4 CARBON AND ITS COMPOUNDS

BASIC CONCEPTS – A FLOW CHART

CARBON AND ITS COMPOUNDS

Type of bonding in carbon

Covalent Bond

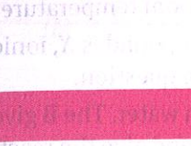
- Carbon shares its valence electrons with other elements or other carbon atoms.
- Covalent compounds have low melting and boiling points, and are poor conductors of electricity.

Types of covalent bonds

Single Covalent Bond

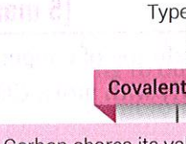
H — H
H_2 molecule

Double Covalent Bond



O = O
O_2 molecule

Triple Covalent Bond



N ≡ N
N_2 molecule

Versatile Nature of Carbon

- *Catenation:* Self-linking property of carbon atoms through covalent bonds to form long chains and rings.
- *Tetravalency:* Since carbon has a valency of four, it is capable of making bonds with four other atoms of carbon or any other element

Types of carbon compounds based on saturation

Saturated Compounds

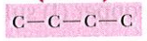
- Carbon compounds having only single bond (called alkane) between the carbon atoms are called saturated carbon compounds.
- *Examples:* Methane, ethane, propane, etc.

Unsaturated Compounds

- Carbon compounds having double bond (called alkene) or triple bond (called alkyne) between the carbon atoms.
- *Examples:* Ethene, ethyne, propene, propyne, etc.

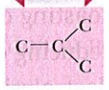
Types of carbon compounds based on skeleton

Straight Chain

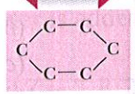


C—C—C—C

Branched Chain



Closed Chain (Ring)



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

Chemical Properties of Carbon

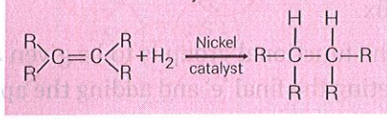
Combustion

Burn in oxygen to give carbon dioxide along with heat and light.

$CH_3CH_2OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$ + Heat and light

Addition Reaction

Unsaturated hydrocarbons add hydrogen in the presence of catalyst to give saturated hydrocarbons,



Oxidation

Oxygen is added to the starting material by oxidising agents.

$CH_3CH_2OH \xrightarrow[\text{or, acidified } K_2Cr_2O_7 + \text{heat}]{\text{Alk. } KMnO_4 + \text{heat}} CH_3COOH$

Substitution Reaction

One or more hydrogen atoms of a hydrocarbon are replaced by some other atoms.

CH_4 (Methane) + Cl_2 (Chlorine) $\xrightarrow{\text{Sunlight}}$ CH_3Cl (Chloromethane) + HCl (Hydrogen chloride)

Properties of some carbon compounds

Ethanol

- Reaction with sodium

$2Na + 2CH_3CH_2OH \longrightarrow 2CH_3CH_2O^-Na^+ + H_2$
(Sodium, Ethanol, Sodium ethoxide, Hydrogen)

- Dehydration reaction

$CH_3-CH_2OH \xrightarrow{\text{Hot conc. } H_2SO_4} CH_2=CH_2 + H_2O$

Ethanoic Acid

- Esterification reaction

$CH_3COOH + C_2H_5OH \xrightarrow{H_2SO_4} CH_3COOC_2H_5 + H_2O$
(Ethanoic acid, Ethanol, Ethyl ethanoate (ester))

Saponification reaction

$CH_3COOC_2H_5 \xrightarrow{NaOH} CH_3COONa + C_2H_5OH$
(Ester, Sodium acetate, Alcohol)

- Reaction with carbonates and hydrogencarbonates

$2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + H_2O + CO_2$

$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + H_2O + CO_2$
(Ethanoic acid, Sodium acetate)

- Reaction with a base

$NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$
(Base, Acid, Salt)

MORE POINTS TO REMEMBER

- **Homologous series:** A series of compounds in which the same functional group substitutes for hydrogen in a carbon chain is called a homologous series.
- The general formula for alkanes can be written as C_nH_{2n+2}, where $n = 2, 3, 4, ...$
- The general formula for alkenes can be written as C_nH_{2n}, where $n = 2, 3, 4, ...$
- The general formula for alkynes can be written as C_nH_{2n-2}, where $n = 2, 3, 4, ...$
- **Naming a carbon compound:**
  - (*i*) Identify the number of carbon atoms in the compound.
  - (*ii*) In case a functional group is present, it is indicated in the name of the compound with either a prefix or a suffix.
  - (*iii*) 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.
  - (*iv*) If the carbon chain is unsaturated, then the final 'ane' in the name of the carbon chain is substituted by 'ene' or 'yne'.
- **Isomerism:** The compounds which possess the same molecular formula, but different structural formulae, are called isomers and the phenomenon is known as isomerism. For example, butane with a molecular formula C_4H_{10} has two isomers.

$CH_3-CH_2-CH_2-CH_3$ (*n*-butane) and $CH_3-\underset{\underset{CH_3}{|}}{CH}-CH_3$ (iso-butane)

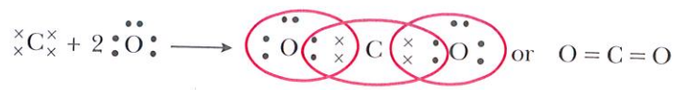
- **Allotropy** is the existence of a chemical element in two or more forms, which may differ in the arrangement of atoms in crystalline solids or in the occurrence of molecules that contain different number of atoms. For example, diamond and graphite are the two allotropes of carbon.
- **Soaps:** The molecules of soap are sodium or potassium salts of long-chain carboxylic acids. The ionic-end of soap dissolves in water while the carbon chain dissolves in oil. The soap molecules, thus form structures called micelles where one end of the molecules is towards the oil droplet while the ionic-end faces outside. This forms an emulsion in water. The soap micelle thus helps in dissolving the dirt in water and we can wash our clothes clean.
- **Detergents:** Detergents are ammonium or sulphonate salts of long chain carboxylic acids. 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.

NCERT Intext Questions

Q. 1. What would be the electron dot structure of carbon dioxide which has the formula CO_2?

Ans. In carbon dioxide molecule, the two oxygen atoms are bonded on either side with carbon atom by double bonds. Thus, there are 2 double bonds in CO_2.

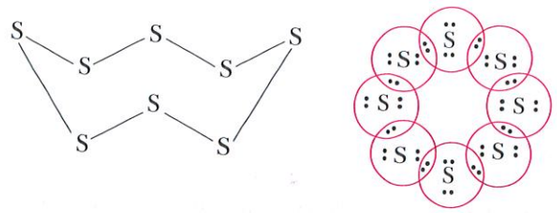
Carbon shares its two electrons in the formation of a double bond with one oxygen atom and another two electrons with another oxygen atom. In this process, both the oxygen atoms and the carbon atom acquire the stable electronic configuration of the noble gas neon. The formation of CO_2 molecule is shown below:



Valencies of C and O are 4 and 2 respectively.

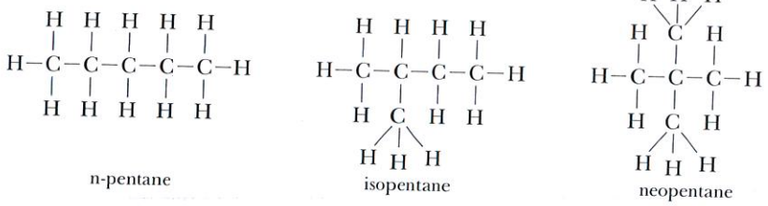
Q. 2. What would be the electron dot structure of a molecule of sulphur which is made up of eight atoms of sulphur?

Ans. The eight atoms of sulphur are joined together in the form of a ring.



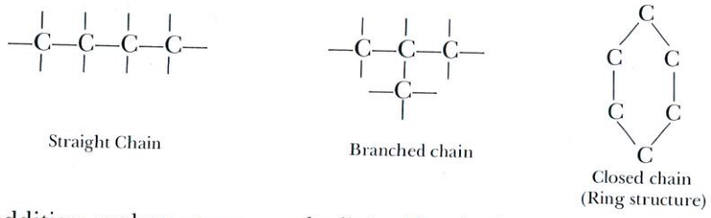
Q. 3. How many structural isomers can you draw for pentane?

Ans. The five carbon atoms in pentane, C_5H_{12} can be arranged in three different ways to give three structural isomers:



Q. 4. What are the two properties of carbon which lead to the huge number of carbon compounds we see around us?

Ans. (*i*) **Catenation:** Carbon has the unique ability to form bonds with other atoms of carbon, giving rise to large molecules. This property 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.

(*ii*) **Tetravalency:** Since carbon has a valency of four, it is capable of bonding with four other atoms of carbon or atoms of some other monovalent elements. In order to satisfy its tetravalency, carbon can form double or triple bonds with other C-atoms or with oxygen, nitrogen also. Compounds of carbon are formed with oxygen, hydrogen, nitrogen, sulphur, chlorine and many other elements giving rise to compounds with specific properties which depend on the elements other than carbon present in the molecule.

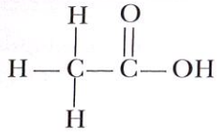
Q. 5. Draw the structures for the following compounds:

(*i*) Ethanoic acid **(*ii*) Bromopentane**

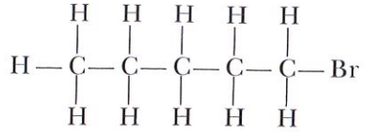
(*iii*) Butanone **(*iv*) Hexanal**

Are structural isomers possible for bromopentane?

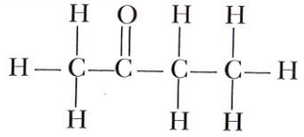
Ans. (*i*) Ethanoic acid



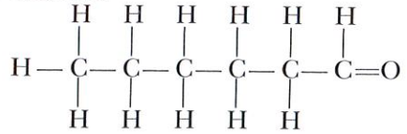
(*ii*) Bromopentane



(*iii*) Butanone



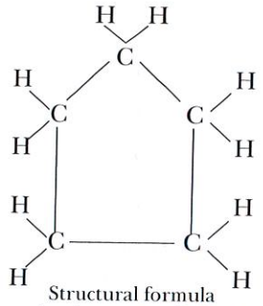
(*iv*) Hexanal



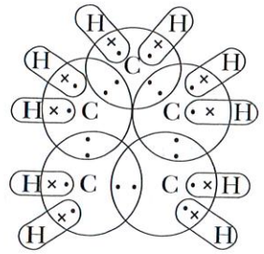
Yes, structural isomers are possible for bromopentane.

Q. 6. What will be the structural formula and electron dot structure of cyclopentane?

Ans. The molecular formula of cyclopentane is C_5H_{10}. Five carbon atoms of cyclopentane are connected by single bonds in a cyclic form. Following are the structural formula and electron dot structure of cyclopentane.

