Chapter 4: Carbon & Its compounds

C04

1. **(Activity 4.1) Make a list of ten things you have used or consumed since the morning. If there are items which are made up of more than one material, put them into both the relevant columns.**

Things made of metal	Things made of glass/clay	Others
Fan, Refrigerator, Spoon, TV, Pen, Telephone, Key, Coins, Tiffin box, Bus	Cup, Tumbler, TV, Bulb, Saucer, Watch, Picture frame, Flower vase, Statue, Bottle	Clothes, Tooth brush, Tooth paste, Shoes, Purse, Pencil, Bread, Milk, Books, Chair

2. **What would be the product if a compound containing carbon is burnt?**

When a carbon compound is burnt in presence of sufficient amount of oxygen, carbon dioixide and water is produced.

$C_xH_y + zO_2 \longrightarrow xCO_2 + n\ H_2O$

3. **Write the percentage of carbon present in the earth's crust.**

The earth's crust has only 0.02% carbon in the form of minerals (like carbonates, hydrogen carbonates, coal and petroleum) and the atmosphere has 0.03% of carbon dioxide.

4. **Write the properties of carbon compounds.**

a) Most carbon compounds are poor conductors of electricity.

b) The force of attraction of the molecules is not very strong.

c) The bonding in carbon compounds does not give rise to any ions.

5. **Write the distribution of electrons in various shells for carbon.**

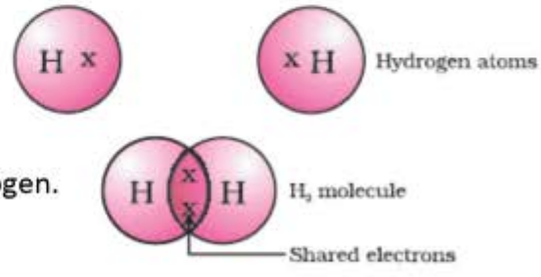
The atomic number of carbon is 6. Its electronic configuration is (2, 2, 2) $1s^2$, $2s^2$ $2p^2$.

6. **How many valence electrons will carbon have?**

Carbon has 4 valence electrons.

7. **Explain the formation of hydrogen molecule.**

The atomic number of hydrogen is 1. It has one electron in its K shell and requires one more electron to fill the K shell. Two hydrogen atoms share their electrons to form a molecule of hydrogen.



8. **Explain the formation of chlorine molecule.**

A chlorine atom has an electron arrangement of 2,8,7. It has seven valence electrons. Each chlorine atom needs one more electron to achieve a stable octet electron arrangement. Two chlorine atoms will combine with each other. Each of these two chlorine atoms contributes one electron to each other for sharing. The two chlorine atoms share one pair of electrons that bind them together.

Hence, a covalent molecule with a single covalent bond is formed. It has the molecular formula of Cl_2.

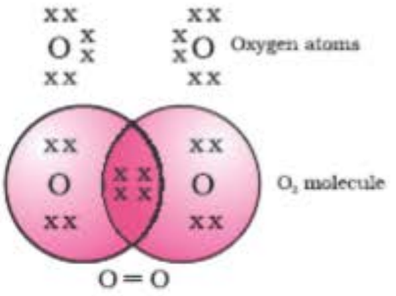
The formation of the chlorine molecule can be represented as shown below.

9. Explain the formation of oxygen molecule.

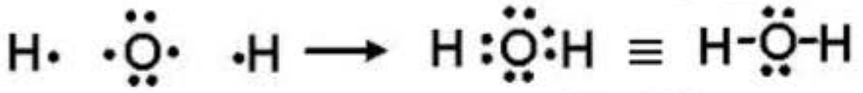
OR

Give reason: Double bond is formed between two atoms of oxygen.

The atomic number of oxygen is 16. Its electronic configuration is (2, 8, 6). A double bond is formed between two oxygen atoms. The outermost shell has 6 electrons. It requires two electrons to complete its octet. Each oxygen atom shares two electrons with another oxygen atom. The two electrons contributed by each oxygen atom give rise to two shared pairs of electrons.



10. Depict a molecule of water showing the nature of bonding between atoms.

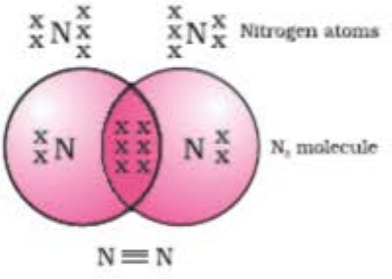


11. Does the molecule of water have single bonds or double bonds?

Water molecule has a single covalent bond.

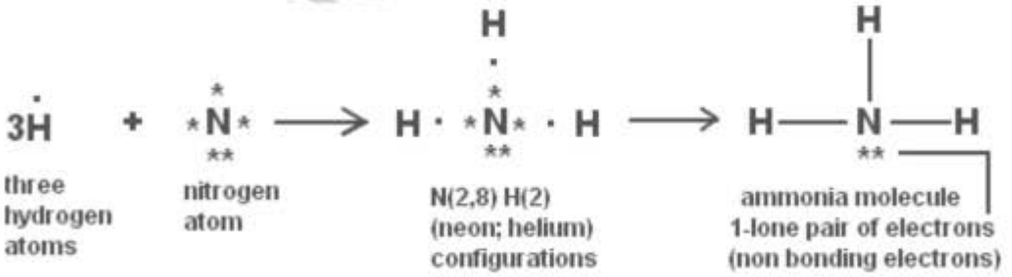
12. Explain the formation of molecule of nitrogen.

Atomic number of nitrogen is 7. Its electronic configuration is (2, 5). In order to attain an octet, each nitrogen atom in a molecule of nitrogen contributes three electrons giving rise to three shared pairs of electrons. This is said to constitute a triple bond between the two atoms.



13. Draw the electron dot structure of ammonia.

The formula of ammonic is NH3.

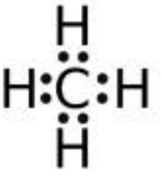


14. Does a molecule of ammonia have single, double or triple bonds?

Ammonia has single bonds.

15. Explain the formation of methane.

Carbon atom has atomic number 6. Its electronic configuration is 2, 4. It has four electrons in its valence shell and needs 4 more electrons to get the stable noble gas configuration. Hydrogen atom has one electron and needs one more electron to get stable electronic



configuration of nearest noble gas, helium. Therefore, one atom of carbon shares its four electrons with four atoms of hydrogen to form four covalent bonds.

16. Why is carbon tetravalent?

Carbon is tetravalent because it has four valence electrons. In order to achieve noble gas configuration, carbon shares these electrons with four atoms of hydrogen.

17. What is meant by covalent bond?

Bonds which are formed by the sharing of an electron pair between two atoms is known as covalent bonds.

