Carbon and Its Compounds

Question 1:

Name the element whose one of the allotropic forms is buckminsterfullerene.

Solution :

Carbon

Question 2:

What are the two properties of carbon which lead to the formation of a large number of carbon compounds ?

Solution :

Catenation(Self linking of carbon atoms to form long chains) and Tetravalency.

Question 3:

State whether the following statement is true or false :

Solution :

False

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Question 4:

Name the scientist who disproved the 'vital force theory' for the formation of organic compounds.

Solution :

Friedrich Wohler.

Question 5:

Name the element whose allotropic form is graphite.

Solution :

Carbon.

Question 6:

In addition to some propane and ethane, LPG cylinders contain mainly two isomers of another alkane. Name the two isomers and write their condensed structural formulae.

Solution :

n-butane and iso-butane.

Question 7:

Buckminsterfullerene is a spherical molecule in which 60 carbon atoms are arranged in interlocking hexagonal and pentagonal rings of carbon atoms.

How many hexagons of carbon atoms are present in one molecule of buckminsterfullerene ?

How many pentagons of carbon atoms are present in one molecule of buckminsterfullerene ?

Solution :

(a) 20 hexagons

(b) 12 pentagons

Question 8:

Name the black substance of pencil. Will the current flow through the electrical circuit when we use the sharpened ends of the pencil to complete the circuit ?

Solution :

Graphite

Yes, current will flow through the circuit since graphite is a good conductor of electricity.

Question 9:

How does graphite act as a lubricant ?

Solution :

Graphite is used as a lubricant in the form of graphite powder or mixed with petroleum jelly or with any lubricant oil to form graphite grease.

Question 10:

Name the hardest natural substance known.

Solution :

Diamond

Question 11:

Which of the following molecule is called buckminsterfullerene ?

C_{90} C_{60} C_{70} C_{20}

Solution :

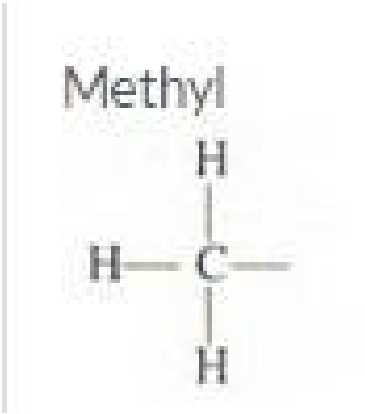
C_{60} is called buckminsterfullerene

Question 12:

Give the name and structural formula of an alkyl group.

Solution :

Methyl

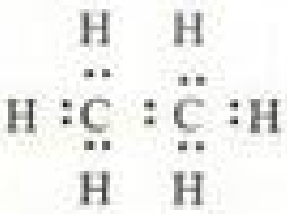


Question 13:

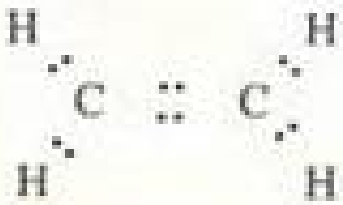
Write the electron-dot structures for : (i) ethane, (ii) ethene, and (iii) ethyne.

Solution :

(a) Ethane



(b) Ethene



(c) Ethyne

Question 14:

Give the IUPAC name of the following compound :

C_2H_6

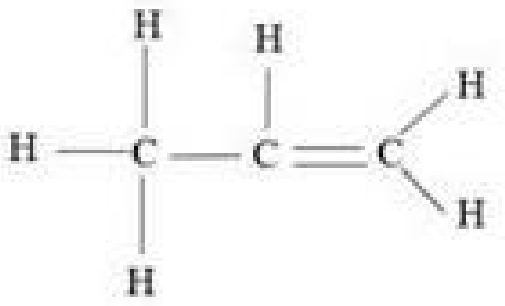
Solution :

Ethane.

Question 15:

Write the structural formula of propene.