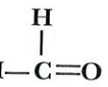
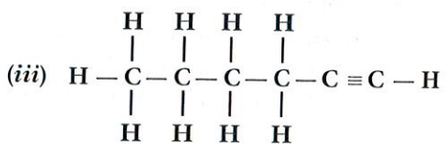


Structural formula of cyclopentane (C_5H_{10})



Electron dot structure of cyclopentane (C_5H_{10})

Q. 7. What are the names of following compounds?

(*i*) $CH_3—CH_2—Br$ (*ii*)  (*iii*) 

Ans. (*i*) Bromoethane or ethyl bromide (*ii*) Methanal or formaldehyde
(*iii*) Hexyne

Q. 8. Why is the conversion of ethanol to ethanoic acid an oxidation reaction?

Ans. The conversion of ethanol into ethanoic acid is called an oxidation reaction because oxygen is added to it during this conversion.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} + \underset{\substack{\text{Nascent oxygen}\\ \text{(From oxidising agent)}}}{2[O]} \xrightarrow[\text{Or Acidified } K_2Cr_2O_7 + \text{Heat}]{\text{Alkaline } KMnO_4 + \text{Heat}} \underset{\text{Ethanoic acid}}{CH_3COOH} + \underset{\text{Water}}{H_2O}$$

Note: *A substance which gives oxygen for oxidation is called an oxidising agent. Alkaline potassium permanganate and acidified potassium dichromate oxidise alcohols to acids, that is, adding oxygen to the starting material. Hence, they are known as oxidising agents.*

Q. 9. A mixture of oxygen and ethyne is burnt for welding. Can you tell why a mixture of ethyne and air is not used?

Ans. If a mixture of oxygen and ethyne is burnt, then ethyne burns completely producing a blue flame. The oxygen-ethyne flame is extremely hot and produces a very high temperature which is used for welding metals. A mixture of ethyne and air is not used for welding because burning of ethyne in air produces a sooty flame due to incomplete combustion, which is not hot enough to melt metals for welding.

Q. 10. How would you distinguish experimentally between an alcohol and a carboxylic acid?

Ans. All the carboxylic acids decompose sodium hydrogencarbonate giving brisk effervescence of carbon dioxide gas whereas ethanol does not react with sodium hydrogencarbonate.

Experiment:

(*i*) Take two test tubes, label them as A and B.
(*ii*) Take about 0.5 g of sodium hydrogencarbonate ($NaHCO_3$) in each test tube.
(*iii*) Add 2 mL of ethanol in test tube A and 2 mL of ethanoic acid in test tube B.
(*iv*) We can observe the gas bubbles in test tube B. No such bubbles are seen in test tube A. Pass the gas produced in test tube B through lime water taken in another test tube.
(*v*) We will find that lime water turns milky. It is a test for carbon dioxide.

Hence, this experiment proves that when ethanoic acid reacts with sodium hydrogencarbonate then carbon dioxide gas is produced with an effervescence (a rapid evolution of gas bubbles). Ethanol does not react with $NaHCO_3$.

Q. 11. What are oxidising agents?

Ans. A substance which gives oxygen for oxidation is called an oxidising agent. Alkaline potassium permanganate and acidified potassium dichromate are strong oxidising agents.

Q. 12. Would you be able to check if water is hard by using a detergent?

Ans. No, we would not be able to check whether a sample of water is hard by using a detergent because a detergent forms lather easily even in hard water.

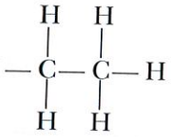
Q. 13. People use a variety of methods to wash clothes. Usually after adding the soap, they 'beat' the clothes on a stone, or beat it with a paddle, scrub with a brush or the mixture is agitated in a washing machine. Why is agitation necessary to get clean clothes?

Ans. Agitation is necessary to get clean clothes because the soap micelles which entrap oily or greasy particles on the surface of dirty cloth have to be removed from its surface. When the wetted cloth in soap solution is agitated, the micelles containing oily or greasy dirt particles get removed from the surface of dirty cloth and go into the water and the dirty cloth gets cleaned.

NCERT Exercises

Q. 1. Ethane, with the molecular formula C_2H_6 has:

(*a*) 6 covalent bonds **(*b*) 7 covalent bonds**
(*c*) 8 covalent bonds **(*d*) 9 covalent bonds**

Ans. (*b*) 7 covalent bonds: 

Q. 2. Butanone is a four carbon compound with the functional group:

(*a*) carboxylic acid **(*b*) aldehyde**
(*c*) ketone **(*d*) alcohol**

Ans. (*c*) ketone

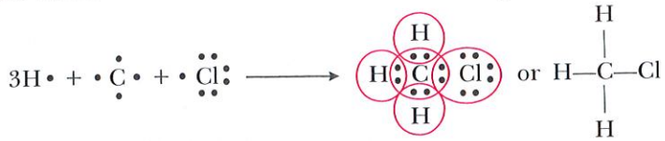
Q. 3. While cooking, if the bottom of the vessel is getting blackend on the outside, it means that:

(*a*) the food is not cooked completely. **(*b*) the fuel is not burning completely.**
(*c*) the fuel is wet. **(*d*) the fuel is burning completely.**

Ans. (*b*) the fuel is not burning completely.

Q. 4. Explain the nature of the covalent bond using the bond formation in CH_3Cl.

Ans. CH_3Cl is chloromethane. It is made up of one carbon atom, three hydrogen atoms and one chlorine atom. Carbon atom has 4 outermost electrons, each hydrogen atom has 1 electron and chlorine has 7 outermost electrons. Carbon shares its four outermost electrons with three hydrogen atoms and one chlorine atom to form CH_3Cl as follows:

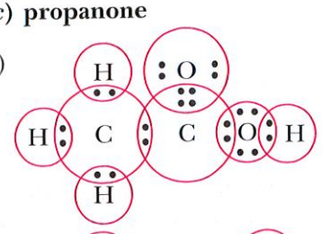


Each atom in CH_3Cl has a noble gas electron arrangement. Carbon attains the nearest noble gas configuration of neon, hydrogen acquires the configuration of helium while chlorine achieves the configuration of argon. Chloromethane contains three C—H and one C—Cl covalent bonds.

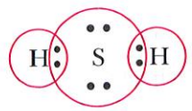
Q. 5. Draw the electron dot structures for:

(*a*) ethanoic acid **(*b*) H_2S**
(*c*) propanone **(*d*) F_2**

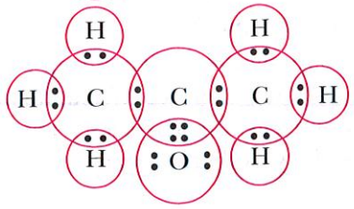
Ans. (*a*)



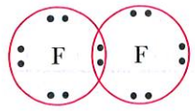
(*b*)



(*c*)



(*d*)



Q. 6. What is a homologous series? Explain with an example.

Ans. A homologous series is a group of organic compounds having same functional group and similar chemical properties in which the successive compounds differ by CH_2 group. They can be represented by same general formula.

Homologous Series of Alkanes: All the alkanes have similar structures with single covalent bonds and show similar chemical properties. Therefore, alkanes can be grouped together in the form of a homologous series. The first six members of the homologous series of alkanes are given in the following table:

Table: Homologous Series

Compound	Molecular Formula	Difference
Alkanes	C_nH_{2n+2} (General formula)	
1. Methane	CH_4	
2. Ethane	C_2H_6	
3. Propane	C_3H_8	$—CH_2—$
4. Butane	C_4H_{10}	
5. Pentane	C_5H_{12}	
6. Hexane	C_6H_{14}	

Q. 7. How can ethanol and ethanoic acid be differentiated on the basis of their physical and chemical properties?

Ans.

Ethanol	Ethanoic Acid
1. Ethanol has a pleasant smell.	1. Ethanoic acid has the smell of vinegar.
2. The boiling point of ethanol is 351 K.	2. The boiling point of ethanoic acid is 391 K.
3. Ethanol reacts with alkaline $KMnO_4$ to give ethanoic acid.	3. Ethanoic acid does not react with alkaline $KMnO_4$.
4. Ethanol does not react with sodium hydrogencarbonate.	4. It gives brisk effervescence with sodium hydrogencarbonate: $CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + H_2O + CO_2\uparrow$

Q. 8. Why does micelle formation take place when soap is added to water? Will a micelle be formed in other solvents such as ethanol also?

Ans. When soap is added to water, micelle formation takes place. This is because the hydrocarbon chains of soap molecules are hydrophobic which are insoluble in water, but the ionic ends of soap molecules are hydrophilic and hence soluble in water. Since soap is soluble in ethanol, so micelle formation does not occur.

Q. 9. Why are carbon and its compounds used as fuels for most applications?

Ans. Carbon and its compounds are used as fuels because they burn in air releasing a large amount of heat energy.

$$C + O_2 \longrightarrow CO_2 + \text{Heat}$$
$$CH_4 + 2O_2 \longrightarrow CO_2 + H_2O + \text{Heat}$$

Q. 10. Explain the formation of scum when hard water is treated with soap.

Ans. Soap does not give foam easily with hard water. Hard water contains calcium and magnesium salts. Soap first reacts with the calcium ions and magnesium ions to form insoluble precipitates of calcium and magnesium salts of fatty acid.

$$\underset{\text{(soap)}}{\text{Sodium stearate}} + \text{Hard water} \longrightarrow \underset{\text{(scum)}}{\text{Calcium stearate}} + \text{Magnesium stearate}$$

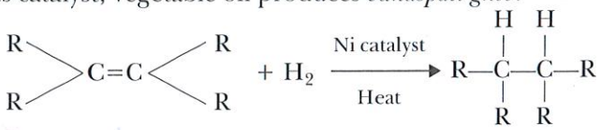
Q. 11. What change will you observe if you test soap with litmus paper (red or blue)?

Ans. A soap is the salt of a strong base (sodium hydroxide) and a weak acid (carboxylic acid), so a solution of soap in water is basic in nature. Being basic, a soap solution will turn red litmus paper blue.

Q. 12. What is hydrogenation? What is its industrial application?

Ans. The addition of hydrogen to an unsaturated hydrocarbon to get a saturated hydrocarbon is called hydrogenation. This process takes place in the presence of nickel or palladium metals as catalyst.

It has an important industrial application. It is used to prepare vegetable ghee from vegetable oils. Vegetable oils such as groundnut oils, cottonseed oils and mustard oils are unsaturated and also contain double bonds (C=C). On hydrogenation (addition of hydrogen), in the presence of nickel as catalyst, vegetable oil produces *vanaspati ghee*.



Vegetable oil (liquid state) — Vanaspati ghee (solid state)

Q. 13. Which of the following hydrocarbons undergo addition reactions?

C_2H_6, C_3H_8, C_3H_6, C_2H_2 and CH_4

Ans. The unsaturated hydrocarbons undergo addition reactions. Out of the given hydrocarbons, C_3H_6 (alkene) and C_2H_2 (alkyne) are unsaturated. Therefore, C_3H_6 and C_2H_2 will undergo addition reactions.

Q. 14. Give a test that can be used to differentiate between butter and cooking oil.

Ans. If a carbon compound decolourises bromine water, it will be an unsaturated compound. Thus, we can distinguish between a cooking oil and butter by the bromine water test.

(*i*) Cooking oil decolourises bromine water. This shows that it is an unsaturated compound.

(*ii*) Butter does not decolourise bromine water. This shows that it is a saturated compound.

Q. 15. Explain the mechanism of the cleaning action of soaps.

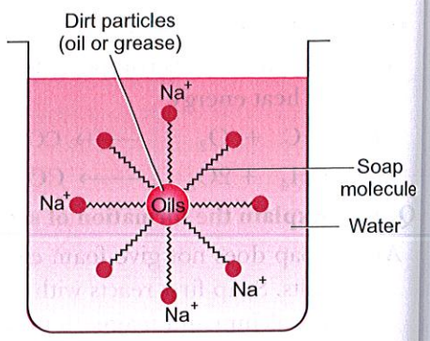
Ans. **Cleaning Action of Soap:** A soap molecule consists of two dissimilar parts:

(*i*) A short ionic part comprising the carboxylate salt, $—COO^-Na^+$.This is the polar end. This is water soluble (*i.e.*, hydrophilic or water attracting) and, therefore, remains attached to water.

