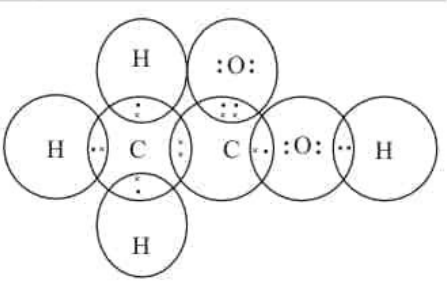
(C) Propanone. **(D) F_2** **[NCERT]**

Ans. **(A) Ethanoic acid (CH_3COOH):**

Number of valence electrons of carbon = 4, hydrogen = 1, oxygen = 6

Structural formula and electron dot structure is given below:

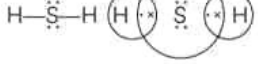




(B) Hydrogen sulphide (H_2S):

Number of valence electrons of sulphur = 6, hydrogen = 1

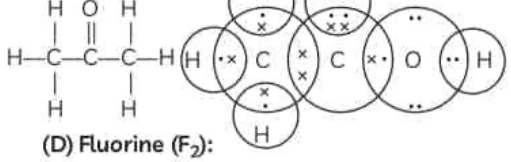
Structural formula and electron dot structure is given:



(C) Propanone (CH_3COCH_3):

Number of valence electrons of carbon = 4, hydrogen = 1, oxygen = 6

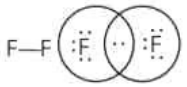
Structural formula and electron dot structure is given as:



(D) Fluorine (F_2):

Number of valence electrons of fluorine = 7

Structural formula and electron dot structure is given below:



Properties of Covalent Compounds

S.No.	Property	Description
(1)	Covalent compounds are usually liquids or gases	This is due to the weak forces of attraction between their molecules.
(2)	Covalent compounds have usually low melting and boiling points	Covalently bonded molecules are seen to have strong bonds within the molecule, but intermolecular forces are small
(3)	Usually insoluble in water but soluble in organic solvents	This is also due to the presence of strong bonds within the molecule and small intermolecular forces
(4)	Covalent compounds do not conduct electricity	Since the electrons are shared between atoms and no charged particles are formed, such covalent compounds are generally poor conductors of electricity.

Differences between Ionic Bond and Covalent Bond

S.No.	Ionic Bond	Covalent Bond
(1)	An ionic bond is a chemical bond between two dissimilar (i.e. a metal and a non-metal) atoms in which one atom gives up an electron to another.	In a covalent bond the two atoms come together to share the electron, instead of an atom taking an electron from another
(2)	An ionic bond is formed between a metal and a non-metal.	A covalent bond is formed between two non-metals that have similar electronegativities.
(3)	Molecules have no definite shapes, as they have lattice structures	Molecules have a definite shape.
(4)	Electrical and thermal conductivity is High	No electrical conductivity but Thermal conductivity is usually low
(5)	Usually High melting point	Lower melting point
(6)	Usually highly soluble in water	lower solubility
(7)	Usually solids at room temperature	Exists as solids, liquids, gases

Allotropes of Carbon

The various physical forms in which an element can exist are called allotropes of the element. Carbon exists in three solid forms called allotropes. The three allotropes of carbon are:

(1) Diamond

(2) Graphite

(3) Fullerenes

Diamond

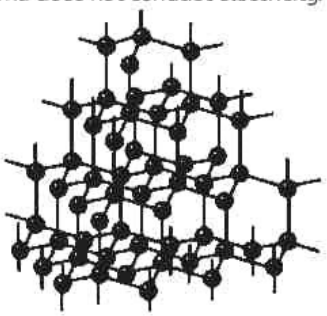
(1) Diamonds are colourless, transparent, sparkle and reflect light, which is why they are described as lustrous.

(2) It is extremely hard and has a high melting point.

(3) It does not conduct electricity.

Structure of diamond: Diamond is one giant molecule of carbon atoms. Every atom in a diamond is bonded to its neighbours by four strong covalent bonds,

why diamond does not conduct electricity.



The Structure of Diamond

Uses of diamond:

(1) Diamond is used in cutting instruments like glass cutters and in rock drilling equipment, as it is extremely hard.

(2) Diamonds are used for making jewellery.

(3) Sharp-edged diamonds are used by eye-surgeons as a tool to remove cataract.

Graphite

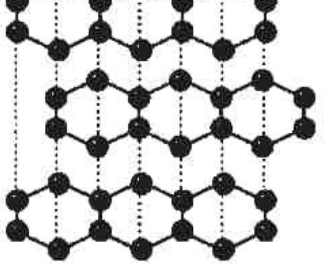
(1) Graphite is black, shiny and opaque.

(2) It is a very slippery material.

(3) Graphite is insoluble in water.

(4) It has a high melting point and is a good conductor of electricity, which makes it a suitable material for the electrodes needed in electrolysis.

Structure of graphite : Graphite contains layers of carbon atoms.In graphite, each carbon atom is bonded to three other carbon atoms in the same plane giving a hexagonal array. One of these 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 the other.



The Structure of Graphite

Uses of graphite:

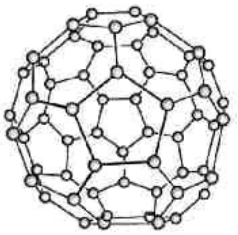
(1) Powdered graphite is used as a lubricant for the fast moving parts of machinery.

(2) It is used for making electrodes in dry cells and electric arcs as it is a very good conductor of electricity.

(3) It is used for making core of pencils called 'pencil leads'.

Fullerenes

Fullerenes form 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 the US architect Buckminster Fuller, the molecule was named fullerene.



Structure of C-60 Bacminster Fullenene

TOPIC 2

VERSATILE NATURE OF CARBON

It is estimated that there are about three million carbon compounds whose formulae are known to chemists which is much greater than the compounds formed by all the other elements put together.

The factors due to which this is possible in the case of carbon are:

Catenation

The property of carbon element due to which its atoms can join or link with one another to form long carbon chains is called catenation. These compounds may have long chains of carbon, branched chains of carbon or even carbon atoms arranged in rings. In addition, carbon atoms may be linked by single, double or triple bonds.

Tetravalency

The atomic number of carbon is 6 and its electronic configuration is 2,4. has a valency of 4, it can bond with four other atoms of carbon or atoms of other monovalent element. Carbon forms compounds with oxygen, hydrogen, nitrogen, sulphur, chlorine and many other elements and these compounds have specific properties which depend on the elements other than carbon present in the molecule.

The bonds that carbon forms with most other elements are very strong due to its small size making hold on to the shared pairs of electrons strongly. The bonds formed by elements having larger atoms are much weaker.

TOPIC 3

HYDROCARBONS

The compounds made up of hydrogen and carbon only are called hydrocarbons. These are the simplest organic compounds and all other compounds are considered to be derived from them by the replacement of one or more hydrogen atoms by other atoms or groups of atoms.

The most important natural source of hydrocarbons is petroleum. There are two types of hydrocarbons:

(1) Saturated hydrocarbons

(2) Unsaturated hydrocarbons

Saturated Hydrocarbons or Alkanes

(1) The hydrocarbons in which the carbon atoms are connected by only single bonds are called saturated hydrocarbons or alkanes.

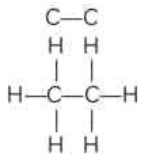
(2) The general formula of saturated hydrocarbons are alkanes is C_nH_{2n+2}, where n is the number of carbon atoms in one molecule. The first few alkanes are methane (CH_4), ethane (C_2H_6) and propane (C_3H_8).

(3) The saturated hydrocarbons are not very reactive.

(4) The saturated hydrocarbons generally give a clean flame. This is because the percentage of carbon is comparatively low which gets oxidized completely on combustion.

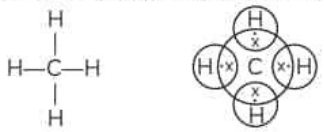
Structure of Saturated Hydrocarbons

The first step is to link the carbon atoms together with a single bond and then use the hydrogen atoms to satisfy the remaining valencies of carbon as shown in fig below.

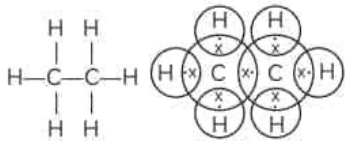


Methane: The simplest alkane is methane (CH_4). Hydrogen has a valency of 1. As carbon has four valence electrons, carbon shares these electrons with four atoms of hydrogen in order to achieve noble gas configuration.

It is widely used as a fuel and is a major component of bio-gas and Compressed Natural Gas (CNG).



Ethane: Ethane is an alkane having two carbon atoms. The molecular formula of ethane is C_2H_6. There are seven single covalent bonds present in one molecule of ethane – one covalent bond between the two carbon atoms and six single bonds between carbon and hydrogen atoms.



Unsaturated Hydrocarbons (Alkenes and Alkynes)

(1) The hydrocarbons in which the two carbon atoms are connected by a double bond or a triple bond are called unsaturated hydrocarbons.

(2) Unsaturated hydrocarbons may be alkenes (C_nH_2n) or alkynes (C_nH_{2n-2}).

(3) The general formula of an alkene is CnH_2n, where n is the number of carbon atoms in one molecule.

(5) The general formula of an alkyne is C_nH_{2n-2}, where n is the number of carbon atoms in one molecule.

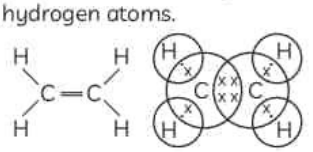
(6) These are more reactive than saturated hydrocarbons due to presence of double and triple bonds which are the sites of chemical reactivity.

(7) These give a yellow flame with lots of black smoke. This is because the percentage of carbon is comparatively higher than saturated hydrocarbons which does not oxidize completely on combustion.

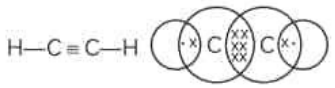
Structure of Unsaturated Hydrocarbons

In the first step, two carbon atoms link together by single bond. Each carbon atom combines with two hydrogen atoms. One valency per carbon atom remains unsatisfied which can be satisfied only if there is a double bond between the two carbon atoms.

Ethene : The simplest alkene: Ethene is the simplest alkene having two carbon atoms and its molecular formula is C_2H_4. There is a double bond between the two carbon atoms and four single bonds between carbon and hydrogen atoms.



ethyne having two carbon atoms and its molecular formula is C_2H_2. There is a triple bond between the two carbon atoms and two single bonds between carbon and hydrogen atoms.



Chains, Branches and Rings

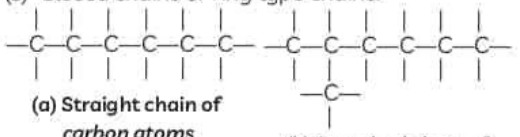
Carbon atoms can form long 'chains' containing tens of carbon atoms.

When carbon atoms combine, three types of chains can be formed:

(1) Straight chains

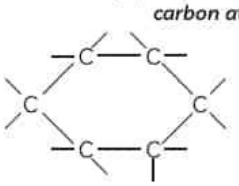
(2) Branched chains

(3) Closed chains or ring type chains.



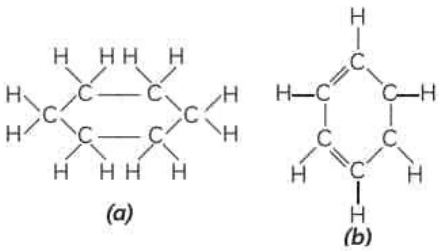
(a) Straight chain of carbon atoms

(b) Branched chain of carbon atoms



(c) Closed chain of carbon atoms

Some compounds have carbon atoms arrangedin the form of a ring as in the case of cyclohexane (C_6H_{12}). Its structure is shown below. Similarly, the structure of benzene (C_6H_6) is also shown alongside:



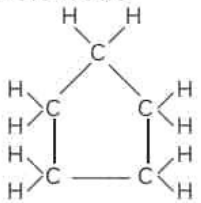
(a) ***(b)***

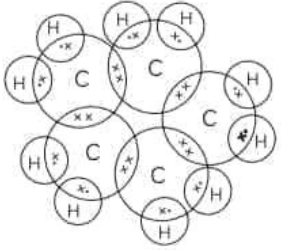
Benzen —C_6H_6

Example 2. What will be the formula and electron dot structure of cyclopentane? [NCERT]

Ans. The formula of cyclopentane is C_5H_{10} and its electron dot structure is given below:

Structural formula:

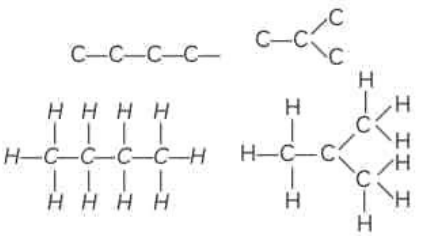




Structural Isomerism

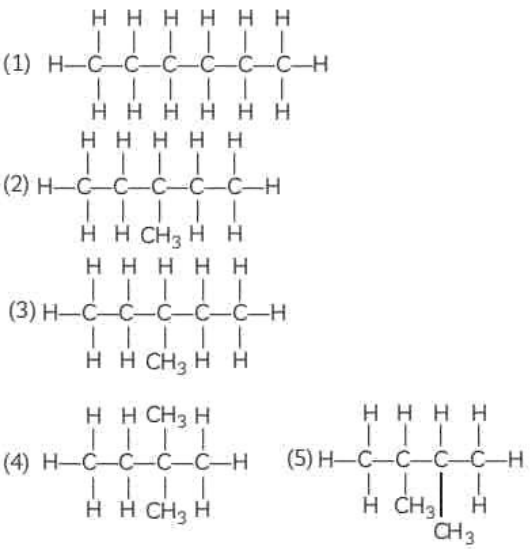
Organic compounds having the same molecular formula but different physical and chemical properties due to different structures are called structural isomers and this property is called isomerism. Isomerism is possible only with hydrocarbons having 4 or more carbon atoms.

If we look at the structure of butane (C_4H_{10}), we find that two different 'skeletons' are possible with four carbon atoms having single covalent bond:



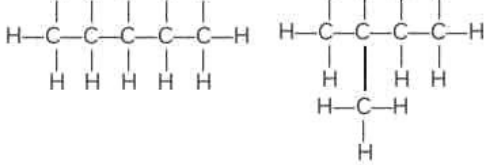
We find that both these compounds have the same molecular formula C_4H_{10} but different structures and hence they called Give isomers.

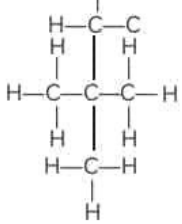
Isomers of hexane:



Example 3. How many structural isomers can you draw for pentane? [NCERT]

Ans. The molecular formula for pentane is C_5H_{12}. There are three structural isomers of pentane as given below:





TOPIC 4

FUNCTIONAL GROUPS

A functional group in an organic compound is an atom or a group of atoms bonded together in a unique fashion, which is usually the site of chemical reactivity in an organic molecule.