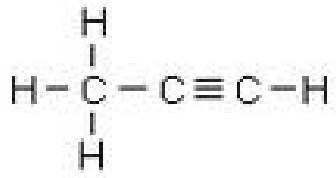
Solution :



Question 16:

Write the structural formula of propyne.

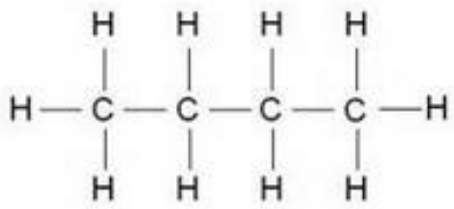
Solution :



Question 17:

Write the structural formula of butane.

Solution :



Question 18:

What do you call the compounds having the same molecular formula but different structural arrangements of atoms ?

Solution :

Isomers.

Question 19:

Write the names of any two isomers represented by the molecular formula C_5H_{12}.

Solution :

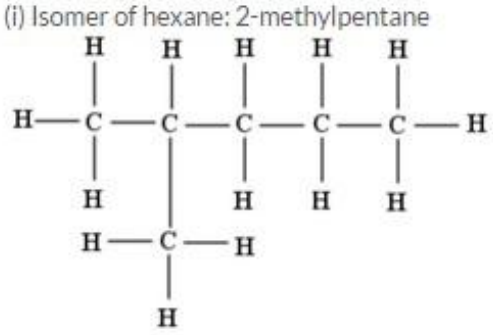
Isopentane and neopentane.

Question 20:

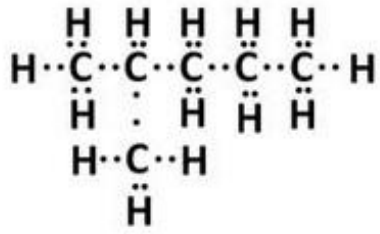
Write down (i) structural formula, and (ii) electron-dot formula, of any one isomer of hexane (C_6H_{14}), other than n-hexane.

Solution :

(i) Isomer of hexane: 2-methylpentane



(ii)



Question 21:

Fill in the following blanks with suitable words :

(a) The form of carbon which is known as black lead is……..

(b) The form of carbon which is used as a lubricant at high temperature is……

(c) Compounds of carbon with hydrogen alone are called……..

(d) C_nH_{2n} is the general formula of……..

(e) Hydrocarbons having the general formula C_nH_{2n-2} are called……..

(f) Ethene and ethyne are examples of……. hydrocarbons.

(g) Ethyne has…….. carbon-hydrogen single bonds.

(h) Carbon compounds have usually…….. melting points and boiling points because they are…… in nature.

(i) The property of carbon atoms to form long chains in compounds is called……

(j) The general formula C_nH_{2n} for cycloalkanes is the same as that of……..

(k) The IUPAC name of ethylene is……

(l) The IUPAC name of acetylene is……..

Solution :

(a) Graphite

(b) Graphite

(c) Hydrocarbons

(d) Alkene

(e) Alkynes

(f) Unsaturated

(g) Two

(h) Low; covalent

(i) Catenation

(j) Alkenes

(k) Ethene

(l) Ethyne

Question 22:

(a) What is the atomic number of carbon. Write its electronic configuration.

(b) What type of chemical bonds are formed by carbon ? Why ?

(c) Name the three allotropic forms of carbon.

Solution :

(a)The atomic number of carbon is 6. Its electronic configuration is 2,4.

(b)Carbon forms covalent bonds because it can achieve the inert gas electron arrangement only by sharing of electrons.

(c)Diamond, graphite and buckminsterfullerene.

Question 23:

(a) What is the general name of all the compounds made up of carbon and hydrogen ?

(b) Why does carbon form compounds mainly by covalent bonding ?

Solution :

(a) Hydrocarbons

(b) Carbon forms covalent bonds because it can achieve the inert gas electron arrangement only by sharing of electrons.