(*ii*) A long hydrocarbon chain which is the non-polar end. This end is hydrophobic *i.e.*, water repelling) and is soluble in oil and grease.

Non-polar end (Hydrophobic) Oil soluble end — $C_{17}H_{35}$ Soap molecule — Polar end (Hydrophilic) Water soluble end

When soap is dissolved in water, it forms a colloidal suspension. In this colloidal suspension, the soap molecules cluster together to form micelles and remain radially suspended in water with the hydrocarbon end towards the centre and the ionic end directed outward. This is shown in the figure.



The dirt particles always adhere to the oily or greasy layer present on the skin or clothes. When a dirty cloth is dipped into a soap solution, its non-polar hydrocarbon end of micelles attach to the grease or oil present in dirt and polar end remains in water layer. The mechanical action of rubbing subsequently, dislodges the oily layer from the dirty surface shaping it into small globules. A stable emulsion of oil in water is formed. The emulsified oil or grease globules bearing the dirt can now be readily washed with water.

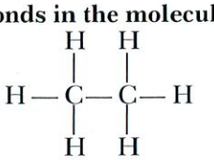
VERY SHORT ANSWER QUESTIONS [1 mark]

Q. 1. Draw the electron dot structure of the gas molecule which is liberated when zinc metal is treated with aqueous NaOH solution.

Ans. Hydrogen gas, H:H

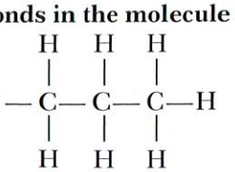
Q. 2. Write the number of covalent bonds in the molecule of ethane. *[CBSE (AI) 2015]*

Ans. There are seven covalent bonds:



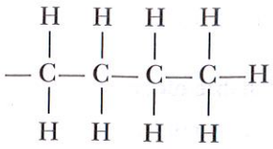
Q. 3. Write the number of covalent bonds in the molecule of propane, C_3H_8. *[CBSE (AI) 2015]*

Ans. There are ten covalent bonds:



Q. 4. Write the number of covalent bonds in the molecule of butane, C_4H_{10}. *[CBSE (AI) 2015]*

Ans. There are thirteen covalent bonds:



Q. 5. Which element exhibits the property of catenation to maximum extent and why? *[CBSE (F) 2016]*

Ans. Carbon exhibits the property of catenation due to strong C—C bond.

Q. 6. What is the molecular formula of the alcohol which can be derived from propane?

Ans. Propane: $CH_3—CH_2—CH_3$ or C_3H_8

Alcohol obtained from propane is C_3H_7OH.

Q. 7 Write the molecular formula of first two members of homologous series having functional group –Cl. *[CBSE Delhi 2017]*

Ans. (*i*) CH_3Cl (*ii*) C_2H_5Cl

Q. 8. Write the melecular formula of first two members of homologous series having functional group –Br. *[CBSE Delhi 2017]*

Ans. (*i*) CH_3Br (*ii*) C_2H_5Br

Q. 9. Write the molecular formula of first two members of homologous series having functional froup –OH. *[CBSE Delhi 2017]*

Ans. (*i*) CH_3OH (*ii*) C_2H_5OH

Q. 10. Give the names of the functional groups:

(*i*) —OH **(*ii*) —C(=O)—** *[CBSE (F) 2015]*

Ans. (*i*) Alcoholic group (*ii*) Ketonic group

Q. 11. Write the molecular formula of (*i*) Methane and (*ii*) Ethanol. *[CBSE Delhi (C) 2015]*

Ans. (*i*) CH_4 (*ii*) C_2H_5OH

Q. 12. Which functional groups always occur at the terminal position of a carbon chain?

Ans. Aldehydic group R—CHO and carboxyl group R—COOH (R = alkyl group).

Q. 13. Name the functional group which always occurs in the middle of a carbon chain.

Ans. Ketonic group always occurs in the middle of a carbon chain.

Q. 14. In an organic compound, which parts largely determine its physical and chemical properties?

Ans. The alkyl part (carbon chain) of an organic compound determines its physical properties whereas the functional group determines its chemical properties.

Q. 15. An organic compound 'X' of molecular formula $C_2H_4O_2$ gives brisk effervescence with sodium bicarbonate. Give the name and formula of X.

Ans. 'X' is ethanoic acid (an organic acid). 'X' $\rightarrow CH_3COOH$

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

Organic acid decomposes sodium bicarbonate and gives brisk effervescence of carbon dioxide gas.

Q. 16. Why is pure ethanoic acid called glacial ethanoic acid (or glacial acetic acid)?

Ans. The melting point of pure ethanoic acid is 290 K and hence it often freezes in cold climate to form a colourless, ice-like liquid. This has given it the name glacial acetic acid.

Q. 17. What is vinegar?

Ans. A 5–8% solution of acetic acid in water is called vinegar and is used widely as a preservative in pickles.

Q. 18. How does carbon attain a stable electronic configuration?

Ans. Carbon attains stable electronic configuration by sharing its four electrons with other atoms.

Q. 19. What is isomerism?

Ans. It is a phenomenon in which compounds have the same molecular formula but different structural formula.

Q. 20. Which of the following formulae represents a saturated hydrocarbon?

C_nH_{2n+2}, C_nH_{2n+1}, C_nH_{2n}, C_nH_{2n-2}

Ans. C_nH_{2n+2}, represents a saturated hydrocarbon.

Q. 21. Which of the following are alkenes?

CH_4, C_2H_6, C_2H_4, C_3H_6 and C_3H_8.

Ans. C_2H_4 and C_3H_6 are alkenes.

Q. 22. What happens when methane is burnt in air?

Ans. Methane burns in air to give carbon dioxide and water.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + \text{Heat energy}$$

Q. 23. A test tube contains a brown coloured liquid. The colour of the liquid in test tube remains unchanged when methane is passed through it, but disappears when ethene is passed. Which element is present in the liquid?

Ans. The element present in the liquid is bromine.

Q. 24. What is the next homologue of C_3H_7OH called?

Ans. The next homologue of C_3H_7OH is called butanol (C_4H_9OH).

Q. 25. Write the name and formula of the 2nd member of homologous series having general formula C_nH_{2n}. *[CBSE Delhi 2015]*

Ans. The 2nd member is propene, C_3H_6.

Q. 26. Write the name and formula of the 2nd member of homologous series having general formula C_nH_{2n+2}. *[CBSE Delhi 2015]*

Ans. The second member is ethane, C_2H_6.

Q. 27. Write the name and formula of the 2nd member of homologous series having general formula C_nH_{2n-2}. *[CBSE Delhi 2015]*

Ans. The 2nd member is propyne, C_3H_4.

Q. 28. Define allotropy. *[CBSE Delhi 2017]*

Ans. Allotropy is the property of an element to exist in different physical forms but have similar chemical properties.

Q. 29. Write the molecular formula of the 2nd and the 3rd member of the homologous series whose first member is methane. *[CBSE (AI) 2017]*

Ans. C_2H_6, C_3H_8

Q. 30. Which two of the following organic compounds belong to the same homologous series?

C_2H_6, C_2H_6O, $C_2H_6O_2$, CH_4O

Ans. CH_4O and C_2H_6O belong to the same homologous series.

Q. 31. Write the name and molecular formula of the first member of the homologous series of alkynes. *[CBSE (F) 2015]*

Ans. The first member is ethyne, C_2H_2.

Q. 32. Write the name and molecular formula of the fourth member of alkane series. *[CBSE (F) 2016]*

Ans. The fourth member of the alkane series is butane C_4H_{10}.

Q. 33. Write the next homologue of each of the following:

(*i*) C_2H_4 **(*ii*) C_4H_6** *[CBSE Delhi 2016]*

Ans. (*i*) C_3H_6 (*ii*) C_5H_8

Q. 34. Name the following compounds:

(*a*) $CH_3—CH_2—OH$ **(*b*) $CH_3—\overset{\overset{H}{|}}{C}=O$** *[CBSE Delhi 2016]*

Ans. (*a*) Ethanol (*b*) Ethanal

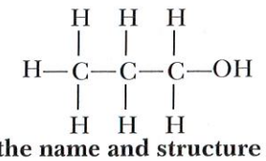
Q. 35. Select saturated hydrocarbons from the following:

C_3H_6; C_5H_{10}; C_4H_{10}; C_6H_{14}; C_2H_4 *[CBSE Delhi 2016]*

Ans. C_4H_{10} and C_6H_{14} are saturated hydrocarbons.

Q. 36. Write the name and structure of an alcohol with three carbon atoms in its molecule. *[CBSE (AI) 2016]*

Ans. The compound is propanol.

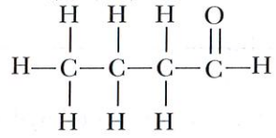


or $CH_3CH_2CH_2OH$

Q. 37. Write the name and structure of an aldehyde with four carbon atoms in its molecule. *[CBSE (AI) 2016]*

Ans. Butanal; $CH_3—CH_2—CH_2—CHO$

or



Q. 38. Name the process by which unsaturated fats are changed to saturated fats. *[CBSE (F) 2015]*

Ans. Hydrogenation

SHORT ANSWER QUESTIONS–I [2 marks]

Q. 1. What is a covalent bond? What type of bond exists in (*i*) CCl_4 (*ii*) $CaCl_2$?

Ans. The chemical bonds formed between two atoms by the sharing of electrons between them is known as a covalent bond. The sharing of electrons between the two atoms takes place in such a way that both the atoms acquire stable electronic configuration of their nearest noble gas.

(*i*) CCl_4 – Covalent bond, (*ii*) $CaCl_2$ – Ionic bond

Q. 2. 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 catenation of the two elements. Give reasons. *[NCERT Exemplar]*

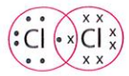
Ans. Carbon exhibits catenation much more than silicon or any other element due to its smaller size which makes the C—C bonds strong while the Si—Si bonds are comparatively weaker due to its large size.

Q. 3. In electron dot structure, the valence shell electrons are represented by crosses or dots.

(*a*) The atomic number of chlorine is 17. Write its electronic configuration.

(*b*) Draw the electron dot structure of chlorine molecule. *[NCERT Exemplar]*

Ans. (*a*) K, L, M
2, 8, 7

(*b*) 

Q. 4. Select the hydrocarbons which are members of the same homologous series. Give the name of each series.

C_3H_8, C_4H_{10}, C_5H_{10}, C_6H_{10}, C_7H_{12} and C_8H_{16}.

Ans. C_3H_8, C_4H_{10} → Alkanes

C_5H_{10}, C_8H_{16} → Alkenes

C_6H_{10}, C_7H_{12} → Alkynes

Q. 5. Name the functional groups present in the following compounds

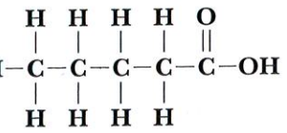
(*a*) $CH_3CO CH_2 CH_2 CH_2 CH_3$ **(*b*) $CH_3 CH_2 CH_2 COOH$**

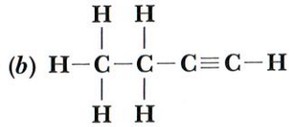
(*c*) $CH_3 CH_2 CH_2 CH_2 CHO$ **(*d*) $CH_3 CH_2 OH$** *[NCERT Exemplar]*

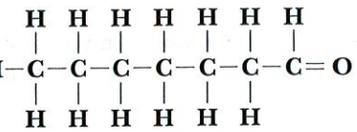
Ans. (*a*) Ketone (*b*) Carboxylic acid

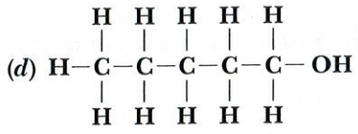
(*c*) Aldehyde (*d*) Alcohol

Q. 6. Write the names of the following compounds.

(*a*) 

(*b*) 

(*c*) 

(*d*)  *[NCERT Exemplar]*

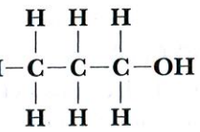
Ans. (*a*) Pentanoic acid (*b*) Butyne

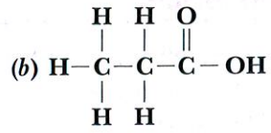
(*c*) Heptanal (*d*) Pentanol

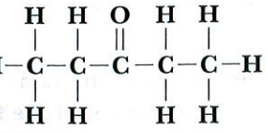
Q. 7. Why are unsaturated hydrocarbons more reactive than saturated hydrocarbons?