18. Write the characteristics of covalent bond.

a) Covalent bonded molecules have strong bonds within the molecule.

b) They have small intermolecular forces.

c) They have low melting and boiling points.

d) They do not form charged particles.

e) They are generally poor conductors of electricity.

19. Give reason:

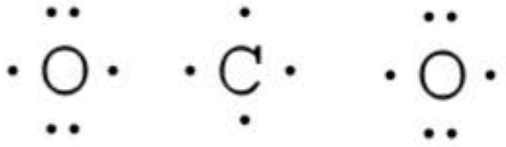
a) Covalent compounds have low melting and boiling points.

Covalent compounds have small inter-molecular force hence they have low melting and boiling points.

b) Covalent compounds do not form charged particles.

The electrons are shared between atoms so no charge particles are formed.

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



21. Why does carbon exist in large number of compounds?

The nature of the covalent bond enables carbon to form a large number of compounds.

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

The two characteristics seen in carbon which helps to form large number of compounds is tetravalency and catenation.

23. What is meant by catenation?

The unique ability of carbon to form bonds with other atoms of carbon, giving rise to large molecules is called catenation.

24. Name two elements that exhibit catenation.

Carbon and silicon.

25. What are saturated carbon compounds?

Compounds of carbon, which are linked by only single bonds between the carbon atoms are called saturated compounds.

26. What are unsaturated carbon compounds?

Compounds of carbon having double or triple bonds between their carbon atoms are called unsaturated compounds.

27. How is the catenation of silicon different from that of carbon?

Silicon forms compounds with hydrogen which have chains of upto seven or eight atoms, but these compounds are very reactive. The catenation of carbon is very strong and stable.

28. Why are carbon-carbon bonds very strong and stable?

Carbon is small in size. This enables the nucleus to hold on to the shared pairs of electrons strongly.

29. What is vital force theory?

It was thought that carbon compounds or organic compounds could only be formed within a living system. It was postulated that a 'vital force' was necessary for their synthesis.

30. Why did the vital force theory fail?

Friedrich Wöhler disproved the vital force theory in 1828 by preparing urea (an organic compound) from ammonium cyanate in the laboratory.

31. Differentiate between saturated and unsaturated compounds.

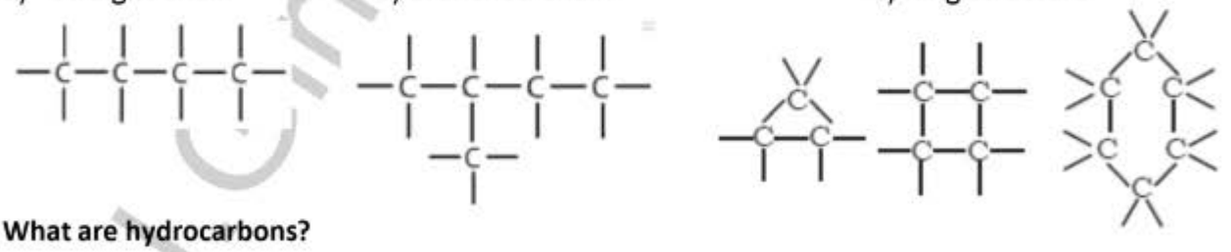
Saturated compounds	Unsaturated compounds
They are linked by only single bond between carbon atoms.	They are linked by double or triple bonds between their carbon atoms.
They are less reactive.	They are more reactive.

32. What are isomers?

Compounds with identical molecular formula but different structures are called structural isomers.

33. Mention the types of carbon chains.

a) Straight chain b) Branched chain c) Ring structure



34. What are hydrocarbons?

Carbon compounds which contain carbon and hydrogen only are called hydrocarbons.

35. What are alkanes?

Alkanes are saturated hydrocarbons in which the carbon atoms are connected by only single bond.

Ex: Methane, Ethane, Propane

36. Mention the characteristics of alkanes.

a) In alkanes the carbon atoms are bonded with maximum number of hydrogen atoms.

b) They have single bond between carbon atoms.

c) Their general formula is C_nH_{2n+2}

d) The primary suffix of these hydrocarbons is 'ane'.

37. What are heteroatoms?

In hydrocarbons, the element replacing hydrogen is referred to as heteroatoms.

38. What are functional groups?

Hydrocarbons in which one or more hydrogen atoms have been replaced by atom or group of atoms of other elements are called functional groups.

39. What are alcohols? Write their general formula.

Compounds containing –OH as the functional group are called alcohols. Their general formula is R – OH or $C_nH_{2n+1}OH$. Example: Propanol.

40. What are aldehydes? Write their general formula.

Compounds containing –CHO as the functional group are called aldehydes. Their general formula is R – CHO. Example: Propanal.

41. What are ketones? Write their general formula.

Compounds containing –one as functional group are called ketones. Their general formula is R – ONE. Example: Propanone.

42. What are carboxylic acids? Write their general formula.

Compounds containing –COOH as the functional group are called Carboxylic acids. Their general formula is R – COOH. Example: Propanoic acid.

43. What decides the properties of carbon compounds?

The presence of a functional group dictates the properties of the carbon compounds.

44. What is homologous series? Give example.

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

Example of homologous series

Alkane series C_nH_{2n+2}

CH_4 Methane, C_2H_6 Ethane

C_3H_8 Propane, C_4H_{10} Butane C_5H_{12} Pentane

It can be noticed that there is a difference of $–CH_2$ unit between each successive compound.

45. Write the difference in molecular masses between propane and butane.

The formula of propane is C_3H_8 and the formula of butane is C_4H_{10}. They differ by a CH_2 group. So the difference in molecular mass is 12 + 1x2 = 12 + 2 = 14u.

46. What are alkenes?

Alkenes are unsaturated hydrocarbons in which one of the carbon atoms are connected by double bond.

47. Write the characteristics of alkenes.

a) The name of these hydrocarbons end with 'ene'.

b) Their general formula is C_nH_{2n}.

Ex: Ethene, Propene, Butene etc.

48. Write the relation between the number of carbon atoms and hydrogen atoms in alkenes.

Alkenes have a general formula is C_nH_{2n}. The ratio of the carbon atoms to the hydrogen atoms is 1:2.

49. Why does the physical properties of compounds in homologous series increase?

The melting and boiling points increase with increasing molecular mass. Hence there is a gradation in physical properties.

50. (Activity 4.2) Calculate the difference in the formulae and molecular masses for (a) CH_3OH and C_2H_5OH (b) C_2H_5OH and C_3H_7OH, and (c) C_3H_7OH and C_4H_9OH.

In all the given pairs of compounds, the molecular formula of the first compound differs from the second by a $-CH_2$ unit. Mass of $CH_2 = 12 + 2x1 = 14u$.

So the difference in molecular mass of the compounds in each pair is 14u.

Is there any similarity in these three?