Question 24:

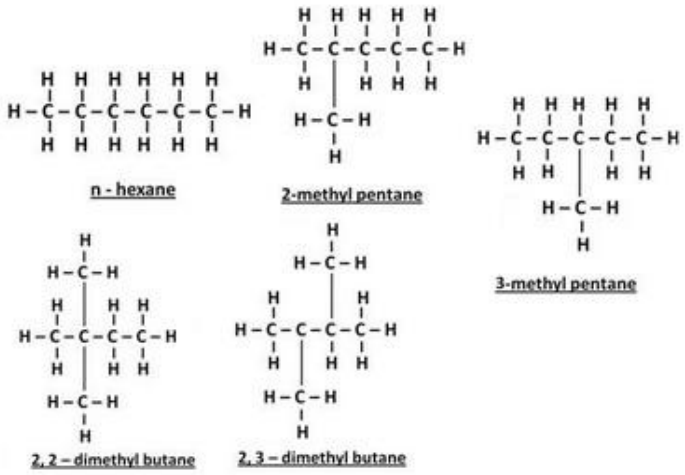
(a) What is meant by catenation ? Name two elements which exhibit the property of catenation.

(b) Write the names and structural formulae of all the possible isomers of hexane.

Solution :

(a) The property of self combination of carbon atoms to form long chains is called catenation. Carbon and Silicon exhibit the property of catenation.

(b)



Question 25:

(a) What is buckminsterfullerene ? How is it related to diamond and graphite ?

(b) Why is diamond used for making cutting tools (like glass cutters) but graphite is not ?

(c) Why is graphite used for making dry cell electrodes but diamond is not ?

Solution :

(a) Buckminsterfullerene is an allotrope of carbon containing clusters of 60 carbon atoms joined together to form spherical molecules. It burns on heating to form carbon dioxide and nothing is left behind. This shows that it is made up of carbon only like diamond and graphite.

(b) Diamond used for making cutting tools but graphite is not because diamond is a very hard substance and graphite is a soft substance.

(c) Graphite is used for making dry cell electrodes but diamond is not b ecause graphite is a good conductor of electricity whereas diamond is a bad conductor of electricity.

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Question 26:

(a) Give the general formula of an : (i) alkane (ii) alkene (in) alkyne.

(b) Classify the following compounds as alkanes, alkenes and alkynes :

C_2H_4, C_3H_4, C_4H_8, C_5H_{12}, C_5H_8, C_3H_8, C_6H_6

Solution :

(a) (i) C_nH_{2n+2}

(ii) C_nH_{2n}

(iii) C_nH_{2n-2}

Alkanes:

C_5H_{12}

C_3H_8

Alkenes:

C_2H_4

C_4H_8

Alkynes:

C_3H_4

C_5H_8

Question 27:

(a) Friedrich Wohler converted an inorganic compound into an organic compound in the laboratory.

(i) Give the name and formula of inorganic compound.
(ii) Write the name and formula of organic compound formed.
(b) Give the molecular formula of butane and mention the names of its two isomers. Name one fuel which contains both these isomers.

Solution :

(a) (i) Ammonium cyanate, NH_4CNO
(ii) Urea, $CO(NH_2)_2$
(b) The molecular formula of butane is C_4H_{10}; Its isomers are n-butane and 2-methylpropane; LPG.

Question 28:

(a) Give IUPAC names and formulae of an organic compound containing single bonds and the other containing a triple bond.
(b) Which of the following is the molecular formula of benzene ?
C_6H_6, C_6H_{10}, C_6H_{12}, C_6H_{14}
(c) Which of the two has a branched chain : isobutane or normal butane ?

Solution :

(a) Methane (single bond):
CH_4
Ethyne (triple bond): C_2H_2
(b) Benzene: C_6H_6
(c) Isobutene

Question 29:

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.

Solution :

Carbon forms strong bonds among themselves and with other elements and this makes the carbon compounds stable whereas silicon shows catenation property due to which it forms compounds with hydrogen having chains of up to 7 or 8 silicon atoms; but due to weak bonds, these compounds are unstable.