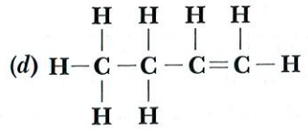
Ans. Unsaturated hydrocarbons are more reactive due to the presence of C=C and C≡C bonds which are weaker than the single bond in saturated hydrocarbons. These double and triple bonds are the reactive sites in the unsaturated hydrocarbons which easily give addition reactions.

Q. 8. Identify and name the functional groups present in the following compounds.

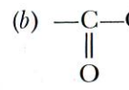
(*a*) 

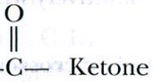
(*b*) 

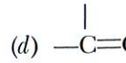
(*c*) 

(*d*)  *[NCERT Exemplar]*

Ans. (*a*) —OH Hydroxyl/Alcohol

(*b*)  Carboxylic acid

(*c*)  Ketone

(*d*)  Alkene

Q. 9. Write the name and molecular formula of an organic compound having its name suffixed with '–ol' and having two carbon atoms in the molecule. With the help of a balanced equation indicate what happens when it is heated with excess of conc. H_2SO_4. *[CBSE Sample Paper 2016]*

Ans. The organic compound is ethanol. Its molecular formula is C_2H_6O and structural formula is C_2H_5OH or CH_3CH_2OH.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[\text{Heat}]{\text{conc. } H_2SO_4} \underset{\text{Ethene}}{CH_2{=}CH_2} + H_2O$$

Q. 10. Complete the reaction(s) given below and classify them as Combustion/Oxidation/ Addition/ Substitution reaction.

(*i*) $CH_3CH_2CH_2OH \xrightarrow[\text{Heat}]{\text{alk.KMnO}_4}$ **(*ii*) $C_2H_4 + H_2 \xrightarrow{\text{Ni catalyst}}$**

Ans. (*i*) CH_3CH_2COOH, Oxidation (*ii*) C_2H_6, Addition.

Q. 11. Carbon, Group (14) element in the Periodic Table, is known to form compounds with many elements. *[NCERT Exemplar]*

Write an example of a compound formed with

(*a*) Chlorine (Group 17 of Periodic Table) **(*b*) Oxygen (Group 16 of Periodic Table)**

Ans. (*a*) Carbon tetrachloride (CCl_4) (*b*) Carbon dioxide (CO_2)

Q. 12. How is ethanol obtained for commercial use?

Ans. When ethene is heated with concentrated sulphuric acid at 75°C (348 K), and treated with water, ethanol is produced.

$$\underset{\text{Ethene}}{CH_2{=}CH_2} + \underset{\text{Water}}{H{-}OH} \xrightarrow{H_2SO_4} \underset{\text{Ethanol}}{CH_3{-}CH_2{-}OH}$$

Q. 13. Name the gas evolved when ethanoic acid reacts with sodium carbonate. How would you identify this gas?

Ans. The gas evolved is carbon dioxide (CO_2). The reaction is as follows:

$$\underset{\text{Ethanoic acid}}{2CH_3COOH} + \underset{\substack{\text{Sodium}\\\text{carbonate}}}{Na_2CO_3} \longrightarrow \underset{\substack{\text{Sodium}\\\text{ethanoate}}}{2CH_3COONa} + \underset{\substack{\text{Carbon}\\\text{dioxide}}}{CO_2} + \underset{\text{Water}}{H_2O}$$

When this gas is passed through lime water, it turns milky. The milky colour of lime water confirms that the gas is carbon dioxide (CO_2).

Q. 14. Write four uses of ethyl alcohol. *[CBSE Sample Paper 2016]*

Ans. (*i*) It is used in the manufacture of paints, medicines, dyes, soaps, etc.

(*ii*) It is used in the preparation of organic compounds like ether, chloroform and iodoform.

(*iii*) It is used as a fuel in internal combustion engines.

(*iv*) It is used in low temperature thermometers.

Q. 15. Mention the physical properties of ethanoic acid.

Ans. (*i*) It is a colourless liquid. (*ii*) It is sour in taste.

(*iii*) It has a characteristic smell. (*iv*) It is soluble in water.

Q. 16. How will you convert ethanoic acid into methane? Explain with the help of equations of the reactions involved.

Ans. $\underset{\text{Ethanoic acid}}{CH_3COOH} + \underset{\substack{\text{Sodium}\\\text{hydroxide}}}{NaOH} \longrightarrow \underset{\text{Sodium ethanoate}}{CH_3COONa} + \underset{\text{Water}}{H_2O}$

Then, sodium ethanoate is heated with sodalime to get methane.

$$\underset{\text{Sodium ethanoate}}{CH_3COONa} + \underset{\substack{\text{Sodium hydroxide}\\\text{(from sodalime)}}}{NaOH} \longrightarrow \underset{\text{Methane}}{CH_4} + \underset{\substack{\text{Sodium}\\\text{carbonate}}}{Na_2CO_3}$$

Q. 17. What is meant by denatured alcohol? What is the need to denature alcohol?

Ans. Denatured alcohol is ethyl alcohol which has been made unfit for drinking purposes by adding poisonous substances like methanol, pyridine, copper sulphate, etc.

Ethanol is an important chemical. It is supplied at concessional rates to industries. It is therefore, made unfit for drinking purposes to prevent its misuse.

Q. 18. Intake of small quantity of methanol can be lethal. Comment. *[NCERT Exemplar]*

Ans. Methanol 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, causes blindness.

Q. 19. A gas is evolved when ethanol reacts with sodium. Name the gas evolved and also write the balanced chemical equation of the reaction involved. *[NCERT Exemplar]*

Ans. Gas evolved is hydrogen.

$$2CH_3CH_2OH + 2Na \longrightarrow 2CH_3CH_2O^-Na^+ + H_2$$

Q. 20. Why are detergents better cleansing agents than soaps? *[NCERT Exemplar]*

Ans. Detergents work as cleansing agent in hard and soft water both because the charged ends of detergents do not form insoluble precipitates with calcium and magnesium ions in hard water.

Q. 21. Why are soaps not suitable for washing clothes with hard water?

Ans. Soaps are not suitable for washing clothes with hard water because of two reasons:

(*i*) Soap reacts with the calcium and magnesium ions present in hard water to form insoluble precipitate called scum. This results in the wastage of soap.

(*ii*) The sticky scum sticks to the clothes being washed and interferes with the cleaning ability of soap. This makes the cleaning of clothes difficult.

Q. 22. Two carbon compounds A and B have the molecular formula C_3H_8 and C_3H_6 respectively. Which one of the two is most likely to show addition reaction? Justify your answer.

Ans. Compound A (C_3H_8) is a saturated and compound B (C_3H_6) is an unsaturated hydrocarbon (with a double bond). As we know that addition reactions are a characteristic property of unsaturated hydrocarbons, thus the compound B (C_3H_6) is most likely to show addition reaction.

Q. 23. How would you bring about the following conversions? Name the process and write the reaction involved.

(*a*) Ethanol to ethene. **(*b*) Propanol to propanoic acid.** *[NCERT Exemplar]*

Ans. (*a*) By the dehydration of ethanol in the presence of concentrated H_2SO_4.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[\text{Heat}]{\text{conc. } H_2SO_4} \underset{\text{Ethene}}{CH_2{=}CH_2} + H_2O$$

(*b*) By the oxidation of propanol using oxidising agent such as alkaline $KMnO_4$.

$$CH_3CH_2CH_2OH \xrightarrow[\text{Heat}]{\text{Alk. } KMnO_4} CH_3CH_2COOH + H_2O$$

Q. 24. Ethene is formed when ethanol at 443 K is heated with excess of concentrated sulphuric acid. What is the role of sulphuric acid in this reaction? Write the balanced chemical equation of this reaction. *[NCERT Exemplar, CBSE Delhi 2015, (F) 2015]*

Ans. Sulphuric acid acts as a dehydrating agent.

$$CH_3CH_2OH \xrightarrow[443\text{ K}]{\text{Hot conc. } H_2SO_4} CH_2{=}CH_2 + H_2O$$

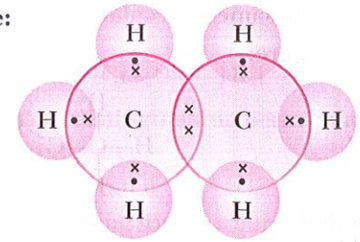
SHORT ANSWER QUESTIONS–II [3 marks]

Q. 1. Write the molecular formula of the following compounds and draw their electron-dot structures:

(*i*) Ethane **(*ii*) Ethene** **(*iii*) Ethyne** *[CBSE (F) 2015]*

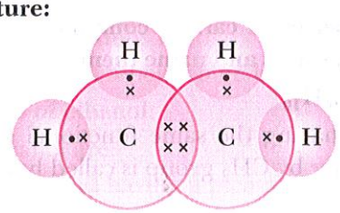
Ans. **(*i*) Ethane:** The molecular formula is C_2H_6.

Electron-dot structure:



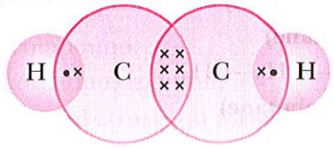
(*ii*) Ethene: The molecular formula is C_2H_4.

Electron-dot structure:



(*iii*) Ethyne: The molecular formula is C_2H_2.

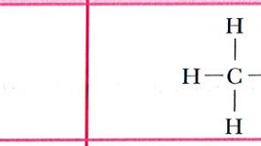
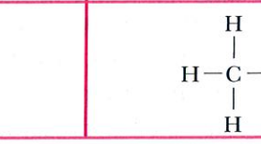
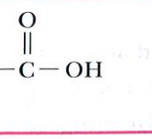
Electron-dot structure:



Q. 2. What is meant by functional group in carbon compounds? Write in tabular form the structural formula and the functional group present in the following compounds:

(*i*) Ethanol **(*ii*) Ethanoic acid** *[CBSE (F) 2015]*

Ans. An atom or a group of atoms which determine the chemical properties of an organic compound is called a functional group.

Name of Compound	Structural Formula	Functional Group
Ethanol		—OH
Ethanoic acid		

Q. 3. Draw the electron-dot structure for ethyne. A mixture of ethyne and oxygen is burnt for welding. In your opinion, why cannot we use a mixture of ethyne and air for this purpose? *[CBSE (AI) 2015]*

Ans. For structure of ethyne, Refer to Q. 1, Short Answer Questions–II.

Ethyne burns in air with a sooty flame because of incomplete combustion caused by the limited supply of air. But when burnt at 3000°C in oxygen it gives a clean flame because of complete combustion. This oxy-acetylene flame is used for welding.