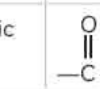
If in a hydrocarbon chain, one or more hydrogen atoms are replaced by atoms of other elements such as halogens, oxygen, nitrogen, sulphuretc, such that the valency of carbon remains satisfied, then the element replacing hydrogen is referred to as a heteroatom.

These heteroatoms confer specific properties to the compound, regardless of the length and nature of the carbon chain and hence are called functional groups.

Important Functional Groups

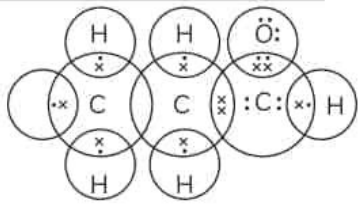
Some important functional groups are given in the Table below.

Free valency or valencies of the group are shown by the single line. The functional group is attached to the carbon chain through this valency by replacing one hydrogen atom or atoms.

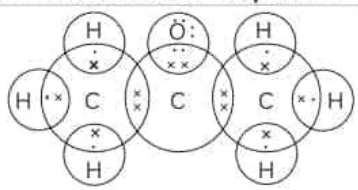
Hetero Atom	Functional Group	Formaula of Functinal group
Cl/Br	Halo-(Chloro/ bromo)	—Cl, —Br (substitutes for hydrogen atom
Oxygen	(1) Alcohol	—OH
	(2) Aldehyde	
	(3) Ketone	
	(4) Carboxylic acid	

The electron dot structure of two compounds propanal, an aldehyde having molecular formula C_2H_5CHO and propanone, a ketone, having molecular formula CH_3COCH_3 are shown below:

Electron Dot Structure of Propanal



Electron Dot Structure of Propanone



Some More Examples of Functional Groups

Formula of Functional Group	Name of Functional Group	Formula of Compound Containing Functional Group	IUPAC name of Compound
- OH	Alcoholic	CH_3OH	Methanol
(ROH)		C_2H_5OH	Ethanol
		C_3H_7OH	Propanol
		C_4H_9OH	Butanol
		$C_5H_{11}OH$	Pentanol

(HCHO or RCHO)		CH_3CHO	Ethanal
		CH_3CH_2CHO	Propanal
		$CH_3CH_2CH_2CHO$	Butanal
>C=O	Ketonic	CH_3COCH_3	Propanone
(RCOR')		$CH_3COCH_2CH_3$	Butanone
		$CH_3COCH_2CH_2CH_3$	2-pentanone
		$CH_3COCH_2CH_2CH_2CH_3$	2-hexanone
-COOH	Carboxylic acid	HCOOH	Methanoic acid
(HCOOH or		CH_3COOH	Ethanoic acid
RCOOH)		C_2H_5COOH	Propanoic acid
		C_3H_7COOH	Butanoic acid
-X	Halogen	CH_3Cl	Chloromethane
		CH_3Br	Bromomethane
		C_2H_5I	Iodoethane
		C_3H_7Br	Bromopropane
$-NH_2$	Amine	CH_3NH_2	Methanamine
		$C_2H_5NH_2$	Ethanamine
$-NO_2$	Nitro	CH_3NO_2	Nitromethane
		$C_2H_5NO_2$	Nitroethane
-COOR	Ester	$HCOOCH_3$	Methyl methanoate
		$HCOOC_2H_5$	Ethyl methanoate
		CH_3COOCH_3	Methyl ethanoate
		$CH_3COOC_2H_5$	Ethyl ethanoate

TOPIC 5

HOMOLOGOUS SERIES

A homologous series is a group of organic compounds having similar structures and similar chemical properties in which the successive compounds differ by CH_2 group.

Characteristics of Homologous Series

(1) All the members of a homologous series can be represented by the same general formula.

(2) Any two adjacent homologues differ by $-CH_2$ or 1 carbon atom and 2 hydrogen atoms in their molecular formula.

(3) The difference in the molecular masses of any two adjacent homologues is 14 u.

(4) All the compounds belonging to the same homologous series have similar chemical properties since these are determined solely by the functional group.

(5) The members of a homologous series show a gradual change in their physical properties with increase in molecular mass. This is because the melting and boiling points increase with increasing molecular mass.

Nomenclature of Carbon Compounds

The names of compounds in a homologous series are based on the name of the basic carbon chain modified by a "prefix" "phrase before" or "suffix" "phrase after" indicating the nature of the functional group.

Naming a carbon compound can be done by the following method :

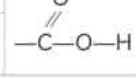
(1) Identify the number of carbon atoms in the compound. A compound having three carbon atoms would have the name propane.

(2) In case a functional group is present, it is indicated in the name of the compound with either a prefix or a suffix

(3) If the name of the functional group is to be given as a suffix, the name of the carbon chain is modified by deleting the final 'e' and adding the appropriate suffix. For example, a three-carbon

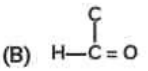
following manner – Propane – 'e' = propan + 'one' = propanone.

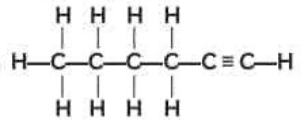
(4) If the carbon chain is unsaturated, then the final 'ane' in the name of the carbon chain is substituted by 'ene' or 'yne'. For example, a three-carbon chain with a double bond would be called propene and if it has a triple bond, it would be called propyne.

Chain	Length	Bond Functional	Functional Group
C_1	meth–		–ene
C_2	eth–		
C_3	prop–	—C≡C—	–yne
C_4	but–	—O—H	–ol
C_5	pent–	—S—N	—thiol
C_7	hept–		

Example 4. How would you name the following compounds?

(A) $CH_3—CH_2—Br$

(B) 

(C) 

[NCERT]

Ans. (A) Bromoethane

(B) Methanal

(C) 1-hexyne (as the triple bond is between the first and second carbon atom, when numbered from right)

TOPIC 6

CHEMICAL PROPERTIES OF CARBON COMPOUNDS

Combustion

Carbon, in all its allotropic forms, burns in oxygen to give carbon dioxide along with the release of heat and light. Most carbon compounds also release a large amount of heat and light on burning.

(1) $C + O_2 \longrightarrow CO_2$ + heat and light

(2) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ + heat and light

(3) $CH_3CH_2OH + O_2 \longrightarrow CO_2 + H_2O$ + heat and light

Example 5. Case Based:

Two students performed the following activities to study the combustion of hydrocarbons.

The first student took some carbon compounds (naphthalene, camphor, alcohol) one by one on a spatula and burned them with teacher's assistance. He observed the nature of the flame and whether smoke is produced. He then placed a metal plate above the flame and noted down his observations.

The second student lighted a bunsen burner and adjusted the air hole at the base to get different types of flames/presence of smoke.

[NCERT Activity 4.3, 4.4]

(A) The observations recorded by the first student are given below:

(I) Napthalene burns with a yellow flame

(II) Camphor burns with a blue flame

(III) Alcohol burns with a blue flame

(IV) No smoke is produced when these substances are burnt

Which of the observations are correct?

(a) Both (I) and (II)

(b) Both (II) and (III)

(c) Both (I) and (III)

(d) (I), (II) and (IV)

(B) The second student recorded his observations which are given as follows:

	Air supply (by adjusting air holes at the base of burner)	Colour of Flame
(a)	Suffcient	Sooty and yellow
(b)	Insuffcient	Clean and yellow
(c)	Insuffcient	Sooty and blue
(d)	Suffcient	Clean and blue

Select the correct observation.

(C) Which out of the following hydrocarbons will give a clean flame when burnt: C_4H_{10} or C_4H_8?

(D) Do saturated hydrocarbons always burn with a blue flame?

(E) Assertion (A): Burning of camphor results in a sooty deposit on a metal plate kept over the flame.

burn with a sooty flame.

(a) **Both (A) and (R) are true and (R) is the correct explanation of the (A).**

(b) **Both (A) and (R) are true, but (R) is not the correct explanation of the (A).**

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

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

Ans. **(A)** *(c) Both (I) and (III)*

Explanation: When alcohol, camphor and napthalene are taken in a spatula and burnet separately, yellow coloured flame is observed in case of camphor and naphthalene as they both are unsaturated hydrocarbons. Whereas, alcohol burns with a blue flame as it is a saturated hydrocarbon

(B) *(d) Air supply: Sufficient; Colour of flame: Clean and blue*

Explanation: When the air supply is sufficient then, the burns with a clean blue flame as it undergoes complete combustions. However, when air supply is insufficient, the fuel burns with a sooty yellow flame as all the carbon particles do not burn completely. So, the unburnt carbon particles deposit as soot.

(C) The hydrocarbon C_4H_{10} or butane will give a clean flame when burnt as it is an alkane, which is a saturated hydrocarbon containing only single covalent bonds between carbon atoms.

(C) No, saturated hydrocarbons burn with a blue flame in sufficient supply of oxygen and burn with a yellow sooty flame when supply of oxygen is insufficient.

(E) *(c) (A) is true, but (R) is false.*

Explanation: When camphor is burned and a metal plate is kept over the flame, it burns with a yellow sooty flame and a sooty deposit is formed on the metal plate. This is because camphor is an unsaturated hydrocarbon and all unsaturated hydrocarbons burn with a sooty flame due to incomplete combustion of carbon particles.

Saturated hydrocarbons burn with a clean flame in sufficient supply of oxygen.

Colour of Flame on Burning Hydrocarbons

Saturated hydrocarbons will generally give a clean blue flame while unsaturated carbon compounds will give a yellow flame with lots of black smoke.

combustion of even saturated hydrocarbons giving a sooty flame.

The gas/kerosene stove used at home has inlets for air so that a sufficiently oxygen-rich mixture is burnt to give a clean blue flame.

If the bottoms of cooking vessels are getting blackened, it means that the air holes are blocked and fuel is getting wasted.

Fuels such as coal and petroleum have some amount of nitrogen and sulphur in them. Their combustion results in the formation of oxides of sulphur and nitrogen which are major pollutants in the environment.

Burning substances and flames: A flame is only produced when gaseous substances burn. When wood or charcoal is ignited, the volatile substances present vapourise and burn with a flame in the beginning.

A luminous flame is seen when the atoms of the gaseous substance are heated and start to glow. The colour produced by each element is a characteristic property of that element.

Formation of Coal and Petroleum

Coal and petroleum have been formed from biomass which has been subjected to various biological and geological processes. Coal is the remains of trees, ferns, and other plants that lived millions of years ago. These were crushed into the earth, perhaps by earthquakes or volcanic eruptions. They were pressed down by layers of earth and rock. They slowly decayed into coal.

Oil and gas are the remains of millions of tiny plants and animals that lived in the sea. When they died, their bodies sank to the sea bed and were covered by silt. Bacteria attacked the dead remains, turning them into oil and gas under the high pressures they were being subjected to.

Oxidation

Oxidation is the reaction in which oxygen is added and hydrogen removed from an alcohol. When alcohol is heated with an oxidizing agent such as alkaline potassium permanganate or acidified potassium dichromate, they undergo oxidation and form carboxylic acid.

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

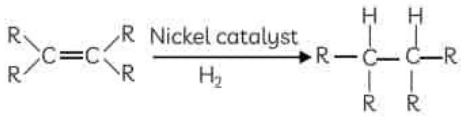
Alkaline potassium permanganate or acidified potassium dichromate are known as oxidising agents as they oxidise alcohols to acids, that is, add oxygen to the starting material.

Addition Reaction

The reaction in which an atom or a group of atoms is added to a molecule is known as addition reaction.

Unsaturated hydrocarbons add hydrogen in the

to give saturated hydrocarbons. This reaction is commonly used in the hydrogenation of vegetable oils using a nickel catalyst. Vegetable oils generally have long unsaturated carbon Chains while animal fats have saturated carbon chains.



Hydrogenation of Vegetable Oils

Oils (such as vegetable, olive, sunflower) are liquids at room temperature. In the food industry, hydrogen is added to oils (in a process called hydrogenation) to make them more solid, or 'spreadable'. The hydrogenation of oils helps to prolong the shelf-life of the food and maintain flavour stability.

Since the process of hydrogenation adds hydrogen atoms to oil, it will reduce the number of unsaturated fatty acids and increase the number of saturated fatty acids in the oil.

Animal fats generally contain saturated fatty acids which are said to be harmful for health. Oils containing unsaturated fatty acids should be chosen for cooking.

Example 6. Which of the following hydrocarbons undergo addition reactions:

C_2H_6, C_3H_8, C_3H_6, C_2H_2 and CH_4. [NCERT]

Ans. Unsaturated hydrocarbons (alkenes and alkynes) undergo addition reactions as they have double and triple covalent bonds which are site of chemical reactivity. The general formula of alkenes is C_nH_{2n} and of alkynes is C_nH_{2n-2}.

Out of the given hydrocarbons, C_2H_6, C_3H_8 and CH_4 are alkanes as they have the general formula C_nH_{2n+2}. Hence they will not undergo addition reaction.

C_3H_6 is an alkene (ethene) and will undergo addition reaction.

Example 7. Give a test that can be used to differentiate chemically between butter and cooking oil. [NCERT]

Ans. Butter contains saturated compounds and cooking oil contains unsaturated compounds. As unsaturated hydrocarbons undergo addition reaction whereas saturated hydrocarbons do not undergo addition reaction, we will use bromine water test to differentiate chemically between butter and cooking oil.

Bromine water (reddish brown in colour) is decolourized by unsaturated hydrocarbons as they will undergo addition reaction with bromine.

$$CH_2 = CH_2 + Br_2 \rightarrow CH_2Br—CH_2Br$$

Whereas, the brown colour of bromine will be retained on reacting with a saturated hydrocarbon. So, when a small amount of butter and cooking oil are taken and treated with bromine water, cooking oil will decolourize the bromine water whereas butter will not have any effect on it.

Substitution Reaction

The reactions in which an atom replaces another atom or a group of atoms from a molecule is called substitution reaction.

Saturated hydrocarbons are fairly unreactive and are inert in the presence of most reagents. In the presence of sunlight, chlorine is added to hydrocarbons in a very fast reaction. Chlorine can replace the hydrogen atoms one by one. It is called a substitution reaction because one type of atom or a group of atoms takes the place of another. A number of products are usually formed with the higher homologues of alkanes.

$CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl$ (In the presence of sunlight)

TOPIC 7

SOME IMPORTANT CARBON COMPOUNDS

Ethanol

Ethanol is an alcohol and is obtained by the fermentation of molasses which are obtained from sugarcane juice. Its molecular formula is C_2H_5OH. Alcohols are carbon compounds containing – OH group attached to a carbon atom. It can also be considered as derived from an alkane by replacing a hydrogen atom by a hydroxyl group (OH).