Yes, all the given pairs of compounds differ by a $-CH_2$ group.

Arrange these alcohols in the order of increasing carbon atoms to get a family.

The order of alcohols is CH_3OH, C_3H_5OH,C_3H_7OH,C_4H_9OH

Can we call this family a homologous series?

Yes they form homologous series.

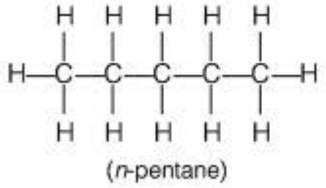
Generate the homologous series for compounds containing up to four carbons for the other functional groups.

Aldehyde group H-CHO, CH_3-CHO, C_2H_5-CHO,C_3H_7-CHO

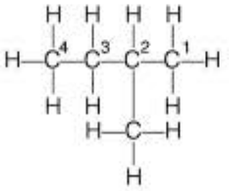
Carboxylic acid group H-COOH, CH_3-COOH, C_2H_5-COOH, C_3H_7COOH

51. How many structural isomers can you draw for pentane?

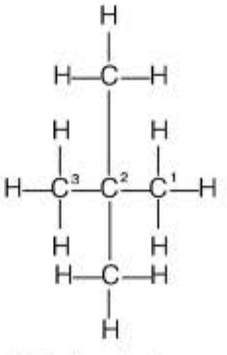
Pentane (C_5H_{12}) has a skeleton of five carbon atoms. It can exist as straight chain as well as two branched chains. The possible structural isomers have been shown below.



(*n*-pentane)



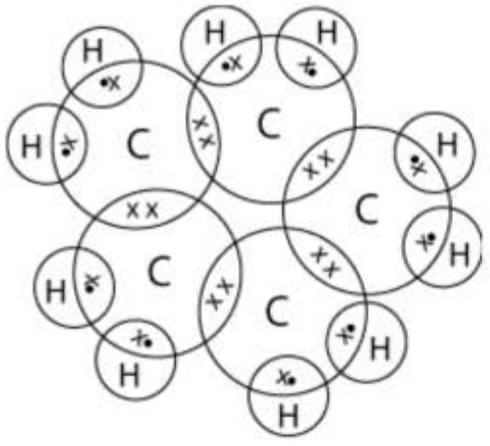
(2-methylbutane)



(2, 2-dimethyl propane)

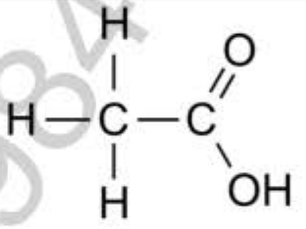
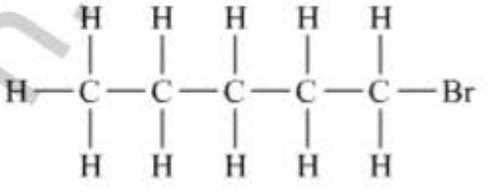
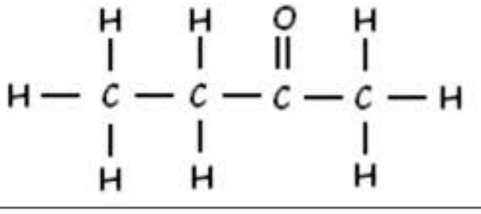
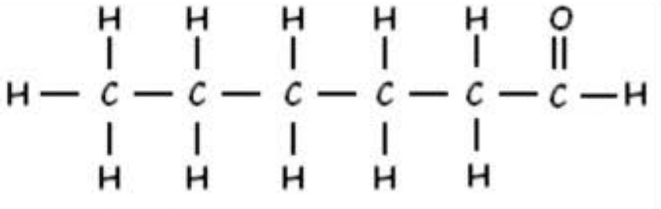
52. What will be the formula and electron dot structure of cyclopentane?

The formula of cyclopentane is C_5H_{10}



53. Draw the structures for the following compounds.

(1) **Ethanoic acid (ii) Bromopentane (iii) Butanone (iv) Hexanal.**

Compound	Formula	Structure
i) Ethanoic acid	CH_3COOH	
ii) Bromopentane	$C_5H_{11}Br$	
iii) Butanone	$CH_3COC_2H_5$	
iv) Hexanal	$C_5H_{11}CHO$	

Are structural isomers possible for bromopentane?

Yes, isomers of bromopentane are

(i) $CH_3CH_2CH_2CH_2CH_2Br$

1-bromopentane

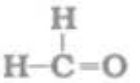
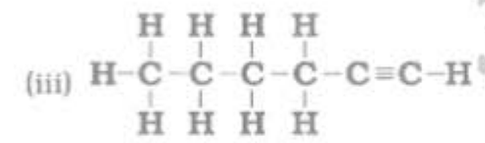
(ii) $CH_3CH_2CH_2\underset{\displaystyle Br}{\underset{|}{C}}HCH_3$

2-bromopentane

(iii) $CH_3CH_2\underset{\displaystyle Br}{\underset{|}{C}}HCH_2CH_3$

3-bromopentane

54. How would you name the following compounds?

(i) $CH_3—CH_2—Br$	Bromoethane
(ii) 	Formaldehyde or methanal
(iii) 	1-hexyne

55. How do carbon compounds react with oxygen?

Carbon, in all its allotropic forms, burn in oxygen to give carbon dioxide along with release of heat and light.

Ex: (i) $C + O_2 \longrightarrow CO_2$ + heat and light

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

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

56. Balance the following reactions.

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

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

(i) $CH_4 + \mathbf{2}O_2 \longrightarrow CO_2 + \mathbf{2}H_2O$ + heat and light

(ii) $CH_3CH_2OH + O_2 \longrightarrow \mathbf{2}CO_2 + \mathbf{3}H_2O$ + heat and light

57. (Activity 4.2) Take some carbon compounds (naphthalene, camphor, alcohol) one by one on a spatula and burn them. Observe the nature of the flame and note whether smoke is produced. Place a metal plate above the flame. Is there a deposition on the plate in case of any of the compounds?

Carbon compound	Nature of flame	Deposits on metal plate
Camphor	Smoky flame	Carbon deposits
Alcohol	Non-smoky flame	No carbon deposit
Acetone	Non-smoky flame	No carbon deposit
Naphthalene	Smoky flame	Carbon deposits

58. (Activity 4.3) Light a Bunsen burner and adjust the air hole at the base to get different types of flames / presence of smoke.

When do you get a yellow, sooty flame?

We get a yellow sooty flame if some of the holes in the bottom of burner are blocked and the burner does not get sufficient oxygen.

When do you get a blue flame?

We get a blue flame if all the holes are open and sufficiently oxygen rich air is available.

59. Which carbon compounds burn with a clean flame?

Saturated hydrocarbons on burning will give a clean flame.