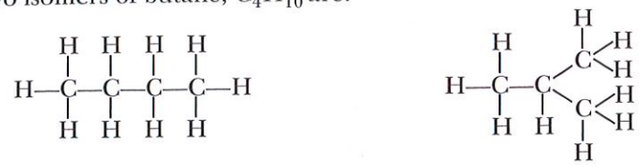
Such a high temperature cannot be achieved without mixing oxygen.

Therefore, a mixture of ethyne and air is not used for welding.

Q. 4. What is meant by isomers? Draw the structures of two isomers of butane, C_4H_{10}. Explain why we cannot have isomers of first three members of alkane series. *[CBSE Delhi 2015]*

Ans. Isomers are compounds having the same molecular formula but different structures.

The two isomers of butane, C_4H_{10} are:



Since branching is not possible, isomers are not possible for the first three members of alkane series.

Q. 5. What is meant by homologous series of carbon compounds? Classify the following carbon compounds into two homologous series and name them.

C_3H_4, C_3H_6, C_4H_6, C_4H_8, C_5H_8, C_5H_{10} *[CBSE (AI) 2015]*

Ans. A group of organic compounds having the same functional group and similar structures in which the successive members differ by CH_2 group is called homologous series.

Alkynes: C_3H_4, C_4H_6, C_5H_8

Alkenes: C_3H_6, C_4H_8, C_5H_{10}

Q. 6. Give an example each of (*i*) open chain (*ii*) branched chain and (*iii*) ring compounds.

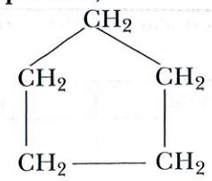
Ans. **(*i*) Open chain compound (*n*-pentane)**

$$CH_3—CH_2—CH_2—CH_2—CH_3$$

(*ii*) Branched chain compound (isobutane)

$$CH_3—\underset{\displaystyle CH_3}{\overset{\displaystyle |}{CH}}—CH_3$$

(*iii*) Ring (cyclopentane)



Q. 7. (*a*) How does the supply of air affect combustion of saturated hydrocarbons?

(*b*) What is indicated by:

(*i*) sooty flame **(*ii*) blue flame of a bunsen burner?**

(*c*) Why are holes provided at the bottom of a bunsen burner?

Ans. (*a*) If air supply is not sufficient, saturated hydrocarbons give yellow sooty flame.

(*b*) (*i*) Yellow sooty flame–Burning of unsaturated hydrocarbons such as ethene and ethyne/ incomplete combustion (any one).

(*ii*) Blue flame–Burning of saturated hydrocarbons/complete combustion.

(*c*) Holes let the supply of air to be adjusted for complete combustion.

Q. 8. Explain the given reactions with examples:

(*a*) Combustion reaction **(*b*) Oxidation reaction**

(*c*) Substitution reaction *[NCERT Exemplar]*

Ans. **(*a*) Combustion reaction:** Carbon compounds burns in oxygen to produce carbon dioxide alongwith release of large amount of heat and light.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + \text{Heat and light}$$

(*b*) Oxidation reaction: Ethanol is oxidised to ethanoic acid in the presence of alkaline $KMnO_4$ (oxidising agent) on heating.

$$CH_3CH_2OH \xrightarrow[\text{Heat}]{\text{Alk.KMnO}_4} CH_3COOH$$

(*c*) Substitution reaction: In the presence of sunlight, chlorine replaces the hydrogen atom of hydrocarbons.

$$CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl + HCl$$

Q. 9. List two tests for experimentally distinguishing between an alcohol and a carboxylic acid and describe how these tests are performed. *[CBSE (AI) 2015]*

Ans. **(*i*) Test with $NaHCO_3$ solution in water.**

On adding carboxylic acid to baking soda, carbon dioxide is liberated with brisk effervescence.

On adding a solution of baking soda to alcohol, no brisk effervescence occurs.

(*ii*) Test with blue litmus solution.

Carboxylic acid turns blue litmus red.

There is no change in colour when a blue litmus solution is added to alcohol.

Q. 10. Write physical properties of ethanol.

Ans. Physical properties of ethanol are:

(*i*) Ethanol is a colourless liquid having a pleasant smell and a burning taste.

(*ii*) Ethanol is a liquid at room temperature.

(*iii*) Ethanol is lighter than air.

(*iv*) Ethanol is miscible with water.

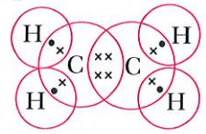
(*v*) Ethanol is a covalent compound.

(*vi*) Ethanol has no effect on litmus solution.

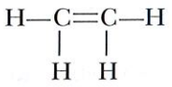
Q. 11. Write molecular, electronic and structural formulae of ethene.

Ans. Molecular formula: C_2H_4

Electronic formula:



Structural formula:



Q. 12. What is a homologous series of carbon compounds ? List its any two characteristics. Write the name and formula of next higher homologous of HCOOH. *[CBSE Delhi (C) 2017]*

Ans. (*i*) A series of compounds in which the same functional group substitutes for hydrogen in a carbon chain is called homologous series.

Characteristics of homologous series:

(*a*) The molecular formulae of any two successive members of a homologous series differ by — CH_2.

(*b*) There is a regular gradation in physical properties of members of a homologous series.

(*ii*) The name of next homologous of HCOOH is ethanoic acid. Its formula is CH_3COOH.

Q. 13. Two carbon compounds X and Y have the molecular formula C_4H_8 and C_5H_{12} respectively. Which one of these is most likely to show addition reaction? Justify your answer. Also give the chemical equation to explain the process of addition reaction in this case. *[CBSE Delhi 2017]*

Ans. C_4H_8 will show addition reaction because it is an unsaturated hydrocarbon due to the presence of a double bond.

$$\underset{\text{Butene}}{C_4H_8} + H_2 \xrightarrow{\text{Ni/Pd}} \underset{\text{Butane}}{C_4H_{10}}$$

Q. 14. Complete the following chemical equations : [CBSE Delhi 2017]

(*i*) $CH_3COOH + Na_2CO_3 \longrightarrow$

(*ii*) $CH_4 + O_2 \longrightarrow$

(*iii*) $C_2H_5OH + Na \longrightarrow$

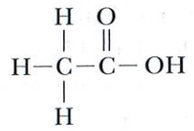
Ans. (*i*) $2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + H_2O + CO_2$

(*ii*) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

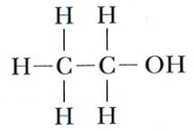
(*iii*) $2C_2H_5OH + 2Na \longrightarrow 2C_2H_5ONa + H_2$

Q. 15. A compound X is formed by the reaction of a carboxylic acid $C_2H_4O_2$ and an alcohol in 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, (*b*) alcohol and (*c*) the compound X. Also write the reaction. [NCERT Exemplar]

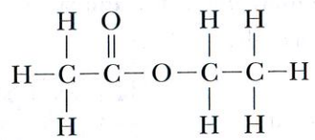
Ans. (*a*) Carboxylic acid is ethanoic acid



(*b*) Alcohol is ethanol



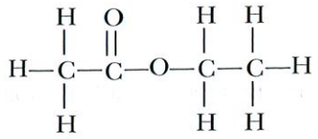
(*c*) X is ethyl ethanoate



$$\underset{\text{Ethanoic acid}}{CH_3—COOH} + \underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow{H_2SO_4} \underset{\text{Ethyl ethanoate}}{CH_3—COOC_2H_5} + H_2O$$

Q. 16. An ester has the molecular formula $C_4H_8O_2$. Write its structural formula. What happens when this ester is heated in the presence of sodium hydroxide solution? Write the balanced chemical equation for the reaction and name the products. What is a saponification reaction?

Ans. Structural formula:



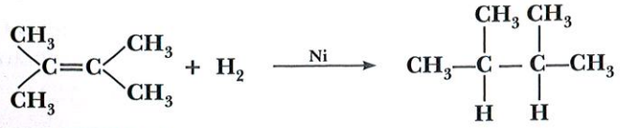
When this ester is heated in the presence of sodium hydroxide solution, it changes into an alcohol and a carboxylic acid.

$$CH_3COOC_2H_5 \xrightarrow{NaOH} CH_3COOH + C_2H_5OH$$

Products: Ethanol and ethanoic acid

Saponification: Reaction of an ester with an acid or a base to give an alcohol and a carboxylic acid. This reaction is known as saponification because it is used in the preparation of soap.

Q. 17. What is the role of metal or reagents written on arrows in the given chemical reactions?

(*a*) 

(*b*) $CH_3COOH + CH_3CH_2OH \xrightarrow{\text{Conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$

(*c*) $CH_3CH_2OH \xrightarrow[\text{Heat}]{\text{Alk. } KMnO_4} CH_3COOH$ [NCERT Exemplar]

Ans. (*a*) Ni acts as a catalyst.

(*b*) Concentrated H_2SO_4 acts as a catalyst and a dehydrating agent.

(*c*) Alkaline $KMnO_4$ acts as an oxidising agent.

Q. 18. Name two oxidising agents that are used for the conversion of alcohols to acids. Distinguish between ethanol and ethanoic acid on the basis of (*i*) litmus test, and (*ii*) reaction with sodium hydrogen carbonate. [CBSE (F) 2017]

Ans. The two oxidising agents are alkaline $KMnO_4$ and acidified $K_2Cr_2O_7$.

(*i*) Ethanol does not affect litmus paper whereas ethanoic acid turns blue litmus red.

(*ii*) Ethanol does not react with $NaHCO_3$ whereas ethanoic acid gives brisk effervesence with the evolution of colourless gas, CO_2.

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

Q. 19. Write chemical equation of the reaction of ethanoic acid with the following : (*a*) Sodium; (*b*) Sodium hydroxide; (*c*) Ethanol.

Write the name of one main product of each reaction. [CBSE (AI) 2016]

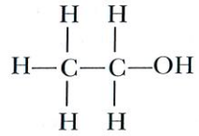
Ans. (*a*) $2CH_3COOH + 2Na \longrightarrow \underset{\substack{\text{Sodium ethanoate/}\\\text{Sodium acetate}}}{2CH_3COONa} + H_2$

(*b*) $CH_3COOH + NaOH \longrightarrow \underset{\substack{\text{Sodium ethanoate/}\\\text{Sodium acetate}}}{CH_3COONa} + H_2O$

(*c*) $CH_3COOH + C_2H_5OH \longrightarrow \underset{\text{Ethyl ethanoate/ester}}{CH_3COOC_2H_5} + H_2O$

Q. 20. Write the structural formula of ethanol. What happens when it is heated with excess of conc. H_2SO_4 at 443 K ? Write the chemical equation for the reaction stating the role of conc. H_2SO_4 in this reaction. [CBSE (AI) 2017]

Ans. Structural formula of ethanol :



When ethanol is heated with excess of conc. H_2SO_4 at 443K, ethene is formed.

$CH_3CH_2OH \xrightarrow[443K]{\text{Conc. } H_2SO_4} C_2H_4 + H_2O$

Conc H_2SO_4 acts as a dehydrating agent.

Q. 21. Complete the following chemical equations : [CBSE Delhi 2017]

(*i*) $CH_3COOC_2H_5 + NaOH \longrightarrow$

(*ii*) $CH_3COOH + NaOH \longrightarrow$

(*iii*) $C_2H_5OH + CH_3COOH \xrightarrow{\text{Conc.}H_2SO_4}$

Ans. (*i*) $CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$

(*ii*) $CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$

(*iii*) $C_2H_5OH + CH_3COOH \xrightarrow{\text{Conc.}H_2SO_4} CH_3COOC_2H_5 + H_2O$

Q. 22. When ethanol reacts with ethanoic acid in the presence of conc. H_2SO_4, a substance with fruity smell is produced. Answer the following:

(*i*) State the class of compounds to which the fruity smelling compounds belong. Write the chemical equation for the reaction and write the chemical name of the product formed.