Physical Properties of Ethanol

(1) Ethanol is a liquid at room temperature.
(2) Ethanol is commonly called alcohol and is the active ingredient of all alcoholic drinks.
(3) It is used in medicines such as tincture iodine, cough syrups, and many tonics because it is a good solvent.
(4) Ethanol is also soluble in water in all proportions.
(5) Long-term consumption of alcohol leads to many health problems.

Property	Description	Chemical Reaction
Combustion of ethanol	Ethanol is a highly inflammable liquid and burns with a blue flame to form CO_2 and H_2O.	$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$
Reaction with sodium	Ethanol reacts with sodium to form sodium ethoxide and hydrogen (it burns with a POP sound)	$2C_2H_5OH + 2Na \longrightarrow 2C_2H_5ONa + H_2$
Oxidation	Alkaline $KMnO_4$ oxidizes ethanol to ethanoic acid.	$CH_3—CH_2OH \xrightarrow[\text{Or acidified } K_2Cr_2O_7 + \text{Heat}]{\text{Alkaline } KMnO_4 + \text{Heat}} CH_3COOH$
Dehydration	When ethanol is heated at 443 K with excess concentrated sulphuric acid, we get ethene.	$CH_3—CH_2OH \xrightarrow[H_2SO_4]{\text{Hot conc.}} CH_3=CH_2 + H_2O$
Esterification	The reaction in which an alcohol reacts with a carboxylic acid in the presence of conc. H_2SO_4 to form a sweet smelling substance known as ester is known as esterification.	$CH_3COOH + C_2H_5OH \longrightarrow CH_3COOC_2H_5 + H_2O$
Saponification	When an ester is treated with an alkali solution, hydrolysis of ester takes place, i.e., the ester is converted back to the constituent alcohol and sodium salt of the acid.	$CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$

Effect of Alcohol on Living Beings

(1) When large quantities of ethanol are consumed, it tends to slow metabolic processes and to depress the central nervous system.

(2) This results in lack of coordination, mental confusion, drowsiness, lowering of the normal inhibitions, and finally stupor.

(3) The individual may feel relaxed but does not realise that his sense of judgement, sense of timing, and muscular coordination have been seriously impaired.

Effect of Methanol

(1) Intake of methanol in very small quantities can cause death.

(2) Methanol is oxidised to methanal in the liver.

(3) Methanol reacts rapidly with the components of cells. It causes the protoplasm to get coagulated, in much the same way an egg is coagulated by cooking.

(4) Methanol also affects the optic nerve, causing blindness.

Uses of Ethanol

(1) It is one of the most important organic chemical and is used as a solvent for lacquers, varnishes, perfumes medicines, etc.

(2) It is used for sterilizing wounds as it is a good antiseptic.

(3) It is used as a fuel in internal combustion engine and as a substitute for petrol in motor cars under the name 'power alcohol'.

(4) It is used for making antifreeze mixtures, which are used in the radiators of motor vehicles in cold countries.

Tests for Alcoholic Group

(1) Sodium metal test: When a small piece of sodium metal is added to the organic liquid, bubbles of hydrogen gas are produced, indicating the presence of alcoholic group.

(2) Ester test: When the organic liquid to be tested is warmed with some glacial acetic acid and a few drops of conc. H_2SO_4, a sweet smelling substance is formed.

Denatured Alcohol

Ethanol is an important industrial chemical and is subjected to very small excise duty. To prevent its misuse for drinking purposes, the alcohol supplied for industrial purposes is rendered unfit for drinking by mixing it with some poisonous substances, such as methanol, pyridine, copper sulphate etc. It is known as denatured alcohol.

Rectified spirit: Ethanol containing 5 percent water is known as rectified spirit.

Harmful effects of drinking alcohol:

(1) Alcohol is an intoxicant. The person loses all senses of discrimination under its influence.

(2) If a person drinks alcohol regularly, he/she becomes dependent on it and becomes an addict.

(3) The body loses its control and gradually one loses one's consciousness if the dose of alcohol is increased.

(4) It may even cause death if consumed in large quantities as it damages the liver.

(5) It worsens the economic condition of a family.

(6) It has a very bad effect on the psychological development of the children.

Ethanoic acid (CH_3COOH) is commonly known as acetic acid. Its dilute solution in water (5-8%) is known as vinegar and is used for preserving food. The melting point of pure ethanoic acid is 290 K and hence it often its name glacial acetic acid.

Physical Properties of Ethanoic Acid

(1) It is a colourless, pungent smelling liquid having a boiling point of 391 K.

(2) It is miscible with water in all proportions.

Chemical Properties of Ethanoic Acid

Property	Description	Chemical reaction
Acidic nature	Ethanoic acid reacts with metals to form metal ethanoates and hydrogen. It also reacts with sodium carbonate and sodium hydroxide.	$CH_3COOH + 2Na \longrightarrow 2CH_3COONa + H_2$ $2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + CO_2 + H_2O$ $CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + CO_2 + H_2O$ These reactions show that the H atom present in – COOH group is acidic in nature.
Reaction with a base	Like mineral acids, ethanoic acid reacts with a base such as sodium hydroxide to give a salt (sodium ethanoate or commonly called sodium acetate) and water.	$NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$
Reaction with alcohols (Esterification)	The reaction in which an alcohol reacts with a carboxylic acid in the presence of conc. H_2SO_4 to form a sweet smelling substance known as ester is known as esterification.	$CH_3COOH + C_2H_5OH \longrightarrow CH_3COOC_2H_5 + H_2O$

Uses of Ethanoic Acid

(1) It is used for making synthetic vinegar which is used for preserving food.

(2) It is used as a reagent in laboratory.

(3) It is used for making white lead [$2PbCO_3.Pb(OH)_2$] which is used as a white paint.

Example 8. How would you distinguish experimentally between an alcohol and a carboxylic acid? [NCERT]

Ans. An alcohol and a carboxylic acid can be distinguished experimentally by reaction with sodium carbonate (Na_2CO_3) or sodium hydrogencarbonate ($NaHCO_3$) as alcohol does not react with $NaHCO_3$ whereas carboxylic acid reacts with $NaHCO_3$ and gives a salt, water and brisk effervescence of carbon dioxide gas.

Example: $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + CO_2 + H_2O$

Saponification Reaction

Esters are sweet-smelling substances. These are used in making perfumes and as flavouring agents. Esters react in the presence of an acid or a base to give back the alcohol and carboxylic acid. This reaction is known as saponification because it is used in the preparation of soap.

TOPIC 8

SOAPS AND DETERGENTS

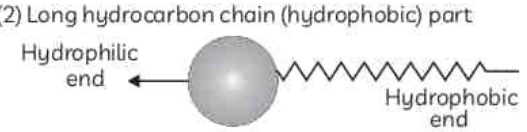
Soaps

The molecules of soap are sodium or potassium salts of long-chain carboxylic acids.

Soap molecule has :

(1) Ionic (hydrophilic) part

(2) Long hydrocarbon chain (hydrophobic) part



Structure of soap molecule

Example 09. What change will you observe if you test soap with litmus paper (red and blue)? [NCERT]

Ans. When soap is tested with blue and red litmus paper, it changes the colour of red litmus to blue but has no effect on blue litmus paper as soap is alkaline in nature.

Micelles

(1) Most dirt is oily in nature and as we know, oil does not dissolve in water.

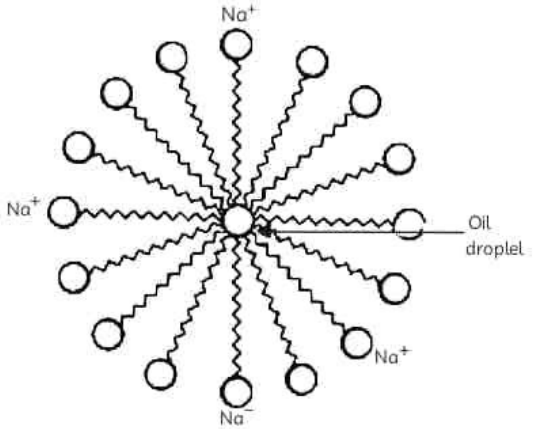
have differing properties, one is hydrophilic, that is, it dissolves in water, while the other end is hydrophobic, that is, it dissolves in hydrocarbons.

(3) 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.

(4) Inside water, these molecules have a unique orientation that keeps the hydrocarbon portion out of the water.

(5) The soap molecules, thus form structures called micelles (Figure) where one end of the molecules is towards the oil droplet while the ionic-end faces outside.

(6) This forms an emulsion in water. The soap micelle thus helps in dissolving the dirt in water and we can wash our clothes clean (Figure below).

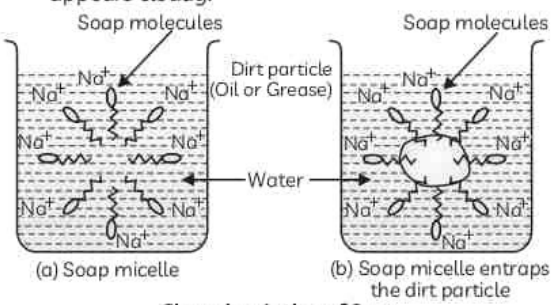


Cleansing Action of Soap

(1) Soap in the form of a micelle is able to clean, since the oily dirt will be collected in the centre of the micelle.

(2) The micelles stay in solution as a colloid and will not come together to precipitate because of ion-ion repulsion.

(3) 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.



Cleansing Action of Soap

Detergents are sodium salts of sulphonic acids or ammonium salts with chlorides or bromide ions. Examples of synthetic detergents are: Sodium n-dodecyl benzene sulphonate and Sodium n-dodecyl sulphate.

Example 10. **Case Based:**

Two students performed the activities to study the action of soap and detergents in soft and hard water.

The first student took about 10 mL of distilled water (or rain water) and 10 mL of hard water (from a tubewell or hand-pump) in separate test tubes and added a couple of drops of soap solution to both. He then shook the test tubes vigorously for an equal period of time.

The second student took two test tubes with about 10 mL of hard water in each and added five drops of soap solution to one and five drops of detergent solution to the other and shook both test tubes for the same period. **[NCERT Activity 4.11, 4.12]**

(A) The observations recorded by the first student on adding a few drops of soap solution to 10 mL distilled water and hard water in separate test tubes is given below:

	Distilled Water	Hard Water
(a)	Lot of foam observed	Lot of foam observed
(b)	Curdy precipitate observed	Lot of foam observed
(c)	Lot of foam observed	Curdy precipitate observed
(d)	Curdy precipitate observed	Curdy precipitate observed

Select the correct observation

(B) The second student recorded the following observations after adding five drops of soap solution and detergent solution to two test tubes containing hard water.

(I) Both the test tube had equal amount of foam

(II) The test tube in which soap was added had less amount of foam

(III) The test tube in which detergent was added had less amount of foam

(IV) A curdy solid was formed in the test tube in which soap was added

Select the incorrect observations. I and III

(a) Both (I) and (III)

(b) Both (I) and (IV)

(c) Both (II) and (IV)

(d) Both (III) and (IV)

(C) What will be observed while using soap in water containing calcium sulphate?

(D) How are soaps and detergents different structurally?

water

Reason (R) : The charged ends of detergents do not form insoluble precipitates with the calcium and magnesium ions in hard water.

For the following questions, two statements are given one labeled Assersion (A) and the other labeled 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 the 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.

Ans. **(A)** *(c) Distilled water: Lot of foam observed; Hard water: Curdy precipitate observed*

Explanation: Soap forms lot of foam with distilled water but forms a curdy white precipitate known as scum when mixed with hard water. This is because the soap molecules react with the calcium and magnesium ions present in hard water to form the scum.

(B) *(a) Both (I) and (III)*

Explanation: Soaps form an insoluble precipitate in hard water Whereas detergents are effective even in hard water as they do not form insoluble precipitates with the calcium and magnesium ions in hard water.

(C) When we use soap in water containing calcium sulphate, soap forms foam with difficulty but forms an insoluble substance called scum as soap molecules react with the calcium salt found in hard water.

(D) The molecules of soap are sodium or potassium salts of long-chain carboxylic acids whereas detergents are generally ammonium or sulphonate salts of long chain carboxylic acids.

(E) *(b) Both (A) and (R) are true, but (R) is not the correct explanation of the (A).*

water as soap molecules react with the calcium and magnesium salts present in hard water, such as $CaSO_4$, $MgSO_4$, $CaCl_2$ and $MgCl_2$, and forms an insoluble substances known as scum.

However, as the structure of detergents is different from that of soap, the charged ends of detergents do not form insoluble precipitates with the calcium and magnesium ions in hard water.

Effectiveness of Soaps and Detergents in Hard Water

Soap is not effective in hard water as soap reacts with the calcium and magnesium salts, which cause the hardness of water, and forms foam with difficulty and an insoluble substance (scum) remains after washing with water.

Detergents are effective in hard water as the charged ends of these compounds do not form insoluble precipitates with the calcium and magnesium ions in hard water. Thus, they remain effective in hard water. Detergents are usually used to make shampoos and products for cleaning clothes.

Differences between Soaps and Detergents

Soaps	Detergents
Soaps are sodium salts of long chain fatty acids. The ionic group present in soap is $-COO^-Na^+$	Detergents are the sodium salts of long chain sulphonic acids. The ionic group present is $-SO_3\text{-}Na^+$ or $-SO_4\text{-}Na^+$
Soaps are not effective cleansing agents in hard water.	Detergents can be used even when water is hard.
Soaps are biodegradable and hence do not cause any environmental pollution.	Some of the detergents are non-biodegradable and hence cause environmental pollution.

[1 mark]

Multiple Choice Questions

1. Carbon exists in the atmosphere in the form of:

(a) Only carbon monoxide

(b) Carbon monoxide in traces and carbon dioxide

(c) Only carbon dioxide

(d) Coal **[NCERT Examplar]**

Ans. *(b) Carbon monoxide in traces and carbon dioxide*

Explanation: Only 0.03% of atmospheric air contatins carbon in the form of carbon dioxide. The natural concentration of carbon monoxide in the air is around 0.2 parts per million (ppm). It is produced by the incomplete combustion of carbon due to a limited supply of oxygen. It is a pollutant which is formed when hydrocarbons such as petrol and diesel are burnt. Carbon monoxide (CO) is short-lived and gets oxidised into carbon dioxide (CO_2).