60. Which carbon compounds burn with a sooty flame?

Unsaturated hydrocarbons will give a yellow flame with lots of black smoke. Even saturated hydrocarbons burning with limited supply of air gives a sooty flame.

61. Why are gas/kerosene stoves provided with holes at the bottom?

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

62. What can you infer if bottoms of cooking vessels getting blackened?

If vessels are getting blackened while cooking means that the air holes are blocked and fuel is getting wasted.

63. Why does burning of coal or charcoal not produce any flame?

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

64. (Activity 4.5) Take about 3 mL of ethanol in a test tube and warm it gently in a water bath. Add a 5% solution of alkaline potassium permanganate drop by drop to this solution.

Does the colour of potassium permanganate persist when it is added initially?

Initially colour of potassium permanganate disappears because coloured permanganate ions of potassium permanganate are consumed to oxidise ethanol.

Why does the colour of potassium permanganate not disappear when excess is added?

When excess of potassium permanganate is added, colour does not disappear because there is no alcohol left and hence there is no reaction.

65. What are oxidising agents?

The substances which are capable of providing oxygen to other substances are called oxidising agents. Ex: Alkaline $KMnO_4$ and acidified $K_2Cr_2O_7$ can both behave as oxidising agents.

66. How can unsaturated hydrocarbons be converted into saturated hydrocarbons?

Unsaturated hydrocarbons add hydrogen in the presence of catalysts such as palladium or nickel to give saturated hydrocarbons.

67. What is a catalyst?

Catalysts are substances that cause a reaction to occur or proceed at a different rate without the reaction itself being affected.

68. What is an addition reaction?

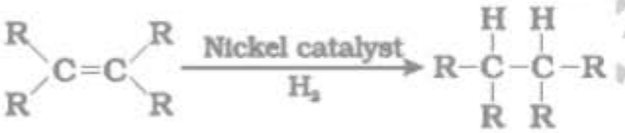
A reaction in which a reactant molecule is added to another reactant molecule is called addition reaction.

For example: Hydrogen is added across the double bond of ethene in the presence of catalysts such as nickel, palladium or platinum to give saturated hydrocarbons.

69. What is hydrogenation?

Addition of hydrogen to alkenes to form alkanes is known as hydrogenation.

70. Show the conversion of alkenes into alkanes by hydrogenation.



71. What is the difference between oils and fats?

Vegetable oils have long unsaturated carbon chains while animal fats have saturated carbon chains.

72. What is meant by substitution reaction?

The reaction in which one or more hydrogen atoms of a hydrocarbon are replaced by some other atoms is called substitution reaction.

73. How does methane react with chlorine?

Methane reacts with chlorine in presence of sunlight.

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

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

Since the conversion of ethanol to ethanoic acid involves the addition of oxygen to ethanol, it is an oxidation reaction.

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

When ethyne is burnt in air, it gives a sooty flame. This is due to incomplete combustion caused by limited supply of air. If ethyne is burnt with oxygen, it gives a clean flame with temperature 3000°C because of complete combustion. This oxy-acetylene flame is used for welding. It is not possible to attain such a high temperature without mixing oxygen. Hence a mixture of ethyne and air is not used.

76. Mention the uses of ethanol.

a) Ethanol is a good solvent.

b) It is an active ingredient in all alcoholic drinks.

c) It is used in medicines such as tincture iodine, cough syrups and many tonics.

77. Why is ethanol called alcohol?

Ethanol is called alcohol due to the presence of OH group in it.

78. What is absolute alcohol?

100% pure ethanol is called absolute alcohol.

79. How does ethanol react with sodium?

Ethanol reacts with sodium to form sodium ethoxide and hydrogen.

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

(Sodium ethoxide)

80. (Activity 4.6) Drop a small piece of sodium, about the size of a couple of grains of rice, into ethanol (absolute alcohol).

What do you observe?

Vigorous reaction occurs and hydrogen gas is bubbled out.

How will you test the gas evolved?

The gas evolved burns with a pop sound when exposed to burning match stick.

How does ethanol react with sulphuric acid? OR Explain the industrial preparation of ethene.

Heating ethanol at 443 K with excess concentrated sulphuric acid results in the dehydration of ethanol to give ethene.

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

81. Name the dehydrating agent in the manufacture of ethene.

Concentrated sulphuric acid.

82. What is the role of sulphuric acid in the manufacture of ethene?

Sulphuric acid removes water from ethanol during the manufacture of ethene.

83. What is denatured alcohol?

Alcohol which is made unfit for drinking is known as denatured alcohol.

84. Why is the consumption of methanol dangerous?

Intake of methanol in very small quantities can cause death. Methanol is oxidised to methanal in the liver. Methanal reacts rapidly with the components of cells. It causes the protoplasm to get coagulated, in much the same way an egg is coagulated by cooking. Methanol also affects the optic nerve, causing blindness.

85. How is ethanol made unfit for drinking?

Ethanol is made unfit for drinking by adding poisonous substances like methanol to it.

86. What is vinegar?

5–8% solution of acetic acid in water is called vinegar.

87. Write the use of vinegar.

Vinegar is used widely as a preservative in pickles.

88. Why is ethanoic acid referred to as glacial acetic acid?

The melting point pointing pure ethanoic acid is 290K and hence it freezes during winter in cold climate. Hence ethanoic acid is referred to as glacial acetic acid.

89. How is carboxylic acid different from mineral acids?

Mineral acids like HCl get completely ionised whereas carboxylic acids are weak acids which do not completely ionise.

90. (Activity 4.7) Compare the pH of dilute acetic acid and dilute hydrochloric acid using both litmus paper and universal indicator.

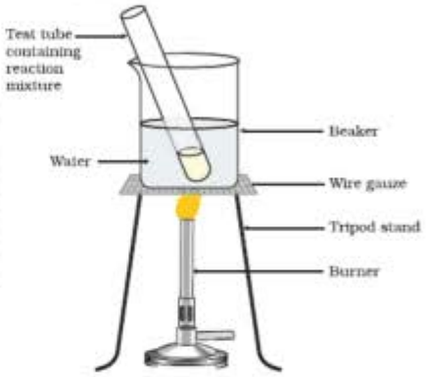
Are both acids indicated by the litmus test?

Both acids, acetic acid and dilute hydrochloric acid turn litmus paper red.

Does the universal indicator show them as equally strong acids?

Universal indicator shows different colours with acetic acid and hydrochloric acid showing clearly that hydrochloric acid is stronger acid than acetic acid.

91. (Activity 4.8) Take 1 mL ethanol (absolute alcohol) and 1 mL glacial acetic acid along with a few drops of concentrated sulphuric acid in a test tube. Warm in a water-bath for at least five minutes as shown in figure. Pour into a beaker containing 20-50 mL of water and smell the resulting mixture.