(*ii*) State the role of conc. H_2SO_4 in this reaction. *[CBSE Delhi 2016]*

Ans. (*i*) The fruity smell compounds are: esters.

Chemical equation:

$$CH_3—\overset{\overset{O}{\|}}{C}—OH + CH_3CH_2OH \xrightarrow{\text{Conc. } H_2SO_4} CH_3—\overset{\overset{O}{\|}}{C}—O—CH_2—CH_3 + H_2O$$

Product's chemical name: Ethyl ethanoate.

(*ii*) Conc. H_2SO_4 acts as a dehydrating agent.

Q. 23. Distinguish between esterification and saponification reactions with the help of the chemical equations for each. State one use of each (*i*) esters, and (*ii*) saponification process.

[CBSE (AI) 2017]

Ans. Esterification: A process in which an alcohol and a carboxylic acid react in the presence of conc. H_2SO_4 to form an ester.

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{Conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$$

Saponification: A process in which an ester reacts with sodium hydroxide to form sodium salt of an acid and alcohol.

$$CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$$

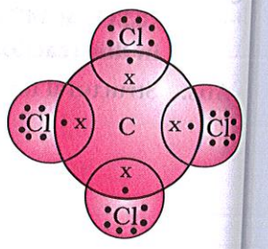
(*i*) Esters are used in ice creams and perfumes.

(*ii*) Saponification process is used in the preparation of soap.

Q. 24. (*a*) Write the formula and draw electron dot structure of carbon tetrachloride.

(*b*) What is saponification? Write the reaction involved in this process.

Ans. (*a*) CCl_4



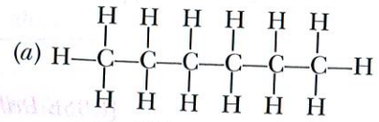
(*b*) Saponification is the process of converting esters into salts of carboxylic acids and ethanol by treating them with a base.

$$CH_3COOC_2H_5 \xrightarrow{NaOH} CH_3COONa + C_2 + H_5OH$$

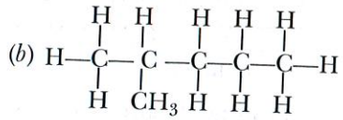
Q. 25. Write the structural formulae of all the isomers of hexane.

[NCERT Exemplar]

Ans. (*a*)



(*b*)



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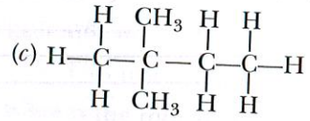

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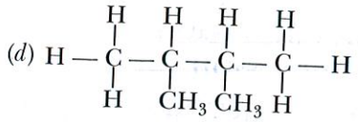

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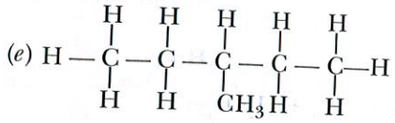


Q. 26. Explain esterification reaction with the help of a chemical equation. Describe an activity to show esterification. *[CBSE (AI) 2017]*

Ans. Esterification : A process in which an alcohol and a carboxylic acid react in the presence of conc. H_2SO_4 to form an ester.

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{Conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$$

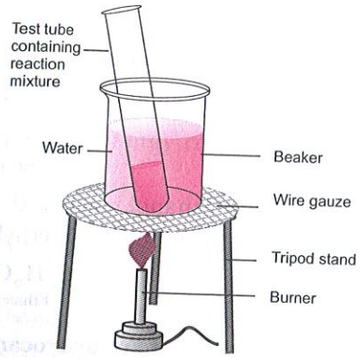
Activity

(*i*) Take 1 ml of ethanol mixed with 1 ml of acetic acid along with few drops of conc. H_2SO_4 in a test tube.

(*ii*) Warm it for 5 minutes in a water bath.

(*iii*) Pour the contents in a beaker containing 20 – 50 mL of water and smell the resulting mixture.

(*iv*) It will give a fruity smell indicating the formation of ester.



Formation of ester

LONG ANSWER QUESTIONS [5 marks]

Q. 1. Both soap and detergent are some type of salts. What is the difference between them? Describe in brief the cleansing action of soap. Why do soaps not form lather in hard water? List two problems that arise due to the use of detergents instead of soaps. *[CBSE (AI) 2015]*

OR

Soaps and detergents are both types of salts. State the difference between the two. Write the mechanism of the cleansing action of soaps. Why do soaps not form lather (foam) with hard water ? Mention any two problems that arise due to the use of detergents instead of soaps. *[CBSE Delhi 2017]*

Ans. Soaps are sodium or potassium salts of long-chain carboxylic acids. Detergents are generally ammonium or sulphonate salts of long chain carboxylic acids.

For cleansing action of soaps, refer to Q. 15 (NCERT Exercises).

Soaps do not form lather in hard water because hard water contains calcium and magnesium salts. Soap molecules react with calcium and magnesium salts to form an insoluble precipitate called scum.

Two problems which arise because of the use of detergents are:

(*i*) Detergents are non-biodegradable; hence, detergents accumulate in the environment and cause problems.

(*ii*) Certain phosphate additives are added to detergents which form a thick green scum over the river water and harm the animal life in the river.

Q. 2. What happens when

(*i*) ethanol burns in air.

(*ii*) ethanol reacts with sodium metal.

(*iii*) ethanol is oxidised with chromic anhydride in glacial ethanoic acid.

(*iv*) ethanol is heated with alkaline potassium permanganate.

(*v*) ethanol is heated with ethanoic acid in the presence of a few drops of concentrated sulphuric acid?

Ans. (*i*) Ethanol is highly inflammable liquid. It catches fire easily and starts burning. Ethanol burns readily in air with a blue flame to form carbon dioxide and water vapour:

$$C_2H_5OH + 3O_2 \xrightarrow[\text{(Burning)}]{\text{Combustion}} 2CO_2 + 3H_2O$$

A lot of heat is produced during the combustion of ethanol.

(*ii*) Ethanol reacts with sodium to produce sodium ethoxide and hydrogen gas:

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

(*iii*) When ethanol is treated with chromic anhydride, then its partial oxidation takes place and ethanal is formed.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[CH_3COOH]{CrO_3 \text{ in}} \underset{\text{Ethanal}}{CH_3CHO}$$

Chromic anhydride oxidises ethanol to ethanal.

(*iv*) Alkaline $KMnO_4$ oxidises ethanol to ethanoic acid.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow{Alk.KMnO_4} \underset{\text{Ethanoic acid}}{CH_3COOH}$$

(*v*) Ethanol reacts with ethanoic acid in presence of concentrated sulphuric acid to form a sweet smelling ester, ethyl ethanoate.

$$\underset{\text{Ethanol}}{C_2H_5OH} + \underset{\text{Ethanoic acid}}{CH_3COOH} \xrightarrow{H_2SO_4} \underset{\text{Ethyl ethanoate}}{CH_3COOC_2H_5} + H_2O$$

Q. 3. (*a*) What are hydrocarbons? Give examples.

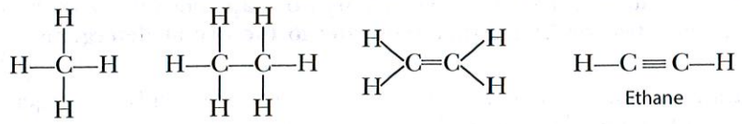
(*b*) Give the structural differences between saturated and unsaturated hydrocarbons with two examples each.

(*c*) What is a functional group? Give examples of four different functional groups. *[NCERT Exemplar]*

Ans. (*a*) Compounds of carbon and hydrogen are called hydrocarbons. For example, methane, ethane, etc.

(*b*) Saturated hydrocarbons contain carbon-carbon single bonds.

Unsaturated hydrocarbons contain at least one carbon-carbon double or triple bond.



(*c*) An atom/group of atoms joined in a specific manner which is responsible for the characteristic chemical properties of the organic compounds is called a functional group. Examples are hydroxyl group (—OH), aldehyde group (—CHO), ketonic group (>C=O), carboxylic group (—COOH), etc.

Q. 4. Why are certain compounds called hydrocarbons ? Write the general formula for homologous series of alkanes, alkenes and alkynes and also draw the structure of the first member of each series. Write the name of the reaction that converts alkenes into alkanes and also write a chemical equation to show the necessary conditions for the reaction to occur. *[CBSE (AI) 2017]*

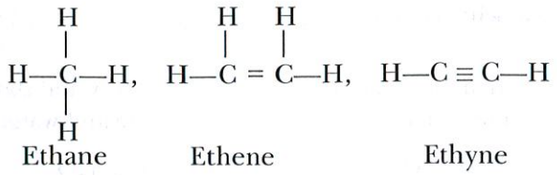
Ans. Hydrocarbons are the compounds of hydrogen and carbon.

General formula for homologous series of:

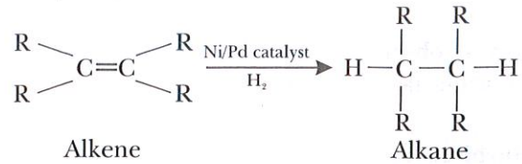
Alkanes – C_nH_{2n+2}

Alkenes – C_nH_{2n}

Alkynes – C_nH_{2n-2}



Addition reaction or hydrogenation converts alkenes into alkanes.



Q. 5. Exptain why carbon forms compounds mainly by covalent bond. Explain in brief two main reasons for carbon forming a large number of compounds. Why does carbon form strong bonds with most other elements? *[CBSE Delhi 2015]*

Ans. Carbon has 4 electrons in its outermost shell, and needs to gain or lose 4 electrons to attain noble gas configuration. Losing or gaining 4 electrons is not possible due to energy considerations, hence it shares electrons to form covalent bonds.

Two reasons for large number of carbon compounds:

(*i*) Catenation: The unique ability of carbon to form bonds with other atoms of carbon giving rise to long chains of different types of compounds.

(*ii*) Tetravalency: Since carbon has a valency of 4, it is capable of bonding with four other atoms of carbon or atoms of elements like oxygen, hydrogen, nitrogen, sulphur, chlorine, etc.

Carbon forms strong bonds with most other elements because of its small size which enables the nucleus to hold on to the shared pairs of electrons strongly.

Q. 6. What are esters ? How are esters prepared ? Write the chemical equation for the reaction involved. What happens when an ester reacts with sodium hydroxide ? Write the chemical equation for the reaction and also state the name and use of this reaction. *[CBSE (F) 2017]*

Ans. Esters are pleasant smelling organic compounds. They are formed by the reaction of carboxylic acids and alcohols in the presence of acid.

$$CH_3COOH + C_2H_5OH \xrightarrow{acid} \underset{\text{(Ester)}}{CH_3COOC_2H_5} + H_2O$$

When an ester reacts with sodium hydroxide, sodium salt of acid is formed.

$$CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$$

Name of the reaction is saponification. It is used in the preparation of soap.