Related Theory

- *Carbon also occurs in the form of minerals such as carbonates, fossil fuels and other organic compounds.*

2. A molecule of ammonia (NH_3) has:

(a) Only single bonds

(b) Only double bonds

(c) Only triple bonds

(d) Two double bonds and one single bond

3. Buckminster fullerene is an allotropic form of:

(a) Phosphorus **(b) Sulphur**

(c) Carbon **(d) Tin**

Ans. *(c) Carbon*

Explanation: Buckminster fullerene is an allotrope of carbon with 60 carbon atoms, which are arranged in the shape of a football. Since this also looks like the geodesic dome designed by the US architect Buckminster Fuller, the molecule was named fullerene.

4. Which of the following is the correct representation of electron dot structure of nitrogen molecule?

(a) :Ṅ:Ṅ: **(b)** :Ṅ::Ṅ:

(c) :Ṅ⋮Ṅ: **(d)** :N⋮⋮N:

5. The correct electron dot structure of a water molecule is:

(a) H·Ö·H **(b)** H:Ö·H

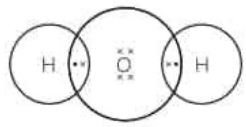
(c) H:Ö:H **(d)** H:O:H **[NCERT]**

Ans. *(c)* H:Ö:H

Explanation: In water molecule, the center oxygen atom contains two lone pairs of electrons and forms two single covalent bonds with two hydrogen atoms.

Oxygen (O) has 6 valence electrons and hydrogen (H) has 1.

All the 8 electrons must be arranged in pairs, so that oxygen completes the octet structure (8 electrons in its valence cell). Each hydrogen atom has now 2 electrons in its valence shell.



6. Which of the following does not belong to the same homologous series?

(a) CH_4 **(b)** C_2H_2

(c) C_3H_8 **(d)** C_4H_8

[CBSE 2016, 15, 14, 11]

Ans. *(d)* C_4H_8

Explanation: Methane (CH_4) is the first member of the homologous series of alkanes. Successive members of the same homologous series differ by —CH_2 unit.

Second member is ethane (C_2H_6) and the third member is propane (C_3H_8). The fourth member should be butane (C_4H_{10}).

Hence, C_4H_8 does not belong to the homologous series of alkanes.

CH_4, C_2H_6, C_3H_8 belong to the same series that is of alkane and differ by —CH_2 unit but C_4H_8 does not belong to alkanes.

7. $CH_2—OH \xrightarrow[\text{Heat}]{\text{Alkaline } KMnO_4} CH_3—COOH$

In the above given reaction, alkaline $KMnO_4$ acts as:

(a) Reducing agent **(b) Oxidising agent**

(c) Catalyst **(d) Dehydrating agent**

[CBSE 2016]

—OH the functional group?

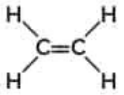
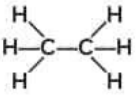
(a) Butanone (b) Butanol

(c) Butanoic (d) Butanal

[CBSE 2011]

9. Structural formula of ethyne is:

(a) H—C≡C—H (b) H_3—C≡C—H

(c)  (d) 

[CBSE 2015]

10. Identify the unsaturated compounds from the following:

(I) Propane (II) Propene

(III) Propyne (IV) Chloropropane

(a) (I) and (II) (b) (II) and (IV)

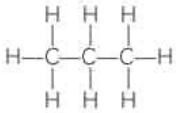
(c) (III) and (IV) (d) (II) and (III)

[NCERT Exemplar]

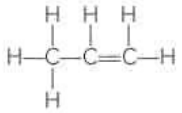
Ans. *(d) (II) and (III)*

Explanation: Alkene and alkyne are unsaturated hydrocarbon as they have double and triple covalent bonds between carbon atoms. Alkanes such as propane are saturated hydrocarbons.

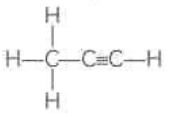
Propane and chloropropane are saturated hydrocarbons which contain only single bonds.



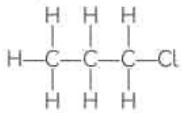
Propane



Propene



Propyne



Chloropropane

Related Theory

- *A hydrocarbon in which two carbon atoms are connected by a 'double bond' or a 'triple bond' is called an unsaturated hydrocarbon.*

11. Chlorine reacts with saturated hydrocarbons at room temperature in the:

(a) absence of sunlight

(b) presence of sunlight

(d) presence of hydrochloric acid

[CBSE 2012, 10]

12. In the soap micelles:

(A) The ionic end of soap is on the surface of the cluster, while the carbon chain is in the interior of the cluster.

(B) The ionic end of soap is in the interior of the cluster and the carbon chain is out of the cluster.

(C) Both ionic end and carbon chain are in the interior of the cluster.

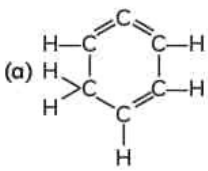
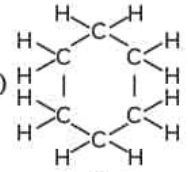
(D) Both ionic end and carbon chain are on the exterior of the cluster.

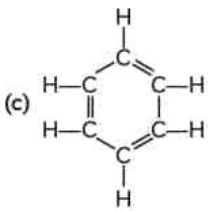
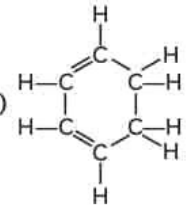
[CBSE 2016, 11]

Ans. *(a) The ionic end of soap is on the surface of the cluster, while the carbon chain is in the interior of the cluster.*

Explanation: The soap molecule has a hydrophilic head and a hydrophobic tail. When soap is mixed into the water, the soap molecules arrange themselves into tiny clusters called 'micelles'. The hydrophilic parts of the soap (water-loving) molecules point outwards, forming the outer surface of the micelle. The hydrophobic part (oil-loving) group together and point towards the inner side. Micelles can trap fats in the centre and help to get rid of oil and dirt.

13. The structural formula of benzene is:

(a)  (b) 

(c)  (d) 

[CBSE 2019]

14. Ethanol reacts with sodium and forms two products. These are:

(a) Sodium ethanoate and hydrogen

(b) Sodium ethanoate and oxygen

(d) Sodium ethoxide and oxygen

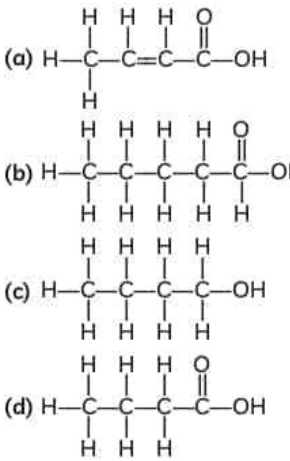
[CBSE 2017, 16, 14, 11]

Ans. *(c) Sodium ethoxide and hydrogen*

Explanation: Ethanol (C_2H_5OH) reacts with sodium to form sodium ethoxide (C_2H_5ONa) along with the liberation of hydrogen gas.

$$2C_2H_5OH + 2Na \longrightarrow 2C_2H_5ONa + H_2$$

15. **The correct structural formula of butanoic acid is:**



[CBSE 2012]

16. **Mineral acids are stronger acids than carboxylic acids because:**

(I) Mineral acids are completely ionised.

(II) Carboxylic acids are completely ionised.

(III) Mineral acids are partially ionised.

(IV) Carboxylic acids are partially ionised.

(a) (I) and (IV) **(b) (II) and (III)**

(c) (I) and (II) **(d) (III) and (IV)**

17. **Which of the following is not a straight chain hydrocarbon ?**

(a) $H_3C-CH_2-CH_2-CH_2-CH_2$ with CH_3 branch

(b) $H_3C-CH_2-CH_2-CH_2-CH_2-CH_3$

(c) $H_2C-H_2C-H_2C-CH_2$ with CH_3 branch and CH_3 branch

(d) CH_3, H_3C branches on CH, then $CH-CH_2-CH_2-CH_3$

[NCERT Exemplar]

Ans. *(c) (II) and (IV)*

Explanation: In structures (1), (2) and (3), all the carbon atoms are attached by covalent bonds in a continuous straight chain.

(1) $H_3\overset{1}{C}-\overset{2}{C}H_2-\overset{3}{C}H_2-\overset{4}{C}H_2-\overset{5}{C}H_2$ with $\overset{6}{C}H_3$ branch

(2) $H_3\overset{1}{C}-\overset{2}{C}H_2-\overset{3}{C}H_2-\overset{4}{C}H_2-\overset{5}{C}H_2-\overset{6}{C}H_3$

(3) $\overset{1}{C}H_3$ branch, $H_2\overset{2}{C}-H_2\overset{3}{C}-H_2\overset{4}{C}-\overset{5}{C}H_2$ with $\overset{6}{C}H_3$ branch

(4) $\overset{1}{C}H_3$, H_3C branches on $\overset{2}{C}H$, then $-\overset{3}{C}H_2-\overset{4}{C}H_2-\overset{5}{C}H_3$

In structure (4), —CH3 group is attached to the second carbon atom of the chain forming a branch. Hence, compound in structure (iv) is a branched chain hydrocarbon.

Related Theory

➥ *A branch chain hydrocarbon contains some side chains which are bonded with parent carbon chain.*

18. **Which among the following are unsaturated hydrocarbons?**

(I) $H_3C-CH_2-CH_2-CH_3$

(II) $H_3C-C\equiv C-CH_3$

(III) $H_3C-CH(CH_3)-CH_3$

(IV) $H_3C-C(CH_3)=CH_2$

(a) (I) and (III) **(b) (II) and (III)**

(c) (II) and (IV) **(d) (III) and (IV)**

[CBSE 2017, 14, 12]

Ans. *(c) (II) and (IV)*

Explanation: Unsaturated hydrocarbons are organic compounds that consist of a double or a triple bond between two adjacent carbon atoms. The hydrocarbons having at least one double bond between two adjacent carbon atoms are called alkenes, whereas the hydrocarbons which contain a carbon-carbon triple bond are referred to as alkynes. Both (II) and (IV) structures have double or triple carbon-carbon bonds respectively.

CHO is:

(a) Propanol (b) Propanone

(c) Ethanol (d) Ethanal

[CBSE 2016, 14]

20. Which of the following represents saponification reaction?

(a) $CH_3COONa + NaOH \xrightarrow{CaO} CH_4 + Na_2CO_3$

(b) $CH_3COOH + C_2H_5OH\ CH_3 \longrightarrow COOC_2H_5 + H_2O$

(c) $2CH_3COOH + 2Na \longrightarrow 2CH_3COONa + H_2$

(d) $CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$

[CBSE 2017, 15, 11]

21. A student takes about 4 mL of distilled water in four test tubes marked P, Q, R and S. He then dissolves in each test tube an equal amount of one salt in one test tube, namely sodium sulphate in P, potassium sulphate in Q, calcium sulphate in R and magnesium sulphate in S. After that he adds an equal amount of soap solution in each test tube. On shaking each of these test tubes well, he observes a good amount of lather (foam) in the test tubes marked :

(a) P and Q (b) Q and R

(c) P, Q and S (d) P, R and S

[CBSE 2015]

22. Consider the following oils:

(I) Mobil oil

(II) Castor oil

(III) Turpentine oil

(IV) Kerosene

(V) Mustard oil

(VI) Coconut oil

Which of these can be used for preparation of soap?

(a) I, II, III, VI

(b) II, V, VI

(c) II, III, V, VI

(d) II, III, VI [CBSE 2016]

Ans. *(b) II, V, VI (Mustard oil, castor oil, coconut oil)*

Related Theory

Oil in soaps used to moisturizes the skin and creates creamy lather.

23. A student is testing water to know which is best for cleansing purposes with soaps. soaps is best wben he uses water obtained from :

(a) rain

(b) tap

(c) hand pump

(d) pond [CBSE 2016]

24. You have four test tubes, A, B, C and D containing sodium carbonate, sodium chloride, lime water and blue litmus solutions respectively. Out of these the material of which test tube/test tubes would be suitable for the correct test of acetic/ ethanoic acid?

(a) only A

(b) A and B

(c) B and C

(d) A and D [CBSE 2015]

25. A student took four test tubes P, Q, R and S and filled about 8 mL of distilled water in each. After that he dissolved an equal amount of Na_2SO_4 in P, K_2SO_4 in Q, $CaSO_4$ in R and $MgSO_4$ in S. On adding an equal amount of soap solution and shaking each test tube well, a good amount of lather will be obtained in the test tubes:

(a) P and Q

(b) P and R

(c) P, Q and S

(d) Q, R and S [CBSE 2017]

26. A student wants to prepare soap in the laboratory. Which of the following sets of materials he should use?

(a) Neem oil and NaCl

(b) Neem oil and Na_2CO_3

(c) Mustard oil and NaOH

(d) Mineral oil and NaOH

[CBSE 2017]

27. You have neem oil in a beaker. In order to study saponification reaction, which of the following chemical substances would you add to this oil?

(a) 20% $Ca(OH)_2$ (b) 20% NaOH

(c) 30% $Mg(OH)_2$ (d) 10% $Ca(OH)_2$

[CBSE 2017]

Ans. (b) *20% NaOH*

Explanation : Oil or fat when treated with sodium hydroxide solution, gets converted into sodium salt of fatty acid (soap) and glycerol.

acid

In option (a) and (d) the base used is $Ca(OH)_2$ whereas in option (c), base used is 30 % $Mg(OH)_2$.

Therefore, the correct option is (b) as it uses 20% NaOH.

28. If you take some distilled water in a test-tube, add an equal amount of acetic acid to it, shake the test-tube well and leave it undisturbed on the test-tube stand, then after about 5 minutes, what would you observe?

(a) There is a layer of water over the layer of acetic acid.

(b) A precipitate is settling at the bottom of the test-tube.

(c) Bubbles of colourless gas are coming out of the test-tube.

(d) There is a clear, colourless transparent solution in the test-tube. **[CBSE 2017]**

Ans. *(d) There is a clear, colourless transparent solution in the test-tube.*

Explanation: Acetic Acid is miscible in water and therefore, when acetic acid is added to water it dissolves readily in water forming a homogeneous solution.

29. Soaps are formed by alkaline hydrolysis of:

(a) Inorganic salts

(b) Carboxylic acids

(c) Esters of long chain fatty acids

(d) Esters of small chain fatty acids

[CBSE 2017]

30. In the preparation of soap addition of sodium chloride causes:

(a) Complete saponification

(b) Complete hydrolysis

(c) Complete precipitation

(d) Complete neutralisation **[CBSE 2017]**

Ans. *(c) Complete precipitation*

Related Theory

The soap is formed by the precipitation by the common salt (NaCl). When the salt is added in the aqueous solution then the reaction occurs and the soap is precipitute out from the solution. When the soap added to the solution then the solubility of the soap became decreased and the soap precipitates out from the solution as a solid form of the soap.

samples of water with temporary hardness labelled as 'A', 'B' and 'C'. He keeps the three samples at different temperatures – A at room temperature, B at 50 °C and C at 95 °C. Which sample will give maximum amount of lather when 10 mL of soap solution is added to each sample and shaken for equal time?