Question 30:

(a) How can diamonds be made artificially ? How do synthetic diamonds differ from natural ones ?
(b) Give any two differences between the properties of diamond and graphite. What causes these differences ?

Solution :

(a)Diamonds can be made artificially by subjecting pure carbon to very high pressure and temperature. The synthetic diamonds are small whereas natural diamonds are big.
(b)(i) Diamond is hard whereas graphite is soft.
(ii)Diamond is a non-conductor of electricity whereas graphite is a good conductor of electricity. The difference in the physical properties of diamond and graphite arises because of the different arrangements of carbon atoms in them.

Question 31:

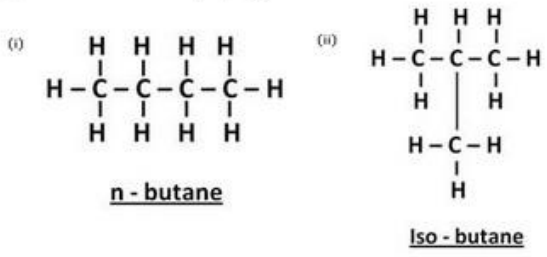
(a) Why does the element carbon from a large number of carbon compounds ?

(b) Write down the structures and names of two isomers of butane (C_4H_{10})

Solution :

(a) Carbon forms a large number of carbon compounds because carbon atoms can link with one another by means of covalent bonds to form long chains of carbon atoms.

(b) Isomers of butane (C_4H_{10})



Question 32:

(a) Give the name and structural formula of one member each of the following :

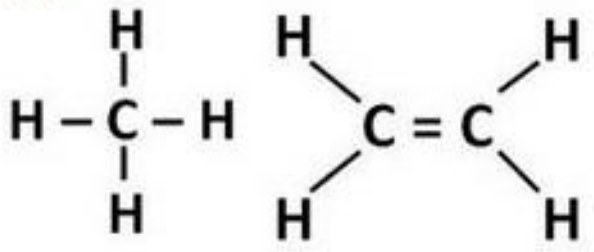
(i) alkane (ii) alkene (iii) alkyne (iv) cycloalkane

(b) Give the common name of (i) ethyne, and (ii) ethene.

(c) Write the molecular formula and structure of benzene.

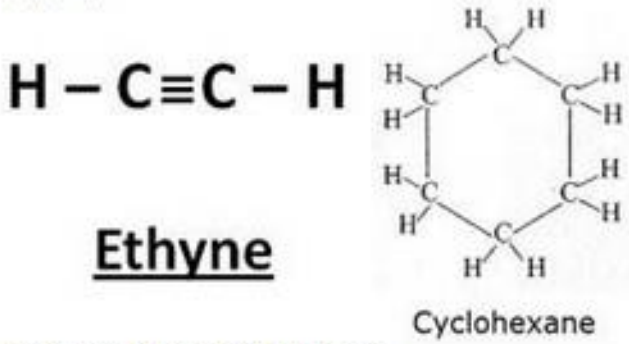
Solution :

(i) (ii)



Methane Ethene

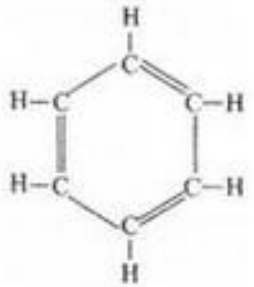
(iii) (iv)



Ethyne Cyclohexane

(b) (i) Acetylene (ii) Ethylene

(c) C_6H_6;



(b) (i) Acetylene

(ii) Ethylene

(c) C_6H_6;

Question 33:

(a) What is the unique property of carbon atom ? How is this property helpful to us ?

(b) Explain why, diamond is hard while graphite is soft (though both are made of carbon atoms).

Solution :

(a) The most unique property of carbon atom is its ability to combine itself, atom to atom to form long chains. This property of self combination is useful to us because it gives rise to an extremely large number of carbon compounds (or organic compounds).