Q. 7. 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 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. *[NCERT Exemplar]*

Ans. C — Ethanoic acid

R — Sodium salt of ethanoic acid (sodium acetate) and gas evolved is hydrogen

A — Methanol

S — Ester (Methyl acetate)

(*a*) $\underset{(C)}{2CH_3COOH} + 2Na \longrightarrow \underset{(R)}{2CH_3COONa} + H_2$

(*b*) $\underset{(C)}{CH_3COOH} + \underset{(A)}{CH_3OH} \xrightarrow{\text{conc. } H_2SO_4} \underset{(S)}{CH_3COOCH_3} + H_2O$

(*c*) $\underset{(C)}{CH_3COOH} + NaOH \xrightarrow{\text{conc. } H_2SO_4} \underset{(R)}{CH_3COONa} + H_2O$

(*d*) $\underset{(S)}{CH_3COOCH_3} + NaOH \longrightarrow \underset{(R)}{CH_3COONa} + \underset{(A)}{CH_3OH}$

Q. 8. Look at the figure and answer the following questions:

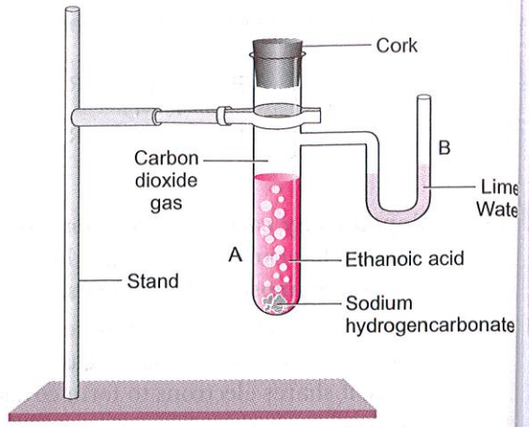
(*a*) What change would you observe in the calcium hydroxide solution taken in tube B?

(*b*) Write the reaction involved in A and B respectively.

(*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]



Ans. (*a*) It will turn milky.

(*b*) $CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + H_2O + CO_2$ (in A)

$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$ (in B)

With excess CO_2, milkiness disappears.

(*c*) As C_2H_5OH and $NaHCO_3$ do not react, a similar change is not expected

$C_2H_5OH + NaHCO_3 \longrightarrow$ No change

(*d*) The lime water is prepared by dissolving calcium oxide in water and decanting the supernatant liquid.

Q. 9. (*a*) Write a chemical equation of each of the following types of chemical reactions of organic compounds. *[CBSE Delhi (C) 2017]*

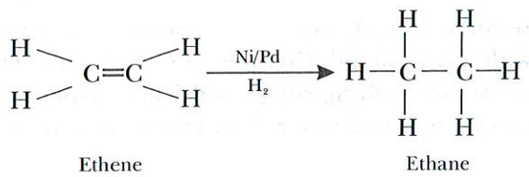
(*i*) Oxidation reaction **(*ii*) Addition reaction**

(*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.

Ans. (*a*) (*i*) $\underset{\text{Ethanol}}{CH_3-CH_2OH} \xrightarrow[\text{Or acidified } K_2Cr_2O_7 + \text{Heat}]{\text{Alkaline } KMnO_4 + \text{Heat}} \underset{\text{Ethanoic acid}}{CH_3COOH}$

(*ii*)



Ethene Ethane

(*iii*) $CH_4 + Cl_2 \xrightarrow{\text{Sunlight}} CH_3Cl + HCl$

(*b*) Ethanol is an alcohol having two carbon atoms in its molecule. Its chemical formula is C_2H_5OH.

When ethanol is heated with excess conc. H_2SO_4 at 443K, ethene is formed

$$\underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow[\text{Heat}]{\text{Conc.}H_2SO_4} CH_2 = \underset{\text{Ethene}}{CH_2} + H_2O$$

Conc. H_2SO_4 acts as a dehydrating agent.

Q. 10. A salt X is formed and a gas is evolved when ethanoic acid reacts with sodium hydrogencarbonate. Name the salt X and the gas evolved. Describe an activity and draw the diagram of the apparatus to prove that the evolved gas is the one which you have named. Also, write chemical equation of the reaction involved. *[NCERT Exemplar]*

Ans. X is sodium ethanoate.

Gas evolved is carbon dioxide.

Activity:

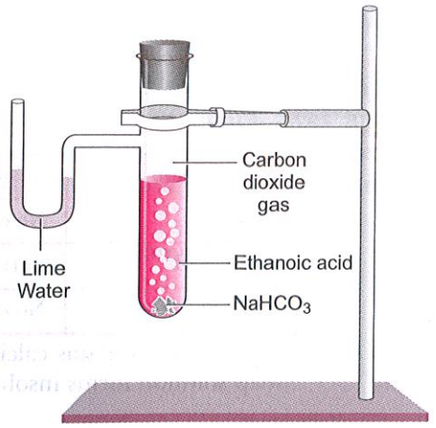
(*i*) Set up the apparatus as shown in the figure.

(*ii*) Take a spatula, full of sodium hydrogen carbonate in a test tube and add 2 mL of dilute ethanoic acid.

(*iii*) We observe that brisk effervescence of a gas is produced in the test tube.

(*iv*) Now pass the gas produced through freshly prepared lime water.

It is observed that lime water turns milky. Only carbon dioxide gas can turn lime water milky. So, this activity proves that when ethanoic acid reacts with sodium hydrogencarbonate, then carbon dioxide is evolved.



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

Q. 11. (*i*) Give a chemical test to distinguish between saturated and unsaturated hydrocarbons.

(*ii*) Name the products formed when ethane burns in air. Write the balanced chemical equation for the reaction showing the types of energies liberated.

(*iii*) Why is reaction between methane and chlorine in the presence of sunlight considered a substitution reaction? *[CBSE Delhi 2016]*

Ans. (*i*) **Br_2-water test:** Br_2-water is a brown coloured liquid.

Unsaturated hydrocarbons give addition reaction with Br_2, so the colour of Br_2-water gets decolourised.

Saturated hydrocarbons do not react with Br_2-water, so the colour of Br_2-water does not get decolourised.

(*ii*) On burning ethane in air, the products obtained are carbon dioxide and water, along with heat and light.

$$2C_2H_6(g) + 7O_2(g) \longrightarrow 4CO_2(g) + 6H_2O(l) + \text{Heat} + \text{Light}$$

(*iii*) Methane reacts with chlorine in the presence of sunlight to form chloromethane and hydrogen chloride.

$$\underset{\text{Methane}}{CH_4} + \underset{\text{Chlorine}}{Cl_2} \xrightarrow{\text{Sunlight}} \underset{\text{Chloromethane}}{CH_3Cl} + \underset{\text{Hydrogen chloride}}{HCl}$$

With the excess of chlorine, all the four hydrogen atoms of methane are replaced by chlorine atoms to form carbon tetrachloride (CCl_4). This reaction is considered as substitution reaction because hydrogen of methane is substituted by chlorine.

Q. 12. Elements forming ionic compounds attain noble gas electronic configuration by either gaining or losing electrons from their valence shells. Explain giving reason why carbon cannot attain such a configuration in this manner to form its compounds. Name the type of bonds formed in ionic compounds and in the compounds formed by carbon. Also explain with reason why carbon compounds are generally poor conductors of electricity. *[CBSE (F) 2015]*

Ans. Carbon has 4 electrons in its outermost shell. It cannot lose 4 electrons to form C^{4+} cation because very high energy is required to remove 4 electrons leaving behind a carbon cation with 6 protons in its nucleus holding onto just 2 electrons. It also cannot gain 4 electrons to form C^{4-} anion because it is difficult for 6 protons to hold onto 10 electrons.

The type of bonds formed in ionic compounds are ionic or electrovalent bonds and in compounds formed by carbon are covalent bonds.

Since the electrons are shared, there are no charged particles in carbon compounds and hence they are poor conductors of electricity.

Q. 13. (*a*) You have three unlabelled test tubes containing ethanol, ethanoic acid and soap solution. Explain the method you would use to identify the compounds in different test tubes by

chemical tests using litmus paper and sodium metal.

(*b*) Give the reason of formation of scum when soaps are used with hard water.

[CBSE (F) 2016]

Ans. (*a*)

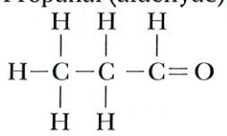
Solution	Blue Litmus Paper	Red Litmus Paper	Sodium Metal
Ethanol	No change	No change	Hydrogen gas
Ethanoic acid	Turns red	No change	Hydrogen gas
Soap	No change	Turns red	Hydrogen gas

(*b*) Hard water contains calcium ions or magnesium ions or both. These ions on reacting with soap solution forms insoluble substance called scum.

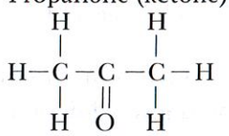
HOTS (Higher Order Thinking Skills)

Q. 1. An aldehyde as well as a ketone can be represented by the same molecular formula, say C_3H_6O. Write their structures and name them. State the relation between the two in the language of science.

Ans. Propanal (aldehyde);



Propanone (ketone);



These two compounds are called isomers *i.e.,* compounds having same molecular formula but different structural formula.

Q. 2. An organic acid 'X' is a liquid which often freezes during winter time in cold countries, has the molecular formula $C_2H_4O_2$. On warming it with ethanol in the presence of a few drops of conc. H_2SO_4, a compound 'Y' with a sweet smell is formed.

(*i*) Identify 'X' and 'Y'.

(*ii*) Write chemical equation for the reaction involved.

Ans. (*i*) X = Ethanoic acid (CH_3COOH)

Y = Ethyl ethanoate ($CH_3COOC_2H_5$)

(*ii*) $\underset{\text{Ethanoic acid}}{CH_3COOH} + \underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow[\Delta]{\text{Conc.}H_2SO_4} \underset{\text{Ethyl ethanoate}}{CH_3COOC_2H_5} + H_2O$

Q. 3. Give reasons for the following observations:

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

(*b*) Use of synthetic detergents causes pollution of water.

Ans. (*a*) We need to adjust air holes of gas burner so that sufficient oxygen-rich mixture is burnt to give a clean blue flame for complete combustion.

(*b*) Synthetic detergents are generally non-biodegradable, that is, they are not decomposed by microorganisms like bacteria. Hence, use of synthetic detergents causes water pollution in lakes and rivers.

Q. 4. (*a*) Why do covalent compounds have low melting points and boiling points?

(*b*) How are carboxylic acids different from mineral acids from ionisation point of view?

Ans. (*a*) The molecules in covalent compounds are held by weak van der Waal's forces, hence they have low melting points and boiling points as compared to ionic compounds.

(*b*) Carboxylic acids (like CH_3COOH) ionise to a very small extent in solution and give very small amount of H^+ ions. Thus, they are weak acids as compared to the mineral acids.

Q. 5. An organic compound 'A' is a constituent of wine and beer and is also used as fuel in spirit lamp. Compound 'A' on heating with alkaline potassium permanganate gives another compound 'B' which turns blue litmus to red. Compound 'A' and 'B' combine in the presence of conc. H_2SO_4 to give a sweet smelling compound 'C'. Identify compounds 'A', 'B' and 'C'. Also write the equations involved in the reaction.

Ans. As compound 'A' is a constituent of wine and beer and is used in spirit lamp it is ethanol.

$$\underset{\text{A(Ethanol)}}{CH_3CH_2OH} \xrightarrow[\text{Heat}]{\text{Alk. } KMnO_4} \underset{\substack{\text{B(Ethanoic acid)}\\ \text{Turns blue litmus red}}}{CH_3COOH}$$

$$A + B \xrightarrow{\text{conc. } H_2SO_4} C$$

$$CH_3CH_2OH + CH_3COOH \xrightarrow{\text{conc. } H_2SO_4} \underset{\substack{\text{Ethyl ethanoate}\\ \text{(Ester)}}}{CH_3COOCH_2CH_3} + H_2O$$

Q. 6. An element of group 14 has two common allotropes, A and B. A is very hard and is bad conductor of electricity while B is soft to touch and good conductor of electricity. Identify the element and its allotropes. Explain reasons for their different properties.