(a) (A) only

(b) Both (A) & (B)

(c) Both (B) and (C)

(d) (C) only **[CBSE 2017]**

Ans. *(d) C only.*

Related Theory

Soap form lather with soft water and at 95° C the hardness of water gets reduced and soap lather in good amount.

32. Which one of the following compounds can show addition reaction?

(a) C_3H_8 **(b)** C_4H_8

(c) CH_3Cl **(d)** C_2H_5OH

33. An organic compound of molecular formula $C_2H_4O_2$ gives brisk effervescence with sodium hydrogencarbonate. The name and formula of the organic compound is:

Select the correct option:

	Name of Organic Compound	Formula of Organic Compound
(a)	Ethanol	C_2H_5OH
(b)	Ethanoic acid	CH_3COOH
(c)	Ethanal	CH_3CHO
(d)	Propanone	CH_3COCH_3

Ans. *(b) The organic compound is ethanoic acid and its formula is CH_3COOH.*

Explanation: Ethanoic acid reacts with sodium carbonate and sodium hydrogen carbonate to form sodium ethanoate, carbon dioxide gas and water.

$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + CO_2 + H_2O$$

34. Carbon compounds have:

(a) High boiling point but low melting point.

(b) High melting but low boiling point.

(c) Low melting and boiling point

(d) High melting and boiling point.

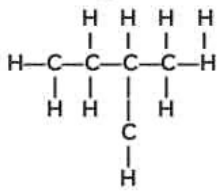
[Delhi Gov. 2021]

ethanol and the compound formed on oxidation of ethanol is:

Select the correct option:

	Substance used for Oxidation of Ethanol	Compound formed on Oxidation of Ethanol
(a)	Alkaline $KMnO_4$	CH_3COOH
(b)	Acidified $KMnO_4$	CH_3COOH
(c)	Alkaline $KMnO_4$	CH_3CHO
(d)	Alkaline $K_2Cr_2O_7$	CH_3COOH

36. The structure of a hydrocarbon is given below :



Study the structure above and select the correct statements:

(I) The molecular formula of the compound is C_5H_{12}

(II) The IUPAC name of the compound is 2-Methyl pentane

(III) It is an isomer of pentane

(IV) It has 14 single covalent bonds

(a) Both (I) and (II)

(b) Both (I) and (III)

(c) (I), (II) and (III)

(d) (I), (III) and (IV)

Ans. *(b) Both (I) and (III)*

Explanation: The structure is that of pentane, whose molecular formula is C_5H_{12} and it shows isomerism. Structural isomers are the compounds with identical molecular formula but different structures.

It has 16 single covalent bonds, – 4 single bonds between carbon atoms and 12 single bonds between C-H atoms.

37. Which of the following compounds do not contain Carboxylic acid functional group?

(I) C_2H_5COOH

(II) C_3H_7OH

(III) CH_3COOH

(IV) CH_3CHO

(a) Both (I) and (II)

(b) Both (II) and (III)

(d) Both (II) and (IV)

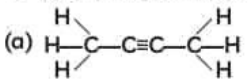
Ans. *(d) Both (II) and (IV)*

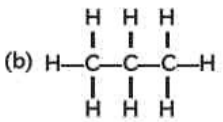
Explanation: The functional group carboxylic acid is represented by HCOOH or RCOOH, where R is the alkyl group.

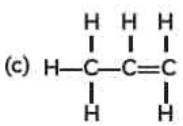
Whereas, the functional group alcohol is represented by ROH and aldehyde by RCHO.

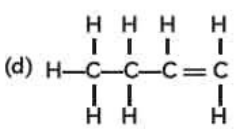
So, (II) is an alcohol, propanol and (IV) is an aldehyde, ethanal.

38. The structural formula of propene is:

(a) 

(b) 

(c) 

(d) 

Assertion-Reason Questions

For the following questions, two statements are given one labeled Assersion (A) and the other labeled 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

39. Assertion (A) : Chemical bonds in organic compounds are covalent in nature.

Reason (R) : Covalent bond is formed by the sharing of electrons in the bonding atoms. [Diksha]

Ans. *(a) (A) and (R) are true and (R) is the correct explanation of the (A).*

tendency to either lose or gain electrons to attain noble gas configuration.

Reason (R) : Carbon has four electrons in its outermost shell and has the tendency to share electrons with carbon or other elements. [CBSE 2020]

41. Assertion (A) : Carbon forms covalent compounds with other atoms.

Reason (R) : Carbon can gain 4 electrons forming C^{4-} anion.

42. Assertion (A) : Covalent compounds have low melting and boiling points.

Reason (R) : Covalently bonded molecules have weak intermolecular forces.

Ans. *(a) (A) and (R) are true and (R) is the correct explanation of the (A).*

43. Assertion (A) : The following belong to the same homologous series: C_2H_4, C_3H_6, C_4H_8.

Reason (R) : Gradation in physical properties is seen with an increase in molecular mass in any homologous series.

44. 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.

[CBSE 2020]

Ans. *(b) Both (A) and (R) are true but (R) is not the correct explanation of the Assertion.*

Explanation: Esterification is a process in which esters are formed by reaction of an acid and alcohol.

$$\underset{\text{(Ethanoic acid)}}{CH_3—COOH} + \underset{\text{(Ethanol)}}{CH_3—CH_2OH} \longrightarrow CH_3—C—C—CH_2—CH_2 + H_2O$$

(Ester)

Saponification is a process in which an ester is converted back to alcohol and sodium salt of carboxylic acid and it is used in the preparation of soap.

$$CH_3COOC_2H_5 \xrightarrow{NaOH} C_2H_5OH + CH_3COONa$$

of a homologous series:

CH_3OH, CH_3CH_3OH, $CH_3CH_2CH_2OH$

Reason (R) : A series of compounds with same functional group but differing by $—CH_2—$unit is called a homologous series.

[CBSE 2020]

Very Short Answer Type Questions

46. Covalent compounds are generally poor conductors of electricity. Why? [CBSE 2020]

47. Covalent compounds have low melting and boiling point. Why? [CBSE 2020]

Ans. Covalent compounds have low melting and boiling points because they are made up of electrically neutral molecules. So, the force of attraction between the molecules of a covalent compound is very weak.

Related Theory

➥ *Diamond and graphite have covalent bonds and are solids but have very high melting and boiling points.*

48. Name a cyclic unsaturated carbon compound. [CBSE 2020]

49. Carbon has four electrons in its valence shell. Which type of compounds can be formed by carbon atom and why? Give any one example of such compounds.

[CBSE 2018]

Ans. Carbon forms covalent compounds with other atoms by sharing electron pairs because of the following reasons:

(1) Carbon cannot form C^{4+} cation by losing four electrons, as it would require a large amount of energy to remove four electrons leaving behind a carbon cation with six protons in its nucleus holding on to just two electrons.

(2) Carbon cannot form C^{4-} anion by gaining four electrons, as it would be difficult for the nucleus with six protons to hold on to ten electrons.

Example of compounds formed by carbon:

(1) Methane (CH_4)

(2) Ethene (C_2H_4)

(3) Propyne (C_3H_4)

(4) Ethanol (C_2H_5OH)

(Any 1 of 4 examples can be written to get full marks)

Related Theory

- *Carbon can share 1, 2 or 3 electron pairs with other carbon atoms or with atoms of other elements to achieve noble gas configuration.*
- *Depending upon the number of electron pairs shared, there can be single, double or triple covalent bond.*
- *Covalent compounds are usually liquids or gases, have usually low melting and boiling points, are usually insoluble in water but soluble in organic solvents and do not conduct electricity.*

50. Write the molecular formula of the first two members of the homologous series having functional group —COOH.

[CBSE 2013]

51. Write the molecular formula of first two members of homologous series having functional group –Cl.

Ans. Molecular formula of first two members of the homologous series having functional group –Cl is CH_3Cl and C_2H_5Cl.

Related Theory

- *Homologous series is a series of carbon compounds in which the hydrogen in a carbon chain is replaced by the same functional group.*
- *The IUPAC name of the compound CH_3Cl is Chloromethane and of C_2H_5Cl is Chloroethane.*
- *The functional group Cl is a halogen which belongs to Group 17 of the modern periodic table and other members of the halogen functional group are Br, I.*

52. Write the name and molecular formula of the fourth member of alkane series.

[CBSE 2015]

Ans. Butane, C_4H_{10}

Related Theory

- *An alkane is a hydrocarbon having single bonds only and are called saturated hydrocarbons*
- *The general formula of saturated hydrocarbon or alkane is C_nH_{2n+2} where n is the number of carbon atoms in one molecule of the alkane.*

53. Why does carbon become stable after sharing four electrons? What type of bond is formed by sharing? [CBSE 2016]

Ans. The element carbon has atomic number as 6 and its electronic configuration is 2, 4 and it is tetravalent. Thus, carbon has 4 valence electrons. It can neither gain nor lose 4 electron to acquire the nearest noble gas configuration. Only way is to share the four valence electrons with the electrons of other atoms

electrons is covalent bond.

54. Write the next homologue of each of the following:

(A) C_2H_4 (B) C_4C_6 [CBSE 2010]

55. Define catenation.

Ans. The property of self-linking of atoms of an element through covalent bonds in order to form straight chain, branched chains or cyclic chains of different sizes is called catenation.

[CBSE Marking Scheme 2019]

56. Which oils should be chosen for cooking to remain healthy? [CBSE 2020]

Ans. Oils containing unsaturated fatty acides should be chosen for cooking to remain healthy whereas animal fats generally contains saturated fats which are harmful for health.

57. Write the number of covalent bonds in the molecule of ethane.

Ans. Seven **[CBSE Marking Scheme 2015]**

58. The molecular formula of 'A' is $C_{10}H_{18}$ and 'B' is $C1_6H_{36}$. Name the homologous series to which they belong. [CBSE 2014]

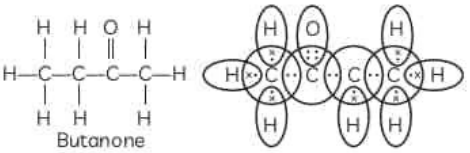
Ans. The molecular formula of 'A' is $C_{10}H_{18}$ and 'B' is $C_{18}H_{36}$.

Both A and B are hydrocarbons, but 'A' belongs to the homologous series alkynes as it satisfies the general formula CnH_{2n-2}, whereas 'B' belongs to alkenes as it satisfies the general formula CnH_2n.

59. Write the number of covalent bonds in the molecular formula of butane C_4H_{10}.

60. Draw the structure of butanone molecule $CH_3COC_2H_5$.

Ans. Butanone is a ketone having four carbon atoms and formula $CH_3COC_2H_5$. Its structural formula and electron dot structure is shown below:



Butanone

61. State the valency of each carbon atom in (A) an alkane and (B) an alkyne. [CBSE 2014]

Ans. The general formula of an alkane is C_nH_{2n+2} and of an alkyne is C_nH_{2n-2}. There is only single covalent bond between carbon atoms which is formed by sharing of one pair of electrons.

bond between two carbon atoms formed by sharing three pairs of electrons. As carbon is a tetravalent element, its valency is always four in all cases.

member of the sries of carbon compounds whose general formula is C_3H_{2n+1}

COMPETENCY BASED Questions (CBQs)

[**1, 4 & 5** marks]

63. *Organic compounds are made up of hydrogen, oxygen, carbon, and a few other elements. But, the number of organic compounds is far bigger than inorganic compounds that do not form bonds.*

Carbon is a chemical element with symbol C and atomic number 6. Carbon is a versatile element and is found in many different chemical compounds, including those found in space.

Carbon is versatile because it can form single, double, and triple bonds. It can also form chains, branched chains, and rings when connected to other carbon atoms. The versatile nature of carbon can be best understood with its features such as tetravalency and catenation.

(A) What is the atomic number and electronic configuration of carbon?

(B) Why are the bonds formed by carbon with other elements strong?

(C) Name two properties of Carbon which lead to formation of a large number of carbon compounds.

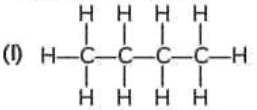
(D) Define catenation and name an element other than carbon which shows this phenomenon to some extent.

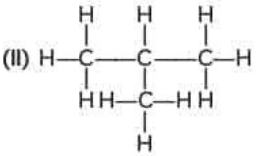
Ans. (A) Atomic number of carbon is 6 and its electronic configuration is: K-shell: 2, L-shell: 4 or (2, 4).

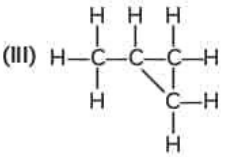
(C) The two properties of carbon which lead to formation of a large number of carbon compounds are *tetravalency* and *catenation*.

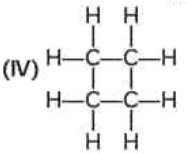
64. *LPG or liquefied Petroleum gas has a very wide variety of uses, mainly used for cylinders across many different markets as an efficient fuel container in the agricultural, recreation, hospitality, industrial, construction, sailing and fishing sectors. It can serve as fuel for cooking, central heating and to water heating and is a particularly cost-effective and efficient way to heat off-grid homes. The main constituent of LPG is butane. LPG is used for cooking in many countries for economic reasons, for convenience or because it is the preferred fuel source.*

Which of the following are correct structural isomers of C_4H_{10}?

(I)


(II)


(III)


(IV)


(a) (I) and (III) **(b) (II) and (IV)**

(c) (I) and (II) **(d) (III) and (IV)**

[CBSE 2016, 15, 14, 11]

65. *A student calculated the difference in the formulae and molecular masses for the following alcohols and tried to find out similarity, if any, in the three groups:*

(II) C_2H_5OH and C_3H_7OH, and

(III) C_3H_7OH and C_4H_9OH.

He also arranged these alcohols in the order of increasing carbon atoms to get a family.

[NCERT Activity]

(A) **The student noted down the following observations after calculating the difference in the formulae and molecular masses for (a) CH_3OH and C_2H_5OH, (b) C_2H_5OH and C_3H_7OH, and (c) C_3H_7OH and C_4H_9OH.**

	Difference in Formulae	Difference in Molecular Mass
(a)	- CH_4	16 u
(b)	- CH_2	16 u
(c)	- CH_4	14 u
(d)	- CH_2	14 u

Select the correct observation.

(B) **The student generated the homologous series HCHO, CH_3CHO, C_2H_5CHO, C_3H_7CHO (upto four carbon atoms) and noted down his observations as:**

(I) **All the compounds belonging to the homologous series have the same functional group.**

(II) **All the compounds given above can be represented by the general formula $C_nH_{2n}O$**

(III) **No other functional group contains the carbonyl group (C=O).**

(IV) **The difference in molecular masses between successive compounds increases uniformly with increase in number of carbon atoms.**

Which of his observations regarding the homologous series is incorrect?