The resulting mixture gives a sweet smell due to the formation of ester called ethyl acetate.

92. How are esters formed?

Esters are most commonly formed by reaction of an acid and an alcohol. Ethanoic acid reacts with absolute ethanol in the presence of an acid catalyst to give an ester.

$CH_3COOH + CH_3–CH_2OH \xrightarrow{Acid} CH_3COOC_2H_5 + H_2O$

(Ethanoic acid) (Ethanol) (Ester)

93. Write the properties of esters.

Esters are sweet-smelling substances.

Esters react in the presence of an acid or a base to form alcohol and carboxylic acid.

94. What is meant by saponification?

The reaction of an ester to react with a base to give back the alcohol and carboxylic acid is called saponification.

95. How does ethyl ethanoate react with sodium hydroxide?

Ethyl ethanoate ($CH_3COOC_2H_5$) when heated with sodium hydroxide gets hydrolysed to form ethyl alcohol and acetic acid.

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

96. How does ethanoic acid react with sodium hydroxide?

Ethanoic acid reacts with a base such as sodium hydroxide to give a salt (sodium ethanoate or commonly called sodium acetate) and water.

$$NaOH + CH_3COOH \longrightarrow CH_3COONa + H_2O$$

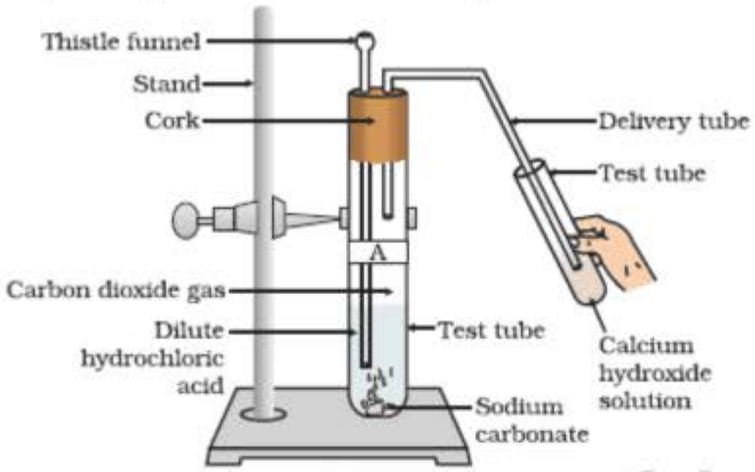
97. How does ethanoic acid react with carbonates and hydrogen carbonates?

Ethanoic acid reacts with carbonates and hydrogen carbonates to give a salt (sodium acetate), carbon dioxide and water.

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

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

98. Set up the apparatus as shown in the figure.



Take a spatula full of sodium carbonate in a test tube and add 2 mL of dilute ethanoic acid. What do you observe?

A gas (Carbon dioxide) evolves with effervescence.

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

Pass the gas produced through freshly prepared lime-water. What do you observe?

The gas evolved turns lime water milky.

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

Can the gas produced by the reaction between ethanoic acid and sodium carbonate be identified by this test?

The evolution of carbon dioxide is identified by this test.

Repeat this activity with sodium hydrogen carbonate instead of sodium carbonate.

Similar observations as above will be seen if we use sodium hydrogen carbonate instead of sodium carbonate.

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

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

Sodium bicarbonate test ($NaHCO_3$ test)

Alcohol + $NaHCO_3$ → No effervescence

Acid + $NaHCO_3$ → Brisk effervescence

The sample which produces brisk effervescence when treated with $NaHCO_3$ due to release of CO_2 is a carboxylic acid.

100. (Activity 4.10) Take about 10 mL of water each in two test tubes. Add a drop of oil (cooking oil) to both the test tubes and label them as A and B. To test tube B, add a few drops of soap solution. Now shake both the test tubes vigorously for the same period of time.

Can you see the oil and water layers separately in both the test tubes immediately after you stop shaking them?

The oil and water do not separate immediately after shaking in both the test tubes and a turbidity is observed.

Leave the test tubes undisturbed for some time and observe. Does the oil layer separate out?

In which test tube does this happen first?

On keeping, oil and water separate in test tube A whereas in test tube B containing soap solution, oil and water from permanent emulsion.

101. What is a soap? Give example.

Soap is a sodium (or potassium) salt of higher fatty acid like palmitic, oleic or stearic acid.

Ex: Sodium palmitate ($C_{15}H_{31}COONa$), Sodium oleate ($C_{16}H_{33}COONa$), Sodium stearate ($C_{17}H_{35}COONa$)

102. Explain the action of soap.

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.

103. What are micelles?

Micelles are clusters of molecules in which water-repelling end tails are in the interior of the cluster and the ionic ends are on the surface of the clusters.

104. Why soap in the form of micelles able to clean?

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

105. (Activity 4.11) Take about 10 mL of distilled water (or rain water) and 10 mL of hard water (from a tube well or hand-pump) in separate test tubes. Add a couple of drops of soap solution to both. Shake the test tubes vigorously for an equal period of time and observe the amount of foam formed.

In which test tube do you get more foam?

The test tube containing distilled water shows more foam. This is because the whole of soap is available to from foam.

In which test tube do you observe a white curdy precipitate?

The test tube containing hand-pump water may show a white curdy precipitate, if it is hard. This is because calcium and magnesium ions form precipitate with soap, thus wasting some of the soap.

106. (Activity 4.12) Take two test tubes with about 10 mL of hard water in each. Add five drops of soap solution to one and five drops of detergent solution to the other. Shake both test tubes for the same period.

Do both test tubes have the same amount of foam?

The test tube containing detergent solution has more amount of foam.

In which test tube is a curdy solid formed?

The test tube containing soap solution shows a curdy solid being formed.

107. Name the salts that cause hardness of water?

Calcium and magnesium salts.

108. Why is soap wasted when used with hard water?

When soap is used with hard water, soap reacts with the calcium and magnesium salts, which cause the hardness of water. Hence a larger amount of soap is used.

109. How are detergents able to clean better?

Detergents are generally 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. So they clean better even in hard water.

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

Detergents are ammonium or sulphonate salts of long chain carboxylic acids. Unlike soap, they do not react with calcium and magnesium ions present in hard water to form scum. They give a good amount of lather irrespective of whether the water is hard or soft. This means that detergents can be used in both soft and hard water. Therefore, it cannot be used to check whether the water is hard or not.

111. 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?

A soap molecule has two parts namely hydrophobic and hydrophilic. With the help of these, it attaches to the grease or dirt particle and forms a cluster called micelle. These micelles remain suspended as a colloid. To remove these micelles (entrapping the dirt), it is necessary to agitate clothes.