Ans. The element is carbon and the two allotropes are diamond and graphite. Diamond has three-dimensional rigid structure and does not have any free electrons. Hence, it is hard and bad conductor of electricity. Graphite forms hexagonal sheet-like structure and one valency (one electron) with carbon is free. Hence, graphite is soft and a good conductor of electricity.

Q. 7. An organic compound A on heating with concentrated H_2SO_4 forms a compound B which on addition of one mole of hydrogen in presence of Ni forms a compound C. One mole of compound C on combustion forms two moles of CO_2 and 3 moles of H_2O. Identify the compounds A, B and C and write the chemical equations of the reactions involved.

[NCERT Exemplar]

Ans. Since compound C gives 2 moles of CO_2 and 3 moles of H_2O, it shows that it has the molecular formula C_2H_6 (Ethane). C is obtained by the addition of one mole of hydrogen to compound B so the molecular formula of B should be C_2H_4(Ethene). Compound B is obtained by heating compound A with concentrated H_2SO_4 which shows it to be an alcohol. So compound A could be C_2H_5OH (Ethanol).

$$\underset{\text{A}}{C_2H_5OH} \xrightarrow{\text{Hot conc. } H_2SO_4} \underset{\text{B}}{C_2H_4} + H_2O$$

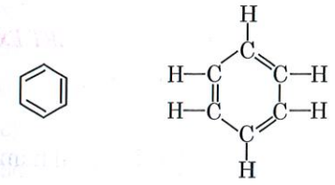
$$\underset{\text{B}}{C_2H_4} + H_2 \xrightarrow{\text{Ni}} \underset{\text{C}}{C_2H_6}$$

$$\underset{\text{C}}{2C_2H_6} + 7O_2 \longrightarrow 4CO_2 + 6H_2O + \text{Heat and light}$$

Q. 8. Write the molecular formula of benzene and draw its structure. List in tabular form the two properties in which covalent compounds differ from ionic compounds. *[CBSE (F) 2017]*

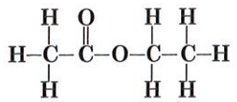
Ans. Molecular formula of benzene is C_6H_6

Structure



Differences :		
	Covalent	**Ionic**
Electrical conductivity	Do not conduct electricity	Conducts electricity
Melting point	Low	High

Q. 9. The structural formula of an ester is:



Write the molecular formula of alcohol and acid from which it would have been formed.

Ans. Alcohol $\longrightarrow$ CH_3CH_2OH/C_2H_5OH

Carboxylic acid $\longrightarrow$ CH_3COOH

Q. 10. An organic compound A of molecular formula C_2H_6O on heating with excess of conc. H_2SO_4 gives compound B of molecular formula C_2H_4. Compound B on reduction gives compound C of molecular formula C_2H_6.

(*a*) Name A, B and C.

(*b*) Write chemical equation for the conversion of A to B.

(*c*) What is the role of conc. H_2SO_4 in the above equation?

Ans. (*a*) A – Ethanol, B – Ethene, C – Ethane

(*b*) $CH_3CH_2OH \xrightarrow[\text{Heat}]{\text{conc. } H_2SO_4} CH_2{=}CH_2 + H_2O$

(*c*) Conc. H_2SO_4 acts as a dehydrating agent.

Q. 11. An organic compound 'A' of molecular formula C_2H_6O on oxidation with dilute alkaline $KMnO_4$ solution gives an acid 'B' with the same number of carbon atoms. Compound 'A' is often used for sterilisation of skin by doctors.

(*i*) Name the compounds 'A' and 'B'.

(*ii*) Write the chemical equation involved in the formation of 'B' from 'A'.

Ans. (*i*) Compound A – Ethanol (ethyl alcohol)

Compound B – Ethanoic acid (acetic acid)

(*ii*) $C_2H_5OH \xrightarrow{\text{Alk. } KMnO_4} CH_3COOH$

Proficiency Exercise

Very Short Answer Questions [1 mark]

1. Name the process of converting vegetable oil to vegetable ghee. *[CBSE Sample Paper 2016, 2017]*
2. What is the general formula of alkanes? Identify the alkanes from the following hydrocarbons.
   CH_4, C_2H_2, C_2H_6, C_3H_6 and C_3H_8
3. Draw the electron dot structure of ethyne and also draw its structural formula. *[NCERT Exemplar]*
4. State the reason why covalent compounds are generally poor conductors of electricity.
5. Draw the structural formula of methanoic acid.
6. A compound 'X' has a formula C_3H_6. It decolourises bromine water. Write the chemical name of 'X'.
7. Write the molecular formula of the 2nd and 3rd member of the homologous series whose first member is ethene. *[CBSE (AI) 2017]*
8. Write the molecular formula of (*i*) ethane and (*ii*) ethanoic acid. *[CBSE Delhi (C) 2017]*

Short Answer Questions–I [2 marks]

9. Unsaturated hydrocarbons contain multiple bonds between the two C-atoms and show addition reactions. Give the test to distinguish ethane from ethene. *[NCERT Exemplar]*
10. What will happen if ethanol reacts with ethanoic acid in the presence of a mineral acid? Name the reaction. Write the chemical equation for this reaction.
11. Give chemical tests to detect the presence of (*a*) ethanol and (*b*) ethanoic acid.
12. Write the two factors because of which carbon compounds exist in large numbers.
13. (*a*) Write your observation, if you dip a red litmus paper in soap solution.
    (*b*) Suggest one method to remove the temporary hardness of water.
14. Explain the cleansing action of soap with the help of a diagram.
15. Give one example of an element other than carbon which forms covalent bond. Also, draw its electron dot structure.
16. How is ethene prepared from ethanol? Give the reaction involved in it. *[NCERT Exemplar]*

Short Answer Questions–II [3 marks]

17. Complete the following chemical equations :
    (*i*) $C_2H_5OH + O_2 \longrightarrow$
    (*ii*) $C_2H_5OH \xrightarrow[443\text{ K}]{\text{Conc. } H_2SO_4}$
    (*iii*) $CH_3COOH + NaHCO_3 \longrightarrow$ *[CBSE Delhi 2017]*
18. Write the name and general formula of a chain of hydrocarbons in which an addition reaction with hydrogen is possible. State the essential condition for an addition reaction. Stating this condition, write a chemical equation giving the name of the reactant and the product of the reaction. *[CBSE (AI) 2015]*
19. Name the reaction which is commonly used in the conversion of vegetable oils to fats. Explain the reaction involved in detail. *[NCERT Exemplar]*
20. Two carbon compounds X and Y have the molecular formula C_3H_6 and C_4H_{10} respectively. Which one of the two is most likely to show addition reaction ? Justify your answer. Also give the chemical equation to explain the process of addition reaction in this case. *[CBSE Delhi 2017]*
21. Name the compound formed when ethanol is heated in excess of conc. sulphuric acid at 443 K. Also write the chemical equation of the reaction stating the role of conc. sulphuric acid in it. What would happen if hydrogen is added to the product of this reaction in the presence of catalysts such as palladium or nickel? *[CBSE Delhi 2016]*
22. A compound X is formed by the reaction of a carboxylic acid $C_2H_4O_2$ and an alcohol in 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 the
    (*a*) carboxylic acid,
    (*b*) alcohol and
    (*c*) compound X.
    Also write the reaction.

23. Write three different chemical reactions showing the conversion of ethanoic acid to sodium ethanoate. Write balanced chemical equation in each case. Write the name of the reactants and the products other than ethanoic acid and sodium ethanoate in each case. *[CBSE (AI) 2016]*

24. (*i*) Name the products obtained on complete combustion of hydrocarbons? How is the gas evolved during combustion tested in the laboratory? Explain in brief.
(*ii*) Write the next higher homologue of:
(*a*) C_3H_6 (*b*) C_5H_8

25. State any three points of differences between ionic and covalent compounds.

26. What happens when
(write chemical equation in each case)
(*a*) ethanol is burnt in air ?
(*b*) ethanol is heated with excess conc. H_2SO_4 at 443 K ?
(*c*) a piece of sodium is dropped into ethanol ? *[CBSE (AI) 2017]*

27. What are hydrocarbons ? Write the general formula of (*i*) saturated hydrocarbons, and (*ii*) unsaturated hydrocarbons and draw the structure of one hydrocarbon of each type. *[CBSE (F) 2017]*

Long Answer Questions [5 marks]

28. What are hydrocarbons? Distinguish alkanes from alkenes and each of them from alkynes, giving one example of each. Draw the structure of each compound cited as example to justify your answer.

29. An organic compound 'A' on heating with another compound 'B' in presence of concentrated sulphuric acid forms a sweet smelling compound 'C':
(*i*) Identify the name of this chemical reaction.
(*ii*) Write a balanced chemical equation for the above chemical reaction.
(*iii*) Write one use of compound 'C'.
(*iv*) Write a balanced chemical equation for the reaction when an acid or a base is added to compound 'C'.

30. Explain the given reactions with the examples: *[NCERT Exemplar]*
(*i*) Hydrogenation reaction (*ii*) Oxidation reaction
(*iii*) Substitution reaction (*iv*) Saponification reaction
(*v*) Esterification reaction

31. Match the reactions given in Column (A) with the names given in Column (B). *[NCERT Exemplar]*

Column A	Column B
(*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*) Neutralisation reaction
(*d*) $CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$	(*iv*) Esterification reaction

32. What is meant by "structural isomers"? Give reason why propane (C_3H_8) cannot exhibit this characteristic. Draw the structures of possible isomers of butane (C_4H_{10}).

33. Esters are sweet-smelling substances and are used in making perfumes. Suggest some activity and the reaction involved for the preparation of an ester with well labeled diagram.

5 PERIODIC CLASSIFICATION OF ELEMENTS

BASIC CONCEPTS – A FLOW CHART

PERIODIC CLASSIFICATION OF ELEMENTS

Earlier Attempts of Element Classification

Döbereiner's Triads (1817)
- Elements with similar properties were arranged into groups of three elements called **triads**.
- He could identify only three triads from the elements known.

Newlands' Law of Octaves (1866)
- Elements were arranged in the order of increasing atomic masses such that properties of the eighth element was the repetition of the properties of first element.
- This law worked well with lighter elements only.

Mendeléev's Periodic Table (1869)

States that the properties of elements are the periodic function of their atomic masses.

Achievements
- Accommodated noble gases which were discovered very late.
- Some gaps were left to accommodate elements to be discovered later.

Limitations
- Could not assign a correct position to hydrogen.
- Position of isotopes could not be explained.
- Wrong order of atomic masses of some elements could not be explained.

Henry Moseley (1913)

Showed that anomalies in arrangement of elements could be removed when the elements were arranged in order of increasing atomic number.

Modern Classification of Elements/Modern Periodic Table
- States that the properties of elements are periodic function of their atomic number.
- Consists of 18 vertical columns called **groups**.
- Consists of 7 horizontal rows called **periods**.
- Atoms of different elements with same number of occupied outer-shells are placed in same period.
- Position of an element tells us about its chemical properties.

Trends in Modern Periodic Table

	Across the period	Down the group
Atomic size	Decreases	Increases
Valency	First increases from 1 to 4 and then decreases to 0.	Remains same
Metallic character (or electropositive character)	Decreases	Increases
Non-metallic character (or electronegative character)	Increases	Decreases