(a) Both (I) and (II)

(b) Both (II) and (III)

(c) Both (III) and (IV)

(d) Both (I) and (IV)

(C) **The names of the next homologues of CH_3OH and CH_3COOH are:**

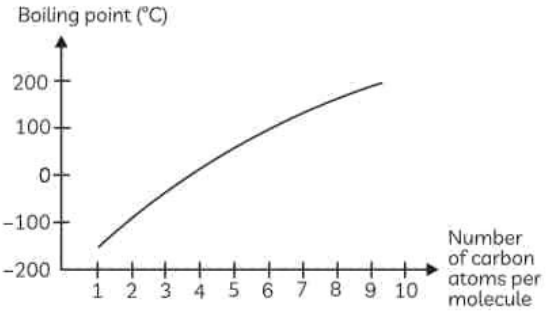
(a) Ethanol and Propanoic acid

(b) Ethanol and Ethanoic acid

(c) Propanol and Propanoic acid

(d) Propanol and Ethanoic acid

the variation in boiling points of alkanes with the number of carbon atoms in the alkanes and answer the question that follows:



Graph of boiling point against number of carbon atoms per molecule for alkanes

Select the incorrect statement:

(a) There is gradation in physical properties with increase in molecular mass in any homologous series.

(b) There is gradation in chemical properties with increase in molecular mass in any homologous series.

(c) The boiling point increases with increasing molecular mass.

(d) The chemical properties are similar in a homologous series.

(E) **The fourth member of alcohol homologous series is:**

(a) Propanol

(b) Butanone

(c) Butanal

(d) Butanol

(B) *(c) Both (III) and (IV)*

Explanation: The homologous series generated by the student, HCHO, CH_3CHO, C_2H_5CHO, C_3H_7CHO, have the same functional group, namely, aldehyde (-CHO).

All the compounds given above can be represented by the general formula $C_nH_{2n}O$ but the carbonyl group (C=O) is also present in ketones (RCOR') and general formula for ketones is also the same $C_nH_{2n}O$. However, the simplest ketone is propanone CH_3COCH_3.

The difference in molecular masses between successive compounds = 14u which is a constant.

used in every household for cleaning purposes. Ali had just studied about the cleansing properties of soaps and also how a micelle is formed when soap is dissolved in water.

The soap molecule has a:

(a) Hydrophilic head and a hydrophobic tail

(b) Hydrophobic head and a hydrophilic tail

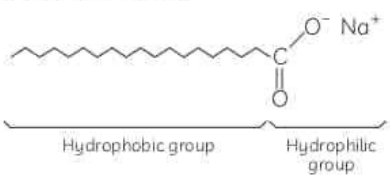
(c) Hydrophobic head and a hydrophobic tail

(d) Hydrophilic head and a hydrophilic tail

[CBSE 2011]

Ans. *(a) Hydrophilic head and a hydrophobic tail*

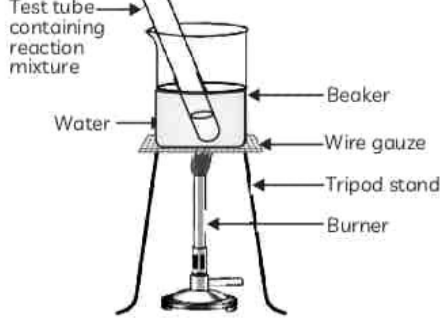
Explanation: The structure of soap molecule consists of a long hydrocarbon tail at one end which is hydrophobic in nature. The other end is the ionic part which is hydrophilic in nature. See below a soap molecule:



67. *Two students performed activities to study the properties of acetic acid.*

The first student wanted to compare the pH of dilute acetic acid and dilute hydrochloric acid using both litmus paper and universal indicator.

The second student took 1 mL ethanol (absolute alcohol) and 1 mL glacial acetic acid along with a few drops of concentrated sulphuric acid in a test tube and warmed in a water-bath for at least five minutes as shown in Fig. below and then poured it into a beaker containing 20-50 mL of water. **[NCERT Activity 4.7, 4.8]**



(A) A student recorded the following observations on finding pH values of dilute acetic acid and dilute hydrochloric acid using both litmus paper and universal indicator.

	Indicator	Change observed on adding dilute acetic acid	Change observed on adding dilute hydrochloric acid
(I)	Blue litmus paper	Blue colour changes to red	Blue colour changes to red
(II)	Blue litmus paper	No change observed	Blue colour changes to red
(III)	Universal indicator	Shows Orange colour	Shows Red colour
(IV)	Universal indicator	Shows Red colour	Shows Yellow colour

Select the rows containing the correct observations:

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (II) and (IV)

(B) Select the incorrect conclusions based on the above activity:

(I) Both dilute acetic acid and dilute hydrochloric acid have equal pH

(II) Dilute acetic acid is a weak acid

(III) Dilute hydrochloric acid is a strong acid

(IV) All acids have equal strengths as they give equal number of H^+ ions in water.

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (II) and (IV)

(C) Vinegar is a solution of

(a) 20% - 30% acetic acid in alcohol

(b) 5% - 8% acetic acid in alcohol

(c) 20% - 30% acetic acid in water

(d) 5% - 8% acetic acid in water

(D) The structural formula and class of compound formed on adding 1 mL ethanol and 1 mL glacial acetic acid along with a few drops of concentrated sulphuric acid in the test tube as shown in activity is:

(a) Structural formula = CH_3-COO-CH_2-CH_3 and Class of compound = Ketone

(b) Structural formula = CH_3-COO-CH_2-CH_3 and Class of compound = Ester

(c) Structural formula = CH_2-CH_3-COO-CH_3 and Class of compound = Ester

(d) Structural formula = CH_2-CH_3-COO-CH_3 and Class of compound = Ketone

(E) The reaction which takes place between glacial acetic acid and absolute alcohol is known as:

(a) Saponification reaction

(b) Substitution Reaction

(c) Esterification Reaction

(d) Hydrogenation Reaction

Ans. (A) *(a) Both (I) and (III)*

Explanation: Both dilute acetic acid and dilute hydrochloric acid are acids and hence change the colour of blue litmus to red. However, as the two acids have different strengths (acetic acid is a weak acid whereas hydrochloric acid is a strong acid), the universal indicator will show different colours with them.

It shows orange colour with acetic acid and red colour with hydrochloric acid.

(B) *(c) Both (I) and (IV)*

Explanation: Dilute acetic acid is a weak acid as it produces less number of hydrogen ions when dissolved in water. Hence, it has hydrochloric acid, which is a strong acid as it produces more number of hydrogen ions in water.

68. *Ankit and his friend Sanjay were getting bored one day. So, they thought of making something creative. Meanwhile Ankit's mother asked him to go to the market to get soap as there was no soap left in the house. So, they thought of making soap with the ingredients available at home!*

The chemical mostly used in the preparation of most of the soaps we use is

(a) Sodium chloride

(b) Potassium hydroxide

(c) Sodium hydroxide

(d) Potassium chloride **[CBSE 2016]**

Ans. (c) *Sodium hydroxide.*

Related Theory

Drain cleaners that contain sodium hydroxide convert `Jats and grease that can clog pipes into soap, which dissolve in H_2O.

69. *Hydrocarbons are a broad group of chemicals that contain hydrogen and carbon atoms. They can be saturated or unsaturated. They are found in every home. Gasoline, kerosene, lamp oil and furniture oil are all examples of hydrocarbons.*

Hydrocarbons are very important for the modern economy. Globally, hydrocarbons are responsible for roughly 85% of energy consumption. This figure may actually understate the role of hydrocarbons in the economy by a significant margin because they are used in a wide range of applications aside from their use as a source of energy. For example, refined petroleum has been used to produce myriad derivative materials that play critical roles in the global economy, such as plastics, solvents, and lubricants.

This is just a partial list of hydrocarbon containing products.

nail enamel dryers and makeup removers.

Cleaning Products – Cleaners (such as: wood oil, metal, adhesive and pine), spot remover and liquid furniture polish.

Automotive – Gasoline, kerosene, gasoline additives, fuel injection cleaners and carburetor cleaners.

(A) **If the number of carbon atoms is denoted by *n*, then the general formula for saturated hydrocarbons is:**

(a) C_nH_{2n}

(b) C_nH_{2n+2}

(c) C_nH_{2n-2}

(d) C_nH_{2n+1}

(B) **A hydrocarbon which is the main component of natural gas is:**

(a) Methyl

(b) Ethene

(c) Butane

(d) Methane

(C) **Select the incorrect statement(s):**

(I) **The straight chain carbon compounds are always saturated hydrocarbons.**

(II) **The branched chain carbon compounds are always unsaturated hydrocarbons.**

(III) **The straight chain carbon compounds may be saturated or unsaturated hydrocarbons.**

(IV) **Cyclic carbon compounds can never be saturated hydrocarbons.**

(a) Both (I) and (II)

(b) (I), (II) and (IV)

(c) (I), (III) and (IV)

(d) (II), (III) and (IV)

(D) **Two students recorded their observations in the table given below on the difference in reactivities of butane and butene:**

	Student A	Student B
(a)	Butane is more reactive than butene	Butane and butene have same reactivity.
(b)	Butene is more reactive than butane	Butane is more reactive than butene
(c)	Butene is more reactive than butane	Butene is more reactive than butane
(d)	Butane and butene have same reactivity.	Butane is more reactive than butene

Select the option giving correct observation by both students A and B.

(E) **The number of isomers of pentane are:**

(a) 2 (b) 3

(c) 4 (d) 5

Ans. (C) *(b) (I), (II) and (IV)*

Explanation: Straight chain, branched chain and cyclic carbon compounds, all may be saturated or unsaturated hydrocarbons.

Saturated hydrocarbons have single covalent bonds between carbon atoms, whereas unsaturated hydrocarbons have double or triple bonds between their carbon atoms.

(D) *(c) Student A: Butane is more reactive than butane; Student B: Butene is more reachive butan.*

Explanation: Butane is a saturated hydrocarbon having molecular formula C_4H_{10} and structural formula CH_3-CH_2-CH_2-CH_3.

Butene is an unsaturated hydrocarbon having molecular formula C_4H_8 and structural formula CH_3-CH=CH-CH_3.

As butene has a double bond between two carbon atoms, it is more reactive than butane, which has only single bonds between its two carbon atoms.

70. *White vinegar, sometimes called distilled or spirit vinegar, has been a mainstay in households worldwide for thousands of years. It's easy to understand why.This versatile liquid presents a treasure trove of uses for cleaning, gardening and cooking. It even has medicinal applications, too.*

Some students studied the physical properties of acetic acid and noted downtheir observations. Which of the following observations is correct?

(a) Smells like rose and soluble in water.

(b) Smells like burning plastic and insoluble in water.

(c) Smells like vinegar and soluble in water.

(d) Smells like rotten egg and soluble in water. **[CBSE 2017]**

Ans. *(c) Smells like vinegar and soluble in water.*

Explanation: Acetic acid is an acid which smells like vinegar and is miscible in water in all proportions. Therefore, (c) is the correct option.

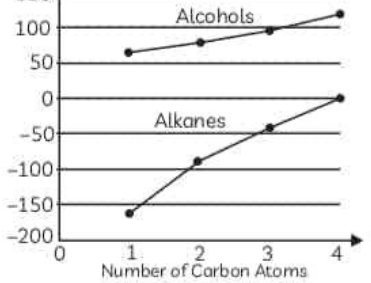
71. *Ethanol is a primary alcohol that is ethane in which one of the hydrogens is substituted by a hydroxyl group. Ethanol is an important industrial chemical; it is used as a solvent, in the synthesis of other organic chemicals, and as an additive to automotive gasoline (forming a mixture known as a gasohol). Ethanol is also the intoxicating ingredient of many alcoholic beverages such as beer, wine, and distilled spirits.*

There are two main processes for the manufacture of ethanol: the fermentation of carbohydrates (the method used for alcoholic beverages) and the hydration of ethylene.

Any proportion of ethanol is properly soluble in water. Furthermore, consumption of even a small quantity of pure ethanol is lethal. Consumption of alcohol for a long period causes adverse health effects.

To discourage the drinking of pure ethanol from personal care or cleaning products, a "denaturant," such as a bitter flavoring, is usually added.

The graph below shows the variation of boiling point of straight chained alcohols and alkanes with number of carbon atoms.



(A) From the graph above, identify the correct physical states of ethane and ethanol at room temperature:

	Physical State of Ethane at Room Temperature	Physical State of ethanol at Room Temperature
(a)	Liquid	Liquid
(b)	Gas	Solid
(c)	Liquid	Gas
(d)	Gas	Liquid

(B) About 3 mL of ethanol is taken in a test tube and warmed gently in water bath. Then a 5 % solution of alkaline potassium permanganate is first added drop by drop to this solution and then in excess.

Which of the following observations are incorrect?

(I) The purple colour of potassium permanganate does not change at all.

(II) The purple colour of potassium permanganate becomes colourless even on adding excess.

(III) The purple colour of potassium permanganate first becomes colourless and then does not change on adding excess

(IV) The purple colour of potassium permanganate fades and becomes light purple.

(a) Only (I)

(b) Only (II)

(c) (I), (II) and (III)

(d) (II), (III) and (IV)

(C) The products formed when ethanol reacts with sodium are:

(a) Sodium ethoxide and hydrogen

(b) Sodium ethanoate and hydrogen

(c) Sodium ethoxide and oxygen

(d) Sodium ethanoate and oxygen

misuse of ethanol produced for industrial use is:

(a) Methanal

(b) Methanol

(c) Propanone

(d) Ethyne

(E) Ethanol on heating at 443 K with cone H_2SO_4 gives

(a) $CH_2 = CH_2$

(b) $HC \equiv HC$

(c) CH_4

(d) C_2H_6

Ans. (A) *(d) Physical state of ethane at room temperature: Gas; Physical state of ethane at room temperature: Liquid*

Explanation: The physical state of ethane at room temperature is gas and that of ethanol is liquid.

The boiling point of ethane is -89oC no space between minus sign and 89 and degree C put proper minus sign and degree sign, which means that it exists as a gas at room temperature. Boiling point of ethanol is 79°C, which means that it is a liquid at room temperature. The boiling points of the first six alkanes and alcohols is given below:

Alkane	Bolling Point (C)	Alcohol	Boiling point (C)
methane	-164	methanol	65
ethane	-89	ethanol	79
propane	-42	1-propanol	97
butane	-0,5	1-butanol	117
pentane	36	1-pentanol	138
hexane	69	1-hexanol	156

(B) *(c) (I), (II) and (III)*

Explanation: Alkaline potassium permanganate is a very strong oxidising agent and thus adds oxygen to the ethanol and converts ethanol to ethanoic acid. When alkaline potassium permanganate is first added drop by drop to ethanol solution, the purple colour of alkaline potassium permanganate disappears. This is because the coloured permanganate ions of alkaline potassium permanganate are consumed to oxidise ethanol solution. However, when excess of alkaline potassium permanganate is added, the purple colour of alkaline

This is because there is no more ethanol left for the reaction.