112. Explain the nature of the covalent bond using the bond formation in CH_3Cl.

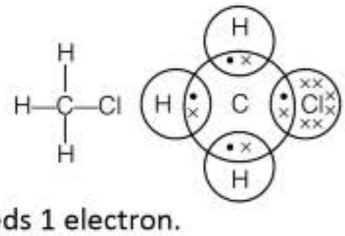
Atomic number of

C = 6; H = 1; Cl = 17

Electronic configuration of Carbon is (2, 4)

Electronic configuration of chlorine is (2, 8, 7)

Electronic configuration of hydrogen is (1)

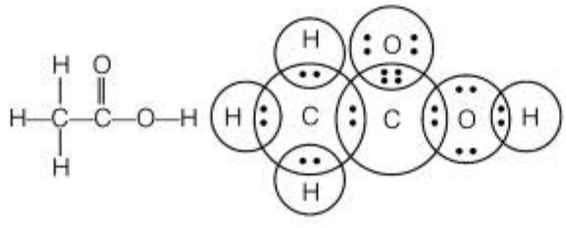


C needs 4 electrons to complete its octet, H needs 1 and Cl needs 1 electron.

Therefore C shares its 4 electrons with each of the 3 H-atoms and 1 with chlorine atom. It thus forms 4 covalent bonds as shown.

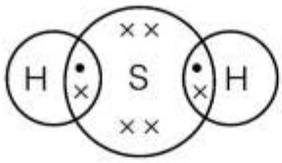
113. Draw the electron dot structures for

(a) Ethanoic acid.



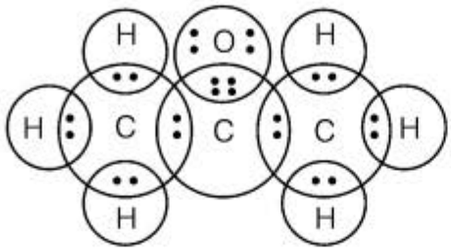
(b) H_2S

H_2S, H—S—H



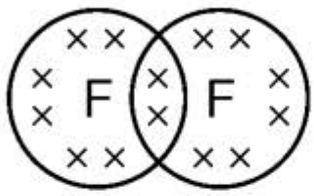
(c) Propanone.

CH_3COCH_3



(d) F_2

F_2, F—F



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

I. Distinction based on physical properties

1. Smell Ethanoic acid has a pungent smell. Ethanol has a pleasant smell.

2. Melting point Ethanol has lower melting point (150 K) than ethanoic acid (290 K).

3. Physical state Ethanoic acid is solid (glacial acetic acid) in winters but ethanol is always a liquid.

II. Distinction based on chemical properties

(i) Action with sodium hydrogen carbonate: On adding a small amount of sodium hydrogen carbonate to ethanoic acid, carbon dioxide gas is evolved with brisk effervescence. However, no such reaction noticed in case of ethanol.

(ii) Action with caustic alkalies Ethanoic acids reacts with both sodium hydroxide (NaOH) and potassium hydroxide (KOH) to form corresponding salt and water. Ethanol fails to react with either of these.

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

A soap is a sodium or potassium salt of long chain fatty acids. It has one polar end and one non-polar end. The polar end is hydrophilic in nature i.e., this end is attracted towards water. The non-polar end is hydrophobic but lipophilic, i.e., it is attracted towards hydrocarbons. When soap is added to water, soap molecules arrange themselves in a cluster to keep the nonpolar portion out of water such that the non-polar ends are in the interior of the cluster and the polar ends are on the surface of the cluster. Since the dirt present on clothes is organic in nature and insoluble in water, the hydrophobic ends of the clusters attach themselves to the dirt. This cluster formation in which the dirt is

entrapped is the micelle. Micelle formation does not occur in alcohol because the alkyl chain of soap becomes soluble in alcohol.

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

Carbon burns in oxygen (air) to form carbon dioxide and water. During this reaction a large amount of heat and light are released. Further, once ignited carbon and its compounds keep on burning without the requirement of additional energy. Hence, they are used as fuels. $C + O_2 \longrightarrow CO_2 + \text{heat} + \text{light}$

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

Soap does not work properly when the water is hard. A soap is a sodium or potassium salt of long chain fatty acids. Hard water contains salts of calcium and magnesium. When soap is added to hard water, calcium and magnesium ions present in water displace sodium or potassium ions from the soap molecules forming an insoluble substance called scum. A lot of soap is wasted in the process. Reaction taking place are shown below.

$$Ca^{2+} + 2RCOONa \longrightarrow (RCOO)_2 CA + 2Na^+$$

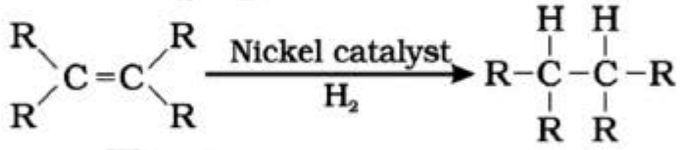
$$Mg^{2+} + 2RCCONa \longrightarrow (RCOO)_2 Mg + 2Na^+$$

118. What change will you observe if you test soap with litmus paper (red and blue)?

Soap is basic in nature, it will turn red litmus blue. The colour of blue litmus will remain blue.

119. What is hydrogenation? What is its industrial application?

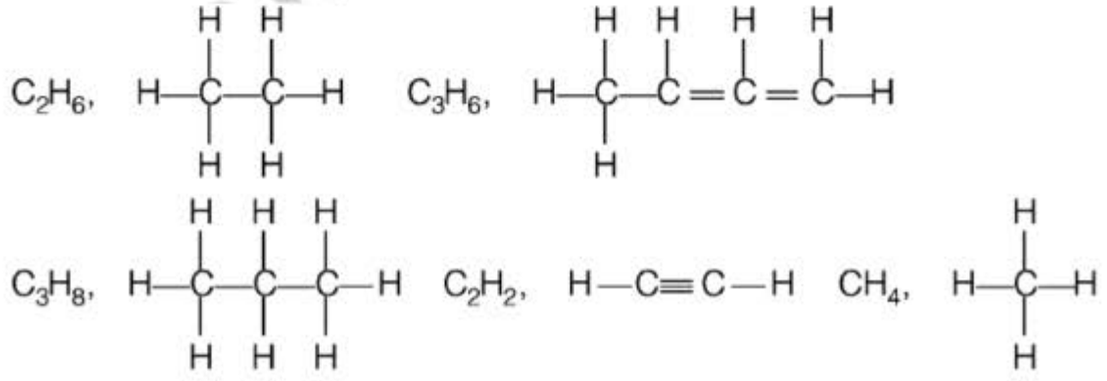
Hydrogenation is the process of addition of hydrogen. Unsaturated hydrocarbons are added with hydrogen in the presence of palladium and nickel catalysts to give saturated hydrocarbons.



This reaction is applied in the hydrogenation of vegetables oils, which contain long chains of unsaturated carbons.