(b) A diamond crystal is a giant molecule of carbon atoms. Each carbon atom in the diamond crystal is linked to four other carbon atoms by strong covalent bonds. The four surrounding atoms are at the four vertices of a regular tetrahedron. This rigid structure of diamond makes it a very hard substance.

The structure of graphite is very different from that of diamond. A graphite crystal consists of layers of carbon atoms or sheets of carbon atoms and these layers are held together by weak Van der Waals forces. Due to this sheet like structure, graphite is a comparatively soft substance.

Question 34:

(a) Giving their structures, state the number of single bonds, double bonds and triple bonds (if any) in the following compounds :

(i) ethyne (ii) ethene (iii) benzene

(b) Write the molecular formula and structure of cyclohexane. How many covalent bonds are there in a molecule of cyclohexane ?

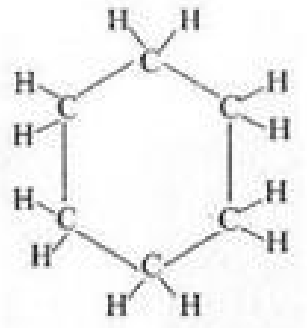
Solution :

(a) (i) Ethyne:- Single bonds: Two; Triple bond: One

(ii) Ethene:- Single bonds: Four; Double bond: One

(iii) Ethane:- Single bonds: Nine; Double bonds: Three

(b) Molecular formula of cyclohexane: C_6H_{12};



Cyclohexane

No. of covalent bonds: 18

Question 35:

(a) Write two points of difference in the structures of diamond and graphite.

(b) Explain why, graphite can be used as a lubricant but diamond cannot.

(c) Explain why, diamond can be used in rock drilling equipment but graphite cannot.

(d) State one use of diamond which depends on its 'extraordinary brilliance' and one use of graphite which depends on its being 'black and quite soft'.

Solution :

(a)

Diamond:

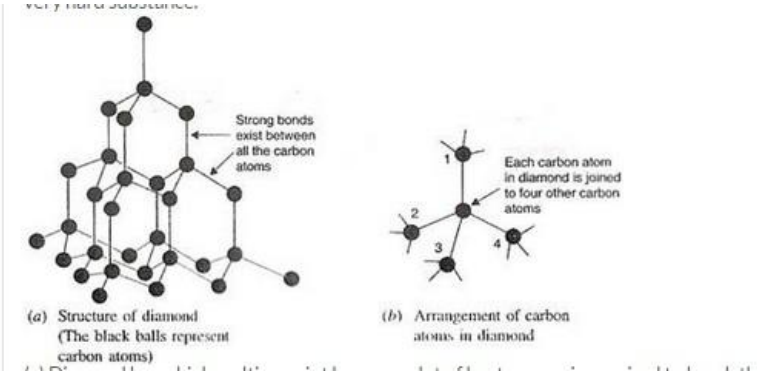
(i) Each carbon atom is linked to four other carbon atoms.
(ii) A diamond crystal has a tetrahedral arrangement of carbon atoms.
Graphite:
(i) Each carbon atom is joined to only three other carbon atoms.
(ii) A graphite crystal has flat hexagonal rings structure.
(b) Due to its softness, powdered graphite can be used a lubricant whereas diamond being extremely hard can not be used as lubricant.
(c) Due to its rigid structure, diamond is the hardest known substance to man. Hence, it is used in rock drilling equipments but graphite is soft and hence not used in rock drilling equipments.
(d) Diamonds are used for making jewellery.
Graphite is used for making pencil cores or 'pencil leads'.

Question 36:

(a) What is diamond ? Of what substance is diamond made ?
(b) Describe the structure of diamond. Draw a simple diagram to show the arrangement of carbon atoms in diamond.
(c) Explain why, diamond has a high melting point.
(d) State any two uses of diamond.