72. *We all know about the Corona pandemic which has affected millions of people not just in India, but all across the world. To save ourselves from this virus, certain measures have to be adopted by each one of us, which includes wearing a mask, maintaining social distancing and sanitization of hands frequently using a good quality sanitizer.*

Write the name and formula of a carbon compound having – OH functional group.

[CBSE 2017]

Ans. Name and formula of a carbon compound having – OH functional group:

	Name	Formula
(1)	Methanol	CH_3OH
(2)	Ethanol	C_2H_5OH
(3)	Propanol	C_3H_7OH
(4)	Butanol	C_4H_9OH

(Any 1 of 4 can be written to get full marks)

Related Theory

- *A functional group in an organic compound is an atom or a group of atoms bonded together in a unique fashion, which is usually the site of chemical reactivity in an organic molecule.*
- *Some other functional groups are aldehydic (-CHO), Ketonic (>C=O), Carboxylic acid (-COOH) and halogen (-X)*

73. *Take a look around you. You will find that most of the common household items such as sugar, vinegar, cooking gas, food, clothes etc. around us are based on carbon. The gases nitrogen, oxygen and carbon dioxide and fuels such as natural gas, kerosene, diesel and petrol have one thing in common and that is the nature of chemical bond between their atoms. All these, and many more substances around us, have covalent bonds between their atoms.*

(A) Given below is a table listing four compounds A, B, C and D and their melting and boiling points.

Compound	Melting Point (°C)	Boiling Point (°C)
A	113	184
B	- 182.5	- 161.5
C	801	1465
D	851	1600

Identify the covalent compounds from the table given above:

(a) Only A

(b) Both A and B

(c) Both A and C

(d) Both B and D

(B) The percentage of carbon in earth's crust and in the atmosphere is given below:

	Percentage of carbon in Earth's Crust	Percentage of Carbon in Atmosphere
(a)	0.02 %	0.02 %
(b)	0.03 %	0.02 %
(c)	0.03 %	0.03 %
(d)	0.02 %	0.03 %

(C) As compared to ionic compounds, covalent compounds have:

(a) low melting and boiling point

(b) high melting but low boiling point

(c) low melting but high boiling point

(d) high melting and boiling point

(D) Given below are four statements:

(I) Nitrogen molecule has triple covalent bond between its atoms

(II) Oxygen molecule has single covalent bond between its atoms.

(III) Methane molecule has four single covalent bonds between carbon and hydrogen atoms

(IV) Oxygen, nitrogen, hydrogen and carbon attain the configuration of nearest inert gas, namely, Neon, after sharing electrons.

Select the correct statement(s):

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (III) and (IV)

(E) Which of the following statements about covalent compounds is incorrect?

(a) have low melting and boiling point

(b) are poor conductors of electricity

(c) are formed between atoms of metals and non-metals

(d) are formed by sharing of electrons between its atoms

Ans. (C) *(a) low melting and boiling point*

Explanation: Covalently bonded molecules have strong bonds within the molecule, but intermolecular forces are small due to which they have low melting and boiling point.

(E) *(c) Covalent compunds are formed between atoms of metals and non-metals*

74. *A gobar gas plant or bio gas plant is useful especially in rural areas since it converts the biomass (cow dung, human wastes etc) into biogas, whose main component is methane.*

What is a saturated hydrocarbon? Write the formula of any one saturated hydrocarbon.

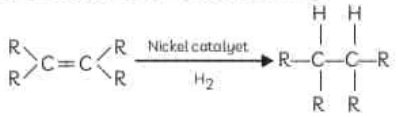
[CBSE 2017]

75. *Swati and Sneha were one day discussing about their favourite foods. Swati told Sneha "The smell of parantha or halwa made in ghee always increases my appetite. While normally I eat only one parantha, but if made in ghee, I have atleast two of them".*

Why is hydrogenation of vegetable oil said to be an addition reaction?

Ans. Addition of hydrogen to unsaturated hydrocarbons in the presence of catalysts such as palladium or nickel to give saturated hydrocarbons is known as addition reaction.

hydrogenation of vegetable oils which have long unsaturated carbon chains.



76. *Raghav used to fall sick during change of season. Every year, he would have bouts of cough and chest congestion. The doctor would prescribe certain antibiotics along with cough syrup. His friend remarked to him that one of the ingredients of cough syrup is the compound A which is the active ingredients of all alcoholic drinks and also used in medicines such as tincture iodine.*

Identify the chemical substance A. What happens when A reacts with sodium?

Ans. The chemical substance A is an ethanol, as ethanol is an active ingredient of alcoholic drinks and also used in tincture iodine and cough syrups.

Ethanol reacts with sodium to form sodium ethoxide and hydrogen.

$$2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2$$

77. ***Chemistry in Automobile:*** *Foran internal combustion engine to move a vehicle down the road, it must convert the energy stored in the fuel into mechanicalenergy to drive the wheels. In your car the distributor and battery provide this starting energy by creating an electrical "spark", which helps in combustion of fuels like gasoline. Below is the reaction depicting complete combustion of gasoline in full supply of air:*

$$2C_8H_{18(l)} + 25O_{2(g)} \longrightarrow 16'X' + 'Y'$$

(A) Which of the following are the products obtained from the reaction mentioned in the above case?

Product X	Product Y
(a) CO_2	H_2O_2
(b) H_2O	CO
(c) CH,OH	H_2O
(d) CO2	H_2O

(B) Identify the types of chemical reaction occurring during the combustion of fuel:

(b) Decomposition & Exothermic reaction

(c) Oxidation & Exothermic reaction

(d) Combination & Endothermic reaction

(C) On the basis of evolution absorption of energy, which of the following processes are similar to combustion of fuel?

(i) Photosynthesis in plants

(ii) Respiration in the liuman body

(iii) Decomposition of vegetable matter

(iv) Decomposition of ferrous sulphate.

(a) (II) and (III) **(b) (IV) and (II)**

(c) (III) and (V) **(d) (II) and (I)**

(D) 'A student while walking on the road observed that a cloud of black smoke belched out from the exhaust stack of moving trucks on the road.' Choose the correct reason for the production of black smoke:

(a) Limited supply of air leads to incomplete combustion of fuel.

(b) Rich supply of air leads to complete combustion of fuel.

(c) Rich supply of air leads to a combination reaction.

(d) Limited supply of air leads to complete combustion of fuel

(E) Although nitrogen is the most abundant gas in the atmosphere, it does not take part in combustion Identify the correct reason for this statement.

(a) Nitrogen is a reactive gas

(b) Nitrogen is an inert gas

(c) Nitrogen is an explosive gas

(d) Only hydrocarbons can take part in combustion

[CBSE Question Bank 2021]

Ans. *(d) X is CO_2 and Y is H_2O*

Explanation: When a hydrocarbon undergoes combustion, it burns in the presence of oxygen and forms carbon dioxide gas and water, along with a lot of heat.

The chemical reaction taking place when gasoline undergoes complete combustion in full supply of air is:

$$2C_8H_{18(l)} + 25O_{2(g)} \longrightarrow 16CO_{2(g)} + 18H_2O_{(g)}$$

(B) *(c) Oxidation & Exothermic reaction*

Explanation: When a fuel undergoes combustion, it combines with oxygen and

therefore, both an oxidation and exothermic reaction.

(C) *(a) (II) and (III)*

Explanation: Both respiration and decomposition of vegetable matter or compost are exothermic processes as heat energy is evolved, whereas, photosynthesis and decomposition of ferrous sulphate are endothermic processes as heat energy is absorbed.

(D) *(a) Limited supply of air leads to incomplete combustion of fuel.*

supply of oxygen, it undergoes incomplete combustion. As a result, the unburnt carbon particles give rise to a black smoke which consists of soot.

(E) *(b) Nitrogen is an inert gas*

Explanation: Although nitrogen is the most abundant gas in earth's atmosphere, it is an inert gas and does not support combustion. Substances undergo combustion only in the presence of oxygen, which is the second most abundant gas in the atmosphere and also a supporter of combustion.

SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

78. Catenation is the ability of an atom to form bonds with other atoms of the same element. It is exhibited by both carbon and silicon. Compare the ability of the catenation of the two elements. Give reasons.

[CBSE 2016, 11, 10]

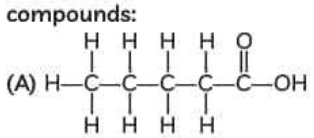
Ans. Catenation is the ability of an atom to form bonds with other atoms of the same element. It is exhibited by both carbon and silicon. Carbon exhibits catenation much more than silicon in-fact no other element exhibits the property of catenation to the extent seen in carbon compounds.

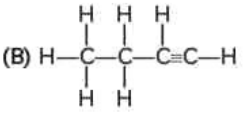
Silicon forms compounds with hydrogen which have chains of upto seven or eight atoms, but these compounds are very reactive. The carbon-carbon bond is very strong and hence stable. This gives us the large number of compounds with many carbon atoms linked to each other.

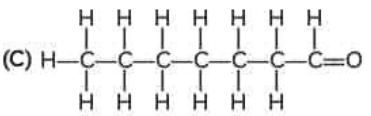
Carbon has a valency of four and it is capable of bonding with four other atoms of carbon or atoms of some other mono-valent elements..

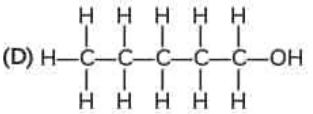
The bonds formed by carbon atoms are very strong and do not break easily so carbon compounds are stable.

79. Write the names of the following compounds:









[NCERT Exemplar]

Ans. (A) Pentanoic acid as it contains five carbon atoms with one —COOH group.

(B) Butyne as it contains four carbon atoms in a straight chain with one triple covalent bond.

(C) Heptanal as it contains seven carbon atoms with one —CHO group (aldehyde group).

(D) Pentanol because it contains 5 carbon atoms with one —OH group.

80. A compound X is formed by the reaction of a carboxylic acid $C_2H_4O_2$ and an alcohol in the presence of a few drops of H_2SO_4. The alcohol, on oxidation with alkaline $KMnO_4$ followed by acidification, gives the same carboxylic acid as used in this reaction. Give the names and structures of:

(A) Carboxylic acid [CBSE 2013]

(B) Alcohol [CBSE 2014]

(C) The compound X. Also write the reaction. [CBSE 2016]

81. Name the functional groups present in the following compounds:

(A) $CH_3COCH_2CH_2CH_2CH_3$ [CBSE 2013]

(C) $CH_3CH_2CH_2CH_2CHO$

(D) CH_3CH_2OH [CBSE 2012, 13, 15]

82. Intake of a small quantity of methanol can be lethal. Comment. [NCERT Exampler]

Ans. When methanol enters our body, it is oxidised to methanal in the liver. Methanal reacts rapidly with the components of cells. It causes the protoplasm to coagulate. It also affects the optic nerve and causes blindness.

83. A gas is evolved when ethanol reacts with sodium. Name the gas evolved and also write the balanced chemical equation of the reaction involved. [CBSE 2018, 16]

Ans. When ethanol reacts with sodium metal, it forms sodium ethoxide ($C_2H_5O^-Na^+$) and hydrogen gas is released. The reaction is as follows:

$$2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2O^-Na^+ + H_2\uparrow$$

So, the gas is hydrogen gas that is evolved during the reaction.

84. Which oils should be chosen for cooking to remain healthy? [CBSE 2020]

Ans. Oils containing unsaturated fatty acides should be chosen for cooking to remain healthy which animals fats generally contain saturated fats which are harmful for health.

85. Match the reactions given in column I with the names given in column II.

Column I	Column II
(A) $CH_3OH + CH_3COOH \xrightarrow{H^+} CH_3COOCH_3 + H_2O$	(I) Addition reaction
(B) $CH_2{=}CH_2 + H_2 \xrightarrow{Ni} CH_3{-}CH_3$	(II) Substitution reaction
(C) $CH_4 + Cl_2 \xrightarrow{Sunlight} CH_3Cl + HCl$	(III) Neutralization reaction
(D) $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$	(IV) Esterification reaction

86. What do you observe when you drop a few drops of acetic acid to a test tube containing:

(A) phenolphthalein

(B) distilled water

(C) universal indicator

(D) sodium hydrogen carbonate powder [CBSE 2016]

87. Two carbon atoms cannot be linked to each other by more than three covalent bonds. Why? [Delhi Gov. 2020]

Ans. Two carbon atoms cannot be linked to each other by more than three covalent bonds because when the two carbon atoms link with each other with four covalent bonds their nuclei come so close to each other that they start repelling each other thus they cannot form the atom as a result of the bond formation between them thus only upto three covalent bonds can be linked between two carbon atoms.

88. Write a chemical test to distinguish between ethanol and ethanoic acid. [CBSE 2012]

89. (A) Why are covalent compounds generally poor conductors of electricity?

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

90. Name the functional groups of the following compounds

(A) $R{-}\overset{\overset{O}{\|}}{C}{-}OH$

(B) $R{-}\overset{\overset{O}{\|}}{C}{-}OR'$

(C) R—OH

(D) R—X [CBSE 2013]

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

91. Unsaturated hydrocarbons contain multiple bonds between the two C-atoms and show addition reaction. Give the test to distinguish ethane from ethene. [NCERT]

Ans. To distinguish between saturated and unsaturated hydrocarbons, a combustion test should be performed.

combustion and burns with blue flame.

Also, it does not leave any residue behind after burning. On the contrary, an unsaturated hydrocarbon undergoes incomplete combustion and burns with yellow flame. Also, it leaves some residue behind after burning. Ethane is a saturated hydrocarbon. Thus, it burns with a blue flame and does not leave a residue behind. Ethene is an unsaturated hydrocarbon. Thus, it burns with a yellow flame and leaves some residue behind.

92. What is saponification? Write the eaction involved in this process. [CBSE 2014]

Ans. Saponification is the alkaline hydrolysis of esters to produce the salts of carboxylic acids and ethanol by treating them with a base like aqueous NaOH or KOH. It is the reverse of esterification reaction.

$$\underset{\text{Ethyl ethanoate}}{CH_3COOCH_2CH_3} + \underset{\text{Sodium hydroxide}}{NaOH} \xrightarrow[\text{Saponification}]{\text{Heat}} \underset{\text{Sodium ethanoate}}{CH_3COONa} + \underset{\text{Ethanol}}{CH_3CH_2OH}$$

93. Name the reaction which is commonly used in the conversion of vegetable oils to fats. Explain the reaction involved in detail. [CBSE 2017, 15, 14, 10]

structure. Name the type of bonds formed in this compounds. Why are such compounds:

(A) have low melting and boiling points?