120. Which of the following hydrocarbons undergo addition reactions: C_2H_6, C_3H_8, C_3H_6, C_2H_2 and CH_4.

Unsaturated hydrocarbons containing double/ triple bond undergo addition reactions.



So, C_3H_6 and C_2H_2 will undergo addition reactions.

121. Give a test that can be used to differentiate chemically between butter and cooking oil.

Butter contains saturated compounds while cooking oil contains unsaturated compounds. Since unsaturated compounds are oxidised by alkaline KMnO4 with disappearance of its pink colour.

When cooking oil is treated with a few drops of alkaline KMnO4, pink colour of KMnO4 disappears. With butter however, the pink colour KMnO4 does not disappear

122. Explain the mechanism of the cleaning action of soaps.

Cleansing action of soaps:

The dirt present on clothes is organic in nature and insoluble in water. Therefore, it cannot be removed by only washing with water. When soap is dissolved in water, its hydrophobic ends attach themselves to the dirt and remove it from the cloth. Then, the molecules of soap arrange themselves in micelle formation and trap the dirt at the centre of the cluster. These micelles remain suspended in the water. Hence, the dust particles are easily rinsed away by water.

Fill in the blanks:

1) The percentage of carbon present in the earth's crust is 0.02%.
2) The percentage of carbon present in the atmosphere is 0.03%.
3) The number of bonds formed between two hydrogen atoms is single.
4) The number of bonds formed between two oxygen atoms is double.
5) The number of bonds formed between two nitrogen atoms is triple.
6) The number of bonds formed in a molecule of ammonia is one.
7) The electronic configuration of carbon is 2, 2, 2.
8) The valency of carbon is 4.
9) Water molecule has single covalent bond.
10) Ammonia has single covalent bond.
11) Bonds which are formed by the sharing of an electron pair between two atoms is known as covalent bonds.
12) Covalent compounds have low melting and boiling points.
13) The unique ability of carbon to form bonds with other atoms of carbon, giving rise to large molecules is called catenation.
14) Two elements that exhibit catenation are carbon and silicon.
15) Compounds of carbon, which are linked by only single bonds between the carbon atoms are called saturated compounds.
16) Compounds of carbon, which are linked by double or triple bonds between the carbon atoms are called unsaturated compounds.
17) The person who disproved the vital force theory was Friedrich Wöhler.
18) Friedrich Wöhler prepared the organic compound urea to disprove the vital force theory.
19) Compounds with identical molecular formula but different structures are called structural isomers.

20) Carbon compounds which contain carbon and hydrogen only are called hydrocarbons.

21) Saturated hydrocarbons in which the carbon atoms are connected by only single bond are called alkanes.

22) The general formula of alkanes is C_nH_{2n+2}

23) In hydrocarbons, the element replacing hydrogen is referred to as heteroatoms.

24) Hydrocarbons in which one or more hydrogen atoms have been replaced by atom or group of atoms of other elements are called functional groups.

25) Compounds containing –OH as the functional group are called alcohols.

26) The general formula of alcohols is –OH.

27) Compounds containing –CHO as the functional group are called aldehydes.

28) The general formula of aldehydes is –CHO.

29) Compounds containing –one as functional group are called ketones.

30) The general formula of ketones is – one.

31) Compounds containing –COOH as the functional group are called Carboxylic acids.

32) The general formula of carboxylic acids is –COOH.

33) A group of organic compounds in which the successive compounds differ by a CH_2 group are called homologous series.

34) In a homologous series, the successive compounds differ by a CH_2 group.

35) The first member of alkane series is methane.

36) The first member of alkene series is ethene.

37) Alcohol which is made unfit for drinking is known as denatured alcohol.

38) Ethanoic acid is commonly called acetic acid.

39) Ethanoic acid belongs to a group of acids called carboxylic acids.

40) 5–8% solution of acetic acid in water is called vinegar.

41) The reaction in which esters react in presence of acid or a base to give alcohol and carboxyl acid is called saponification.

42) The soap molecules from structures called micelles.

43) Hardness of water is caused due to salts of magnesium and calcium.

Multiple Choice questions:

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.

2) Butanone is a four-carbon compound with the functional group:

(a) carboxylic acid. (b) aldehyde.

(c) ketone. (d) alcohol.

3) While cooking, if the bottom of the vessel is getting blackened 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.

4) Carbon exists in the atmosphere in the form of

(a) carbon monoxide only (b) carbon monoxide in traces and carbon dioxide

(c) carbon dioxide only (d) coal

5) Which of the following statements are usually correct for carbon compounds? These

(i) are good conductors of electricity

(ii) are poor conductors of electricity

(iii) have strong forces of attraction between their molecules

(iv) do not have strong forces of attraction between their molecules

(a) (i) and (iii) (b) (ii) and (iii) (c) (i) and (iv) **(d) (ii) and (iv)**

6) A molecule of ammonia (NH_3) has

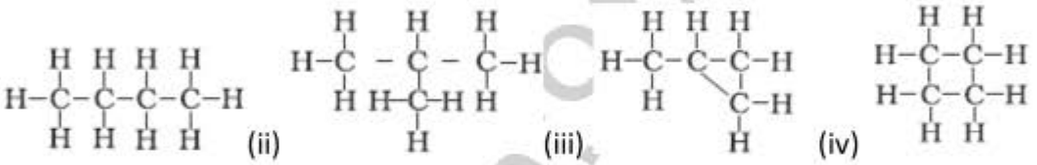
(a) only single bonds (b) only double bonds

(c) only triple bonds (d) two double bonds and one single bond

7) Buckminsterfullerene is an allotropic form of

(a) phosphorus (b) sulphur **(c) carbon** (d) tin

8) Which of the following are correct structural isomers of butane?



(i) (ii) (iii) (iv)

(a) (i) and (iii) (b) (ii) and (iv) **(c) (i) and (ii)** (d) (iii) and (iv)

9) $CH_3-CH_2-OH \xrightarrow{\text{Alkaline } KMnO_4 + \text{Heat}} CH_3-COOH$ **In the above given reaction, alkaline KMnO4 acts as**

(a) reducing agent **(b) oxidising agent**

(c) catalyst (d) dehydrating agent

10) Oils on treating with hydrogen in the presence of palladium or nickel catalyst form fats. This is an example of

(a) Addition reaction (b) Substitution reaction

(c) Displacement reaction (d) Oxidation reaction

11) In which of the following compounds, — OH is the functional group?

(a) Butanone **(b) Butanol** (c) Butanoic acid (d) Butanal

12) The soap molecule has a

(a) hydrophilic head and a hydrophobic tail

(b) hydrophobic head and a hydrophilic tail

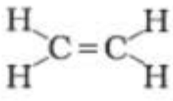
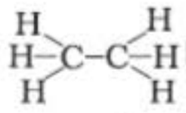
(c) hydrophobic head and a hydrophobic tail

(d) hydrophilic head and a hydrophilic tail

13) Which of the following is the correct representation of electron dot structure of nitrogen?