Solution :

(a) Diamond is a colourless transparent substance having extraordinary brilliance. It is made up of carbon.
(b) A diamond crystal is a giant molecule of carbon atoms. Each carbon atom in the diamond crystal is linked to four other carbon atoms by strong covalent bonds. The four surrounding carbon atoms are at the four vertices of a regular tetrahedron. This rigid structure of diamond makes it a very hard substance.



(c) Diamond has a high melting point because a lot of heat energy is required to break the network of strong covalent bonds in the diamond crystal.
(d) (i) Used in rock drilling equipment (ii) Used in making jewellery.

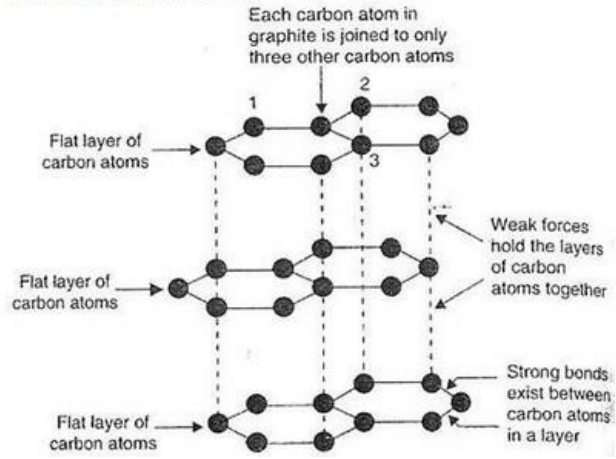
Question 37:

(a) What is graphite ? Of what substance is graphite made ?
(b) Describe the structure of graphite with the help of a labelled diagram.
(c) Why is graphite a good conductor of electricity but diamond is a non-conductor of electricity ?
(d) State any two uses of graphite.

Solution :

(a) Graphite is a greyish-black opaque substance. It is made up of carbon.
(b) The structure of graphite is very different from that of diamond. A graphite crystal consists of layers of carbon atoms or sheets of carbon atoms. Each carbon atom in a graphite layer is joined to other three carbon atoms by strong covalent bonds to form flat hexagonal rings. The various layers of carbon atoms in graphite are held together by weak Van der Waals forces.

Due to this sheet like structure, graphite is a comparatively soft substance.



(c) Due to the presence of free electrons in a graphite crystal, it conducts electricity however; a diamond crystal does not have free electrons so it does not conduct electricity.

(d) (i) Used as a lubricant (ii) Used for making pencil leads.

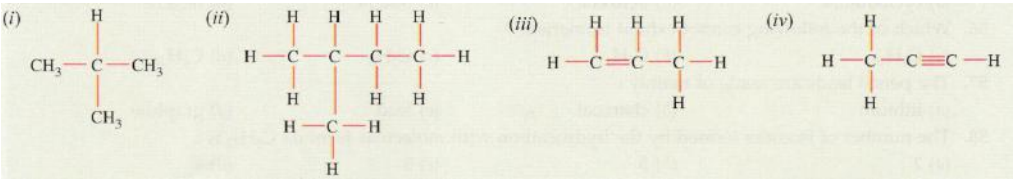
Question 38:

(a) Explain the term 'isomers'. Give one example of isomers.

(b) Write (i) structural formula, and (ii) electron-dot structure, of any one isomer of n-heptane (C_7H_{16})

(c) Write IUPAC name of the compound having the formula n-C_4H_{10}.

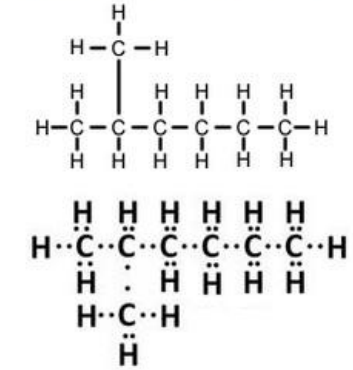
(d) Give the IUPAC names for the following :



Solution :

(a) The organic compounds having the same molecular formula but different structures are known as isomers for ex: n-butane and iso-butane are isomers.