(B) What happens when this compound burns in oxygen? [CBSE 2019]

95. What happens when 5% alkaline potassium permanganate solution is added drop by drop to warm propyl alcohol (propanol) taken in a test tube ? Explain with the help of a chemical equation. [CBSE 2019]

Ans. When 5 % alkaline potassium permanganate solution is added drop by drop to a solution of warm propyl alcohol or propanol, it gets oxidized to propanoic acid.

Here, alkaline potassium permanganate solution is the oxidizing agent.

Equation of the reaction taking place is:

$$CH_2CH_2OH \xrightarrow{\text{Alk } KMnO_4} CH_3CH_2COOH$$

Related Theory

➥ *Alcohols undergo mild or partial oxidation in the presence of Chromic anhydride (CrO_3) and oxidize to form the corresponding carboxylic acid.*

LONG ANSWER Type Questions (LA)

[5 marks]

96. What are covalent compounds? How are they different from ionic compounds? List any two properties of covalent compounds. [CBSE 2017]

97. What is a homologous series of carbon compounds? List its any two characteristics. Write the name and formula of the next higher homologous of HCOOH.

98. The general formula of the organic compounds 'A', 'B' and 'C' is C_nH_{2n}. Their boiling points are – 162 °C, – 42.2 °C and – 0.5 °C respectively. Based on this information answer the following:

(A) Which type of compounds 'A', 'B' and 'C' are and why?

(B) Which of these has maximum number of carbon atoms in the molecule and why?

(C) Write the name and structural formula of the second member of this series.

99. What are structural isomers? Why are isomers of first three members of alkane series not possible?

Write the all possible structures of isomer of fourth member of this series.

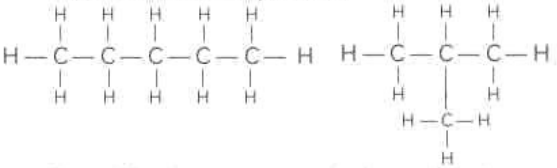
[CBSE 2013]

Ans. Structural Isomers: Compounds having same structural formula but different molecular structures are known as structural isomers.

Isomerism is not possible in first 3 members of alkane because branching is not possible, all

and there is not any possibility of formation of any side chain.

Therefore, no branching is possible for these three elements. Isomers of butane are: There are 2 isomers are possible.



Butane (C_4H_{10}) Iso-butane (C_4H_{10})

Related Theory

The first three members of alkane series are:

Methane CH_4
Methane C_2H_4
Propane C_3H_4

100. (A) **Write two points of difference between saturated and unsaturated hydrocarbons giving one example of each.**

(B) **Write the general formula of alkyne series. Write the name and structure of second member of this series.**

[CBSE 2018]

101. **The formulae of four organic compounds are given below:**

A	B	C	D
C_2H_4	CH_3COOH	C_2H_5OH	C_2H_6

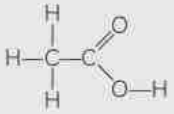
(A) Which one of these compounds *A*, *B*, *C* or *D* is a saturated hydrocarbon?

(B) Identify the organic acid and give its structural formula. **[CBSE 2019]**

Ans. (A) D is a saturated hydrocarbon

(B) B is an organic acid.

Structural formula:



[CBSE Marking Scheme 2019]

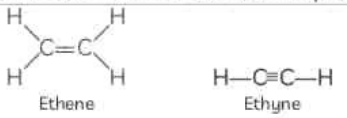
102. (A) Give the structural differences between saturated and unsaturated hydrocarbons with two examples each.

(B) What is a functional group? Give examples of four different functional groups.

[CBSE 2020, 15, 13, 12, 11]

Ans. (A) Saturated hydrocarbons contain carbon-carbon single bonds. Examples of saturated hydrocarbons: methane (CH_4) and ethane ($CH_3—CH_3$).

one carbon - carbon double or triple bond.



Ethene Ethyne

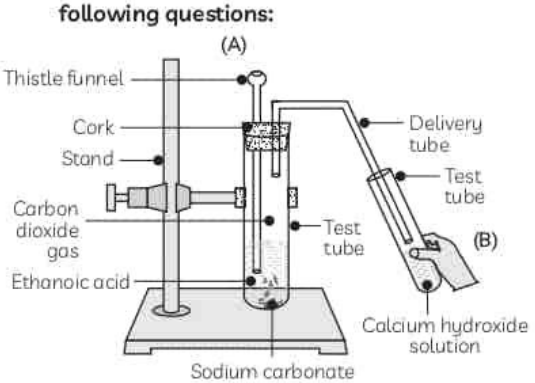
Examples of unsaturated hydrocarbons: ethene ($H_2C=CH_2$) and ethyne ($CH\equiv CH$).

(B) **Functional group:** An atom/group of atoms joined in a specific manner which is responsible for the characteristic chemical properties of the organic compounds or that dictates the properties of the carbon compound, regardless of the length of the carbon chain is known as a functional group. Some important functional groups are given in the table given below:

Name of Functional Group	Formula of Functional group
Alcohol	—OH
Carboxylic acid	—COOH
Aldehyde	—CHO
Ketone	>C=O

103. **A compound C (molecular formula, $C_2H_4O_2$) reacts with Na metal to form a compound R and evolves a gas which burns with a pop sound. Compound C, on treatment with an alcohol A in the presence of an acid, forms a sweet smelling compound S (molecular formula, $C_3H_6O_2$). On addition of NaOH to C, it also gives R and water. S, on treatment with NaOH solution, gives back R and A. Identify C, R, A, S and write down the reactions involved.** **[CBSE 2017, 16]**

104. **Look at the figure and answer the following questions:**



(A) What change would you observe in the calcium hydroxide solution taken in tube B?

A and B respectively. [CBSE 2016]

(C) If ethanol is given instead of ethanoic acid, would you expect the same change?

(D) How can a solution of lime water be prepared in the laboratory?

[NCERT Exemplar]

105. How would you bring about the following conversions? Name the process and write the reaction involved.

(A) Ethanol to ethene [CBSE 2016]

(B) Propanol to propanoic acid [CBSE 2019]

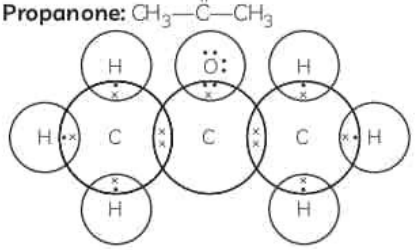
Write the reactions.

106. Draw the possible isomers of the compound with molecular formula C_3H_6O and also give their electron dot structures. [CBSE 2013]

Ans. Isomers are the molecules with same molecular formula but different structural formula.

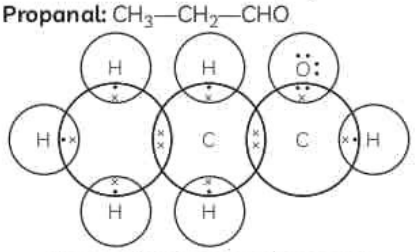
Isomers possible for the molecular formula C_3H_6O are listed below:

Propanone: $CH_3—\overset{\overset{O}{\|}}{C}—CH_3$



Electron dot structure of propanone

Propanal: $CH_3—CH_2—CHO$



Electron dot structure of propanal

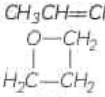
Related Theory

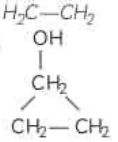
Based on the information given in NCERT, the above two isomers are considered. But other isomers possible are:

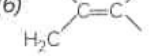
(1) $CH_2=CH—O—CH_3$ *Methoxy ethene*

(2) $CH_2=CH—CH_2—OH$ Prop-2-en-1-ol

(3) $CH_3CH=CH—OH$ Prop-1-en-1-ol

(4)  *Oxetane*

(5)  *Methyloxirane*

(6)  *Cyclopropanol*

107. An organic compound A on heating with concentrated H_2SO_4 forms a compound B, which, on addition of one mole of hydrogen in the presence of Ni, forms a compound C. One mole of compound C on combustion forms two moles of CO_2 and three moles of H_2O. Identify compounds A, B and C and write the chemical equation of the reactions involved. [CBSE 2016]

108. List two tests for experimentally distinguishing between an alcohol and a carboxylic acid and describe how these tests are performed. [CBSE 2015]

109. What happens when 5% alkaline $KMnO_4$ solution is added drop by drop to warm ethanol taken in a test tube? State the role of alkaline $KMnO_4$ solution in this reaction. [CBSE 2016]

Ans. When 5% $KMNO_4$ solution is added in warm solution of ethanol, Ethanol convert into ethanoic acid or acetic acid.

$KMNO_4$ works as oxydising agent in this reaction.

Related Theory

Ethanoic acid commonly known as acetic acid. Solution of acetic acid in water is known vinegar and use as preservative in kitchen. Melting point of ethanoid acid is 290 K and so freez in winter and hence it has another name glacial acetic acid

110. Soaps and detergents both are some type of salts. State the difference between the two. Describe in brief the cleansing action of soap. Why do soaps not form lather (foam) in hard water? Why is excessive use of detergents discouraged? List two reasons. [CBSE 2016]

111. (A) Write a chemical equation of each of the following types of chemical reactions of organic compounds.

(i) Oxidation reaction

(ii) Addition reaction

(iii) Substitution reaction

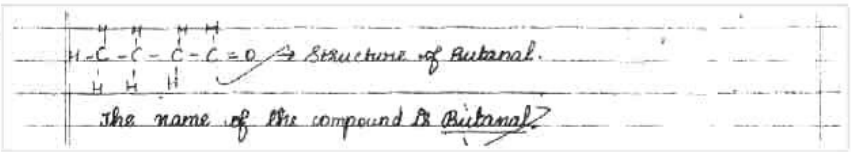
(B) What is ethanol ? What happens when it is heated with excess Conc. H_2SO_4 at 443 K? Write the role of Conc. H_2SO_4 in this reaction. [CBSE 2017]

VERY SHORT ANSWER Type Questions

[1 mark]

1. Write the name and structure of an aldehyde with four carbon atoms in its molecule.

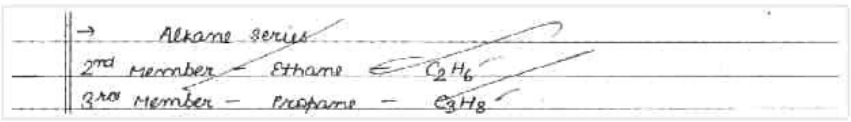
Ans.



[CBSE Topper 2016]

2. Write the molecular formula of the 2nd and the 3rd member of the homologous series whose first member is methane.

Ans.



[CBSE Topper 2017]

3. Write the name and molecular formula of the first member of the homologous series of alkynes.

Ans.

[CBSE Topper 2015]

SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

4. What are homologous series of carbon compounds? Write the molecular formula of two consecutive members of homologous series of aldehydes. State which part of these compounds determines their (i) physical and (ii) chemical properties.

Ans.

Homologous series are a series of carbon compounds with regularly varying chain lengths and the same functional group. Adjacent compounds differ by CH_2 unit and 14u molecular mass.
CH_3-CHO, CH_3CH_2-CHO are two consecutive members of homologous series of aldehydes.

i The carbon chain i.e. the alkyl group determines physical properties.
ii Functional group determines chemical properties.

[CBSE Topper 2014]

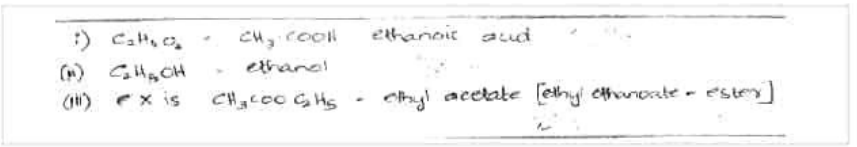
SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

5. A carboxylic acid (molecular formula $C_2H_4O_2$) reacts with an alcohol in the presence of an acid catalyst to form a compound 'X'. The alcohol on oxidation with alkaline $KMnO_4$ followed by

acid, (ii) alcohol and (iii) the compound 'X'.

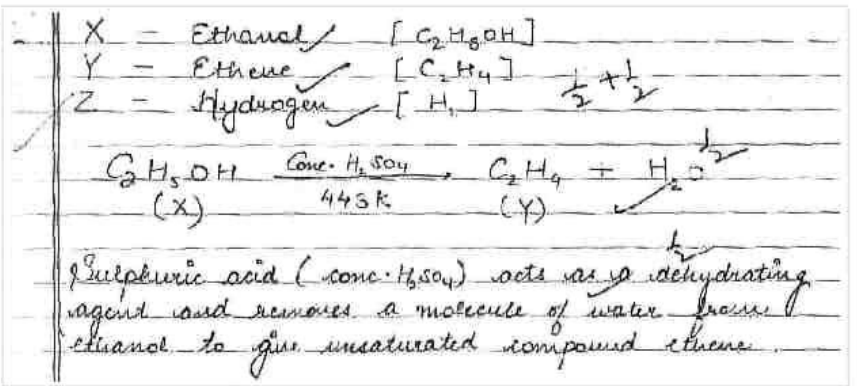
Ans.



[CBSE Topper 2014]

6. 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.

Ans.



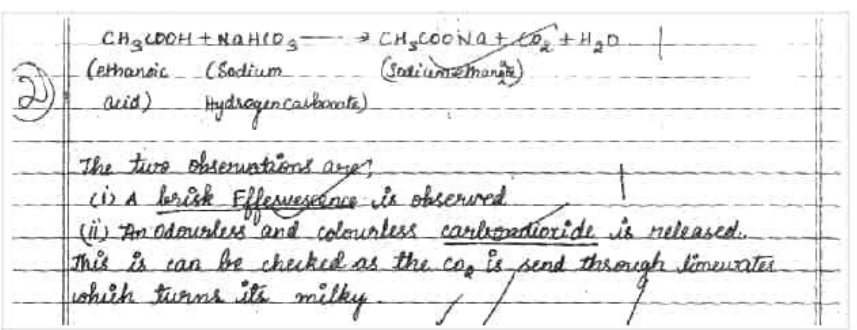
[CBSE Topper 2018]

LONG ANSWER Type Questions (LA)

[5 marks]

7. A student adds a spoon full of powdered sodium hydrogen carbonate to a flask containing ethanoic acid. List two main observations, he must note in his note book, about the reaction that takes place. Also write chemical equation for the reaction.

Ans.



[CBSE Topper 2016]