(a) $:\dot{\ddot{N}} : \dot{\ddot{N}}:$ (b) $:\dot{N}::\dot{N}:$ (c) $:\dot{\ddot{N}}:\dot{N}:$ (d) $:N:::N:$

14) Structural formula of ethyne is

(a) H– C≡ C– H (b) 3 H – C≡ C – H (c)  (d) 

15) Identify the unsaturated compounds from the following

(i) Propane (ii) Propene (iii) Propyne (iv) Chloropropane

(a) (i) and (ii) (b) (ii) and (iv) (c) (iii) and (iv) **(d) (ii) and (iii)**

16) Chlorine reacts with saturated hydrocarbons at room temperature in the

(a) absence of sunlight **(b) presence of sunlight**

(c) presence of water (d) presence of hydrochloric acid

17) In the soap micelles

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

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

(c) both ionic end and carbon chain are in the interior of the cluster

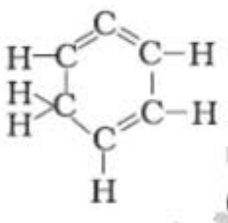
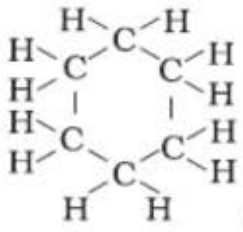
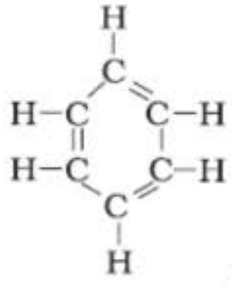
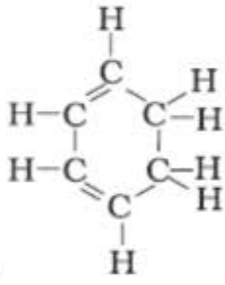
(d) both ionic end and carbon chain are on the exterior of the cluster

18) Pentane has the molecular formula C_5H_{12}. It has

(a) 5 covalent bonds (b) 12 covalent bonds

(c) 16 covalent bonds (d) 17 covalent bonds

19) Structural formula of benzene is

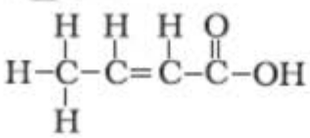
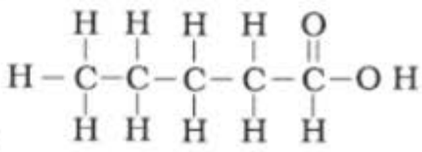
(a)  (b)  **(c)**  **(d)** 

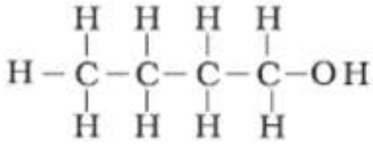
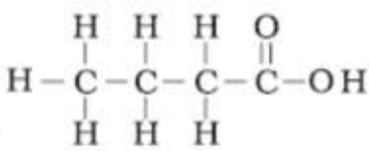
20) Ethanol reacts with sodium and forms two products. These are

(a) sodium ethanoate and hydrogen (b) sodium ethanoate and oxygen

(c) sodium ethoxide and hydrogen (d) sodium ethoxide and oxygen

21) The correct structural formula of butanoic acid is

(a)  (b) 

(c)  (d) 

22) Vinegar is a solution of

(a) 50% – 60% acetic acid in alcohol

(b) 5% – 8% acetic acid in alcohol

(c) 5% – 8% acetic acid in water

(d) 50% – 60% acetic acid in water

23) Mineral acids are stronger acids than carboxylic acids because

(i) mineral acids are completely ionised

(ii) carboxylic acids are completely ionised

(iii) mineral acids are partially ionised

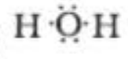
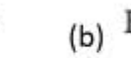
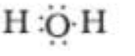
(iv) carboxylic acids are partially ionised

(a) (i) and (iv) (b) (ii) and (iii) (c) (i) and (ii) (d) (iii) and (iv)

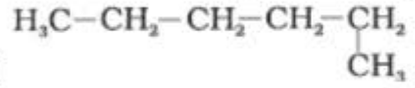
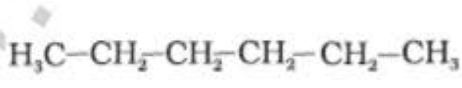
24) Carbon forms four covalent bonds by sharing its four valence electrons with four univalent atoms, e.g. hydrogen. After the formation of four bonds, carbon attains the electronic configuration of

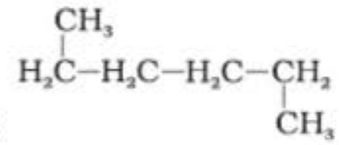
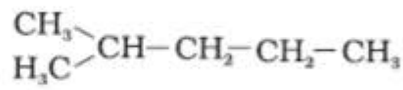
(a) helium **(b) neon** (c) argon (d) krypton

25) The correct electron dot structure of a water molecule is

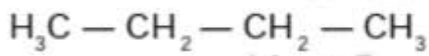
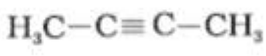
(a)  (b)  **(c)**  (d)

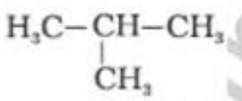
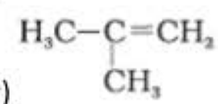
26) Which of the following is not a straight chain hydrocarbon?

(a)  (b) 

(c)  **(d)** 

27) Which among the following are unsaturated hydrocarbons?

(i)  (ii) 

(iii)  (iv) 

(a) (i) and (iii) (b) (ii) and (iii) **(c) (ii) and (iv)** (d) (iii) and (iv)

28) Which of the following does not belong to the same homologous series?

(a) CH_4 (b) C_2H_6 (c) C_3H_8 **(d) C_4H_8**

29) The name of the compound $CH_3 — CH_2 — CHO$ is

(a) Propanal **(b) Propanone** (c) Ethanol (d) Ethanal

30) The heteroatoms present in CH3 — CH2 — O — CH2— CH2 Cl are

(i) oxygen (ii) carbon (iii) hydrogen (iv) chlorine

(a) (i) and (ii)

(b) (ii) and (iii)

(c) (iii) and (iv) **(d) (i) and (iv)**

31) Which of the following represents saponification reaction?

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

(b $CH_3COOH + C_2H_5OH \xrightarrow{H_2SO_4} CH_3COOC_2H_5 + H_2O$

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

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

32) The first member of alkyne homologous series is

(a) ethyne (b) ethene (c) propyne (d) methane