(b) Isomer of n-heptane: 2-methylhexane



(c) Butane

(d) (i) 2-methylpropane

(ii) 2-methylbutane

(iii) Propene

(iv) Propyne

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Question 39:

(a) What are hydrocarbons ? Explain with examples.

(b) Explain the meaning of saturated and unsaturated hydrocarbons with two examples each.

(c) Give the names and structural formulae of one saturated cyclic hydrocarbon and one unsaturated cyclic hydrocarbon.
(d) Give one example of a hydrocarbon, other than pentane, having more than three isomers.
(e) How many isomers of the following hydrocarbons are possible ?
(i) C_3H_8 (ii) C_4H_{10} (iii) C_5H_{12} (iv) C_6H_{14}

Solution :

(a) A compound made up of hydrogen and carbon only is called a hydrocarbon (Hydrogen + Carbon= Hydrocarbon). For exampe: methane (CH_4), ethane (C_2H_6), ethene (C_2H_4), and ethyne (C_2H_2), all are hydrocarbons as they are made up of only two elements: carbon and hydrogen.
(b) Saturated Hydrocarbons: These are the ones in which the carbon atoms are connected by only single bonds. They are also known as alkanes.
Example: Methane (CH_4) and ethane (C_2H_6)
Unsaturated Hydrocarbons: These are the ones in which two carbon atoms are connected by a double bond or a triple bond.
Example: Ethene (C_2H_4) and ethyne (C_2H_2)
(c) Saturated cyclic hydrocarbon: Cyclohexane, C6H12
Unsaturated cyclic hydrocarbon: Benzene, C6H6
(d) Hexane, C_6H_{14}
(e) (i) None (ii) Two (iii) Three (iv) Five

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Question 60:

A solid element X has four electrons in the outermost shell of its atom. An allotrope Y of this element is used as a dry lubricant in machinery and also in making pencil leads.
(a) What is element X ?
(b) Name the allotrope Y.
(c) State whether allotrope Y is a good conductor or non-conductor of electricity.
(d) Name one use of allotrope Y (other than lubrication and pencil leads)
(e) Name two other allotropes of element X.

Solution :

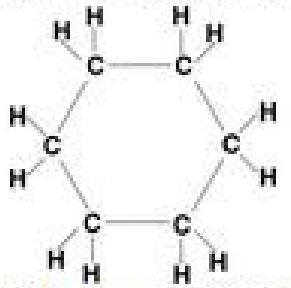
(a) Element X : Carbon
(b) Allotrope Y: Graphite
(c) Y is a good conductor of electricity.
(d) Y is used for making graphite electrodes or carbon electrodes in dry cells.
(e) Allotropes of X: Diamond and buckminsterfullerene

Question 61:

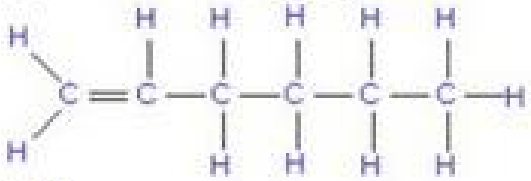
Two organic compounds A and B have the same molecular formula C_6H_{12}. Write the names and structural formulae :
(a) if A is a cyclic compound
(b) if B is an open chain compound
(c) Which compound contains single bonds as well as a double bond ?
(d) Which compound contains only single bonds ?

Solution :

(a) A is cyclohexane, C_6H_{12}



(b) B is hexene, C_6H_{12}



(c) B

(d) A

Question 62:

The solid element A exhibits the property of catenation. It is also present in the form of a gas B in the air which is utilised by plants in photosynthesis. An allotrope C of this element is used in glass cutters.

(a) What is element A ?

(b) What is the gas B ?

(c) Name the allotrope C.

(d) State another use of allotrope C (other than in glass cutters).

(e) Name another allotrope of element A which exists as spherical molecules.

(f) Name a yet another allotrope of element A which conducts electricity.

Solution :

(a) Element A: Carbon

(b) Gas B: Carbon dioxide

(c) Allotrope C: Diamond

(d) Used for making jewellery

(e) Buckminsterfullerene

(f) Graphite

Question 63:

An element E exists in three allotropic forms A, B and C. In allotrope A, the atoms of element E are joined to form spherical molecules. In allotrope B, each atom of element E is surrounded by three other E atoms to form a sheet like structure. In allotrope C, each atom of element E is surrounded by four other E atoms to form a rigid structure.

(a) Name the element E.

(b) What is allotrope A ?

(c) What is allotrope B ?

(d) What is allotrope C ?

(e) Which allotrope is used in making jewellery ?

(f) Which allotrope is used in making anode of a dry cell ?

Solution :

(a) Element E: Carbon

(b) Allotrope A: Buckminsterfullerene

(c) Allotrope B: Graphite

(d) Allotrope C: Diamond
(e) C
(f) B

Question 64:

You are given the following molecular formulae of some hydrocarbons :
C_5H_8; C_7H_4; C_6H_6; C_5H_{10}; C_7H_{12}; C_6H_{12}
(a) Which formula represents cyclohexane as well as hexene ?
(b) Which formula represents benzene ?
(c) Which three formulae represent open chain unsaturated hydrocarbons having double bonds ?
(e) Which two formulae represent unsaturated hydrocarbons having triple bonds ?
(f) Which three formulae can represent cyclic hydrocarbons ?

Solution :

(a) C_6H_{12}
(b) C_6H_6
(c) C_7H_{14};
C_5H_{10}; C_6H_{12}
(d) C_5H_8;
C_7H_{12}
(e) C_7H_{14};
C_5H_{10}; C_6H_{12}

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Question 65:

Which of the following compounds can have a triple bond ?
C_2H_4, C_3H_4, C_3H_6

Solution :

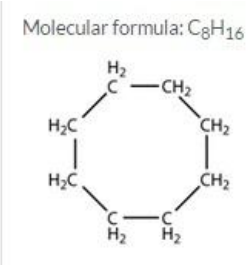
C_3H_4

Question 66:

Write the molecular and structural formula of a cyclic hydrocarbon whose molecule contains 8 atoms of carbon.

Solution :

Molecular formula: C_8H_{16}



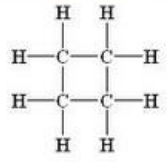
Question 67:

What is the molecular formula and structural formula of a cyclic hydrocarbon whose one molecule contains 8 hydrogen atoms ?

Solution :

Molecular formula: C_4H_8

Molecular formula: C_4H_8



Question 68:

Write the molecular formula of : (i) an alkane (ii) an alkene, and (iii) an alkyne, each having 20 carbon atoms.

Solution :

(i) $C_{20}H_{42}$

(ii) $C_{20}H_{40}$ (iii) $C_{20}H_{38}$

Question 69:

Which of the following compounds can have a double bond ?

C_4H_{10}; C_5H_8; C_5H_{10}

Solution :

C_5H_{10}

Question 70:

Which of the following hydrocarbons is unsaturated ?

C_3H_4; C_2H_6

Solution :

C_3H_4

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Question 1:

Write the molecular formula of ethanol.

Solution :

C_2H_5OH

Question 2:

What is the next higher homologue of methanol (CH_3OH) ?

Solution :

Ethanol (C_2H_5OH)

Question 3:

Identify the functional group present in the following compound and name it according to IUPAC system :

CH_3OH

Solution :

Alcohol group;

Methanol

Question 4:

Give the common name and IUPAC name of the simplest aldehyde.

Solution :

Common name:

formaldehyde

IUPAC name: methanal

Question 5:

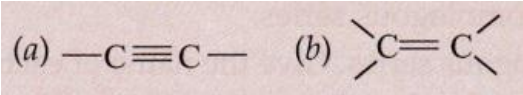
What is the common name of methanal ?

Solution :

Formaldehyde

Question 6:

Write the names of the following functional groups :



Solution :

(i) Alkyne

(ii) Alkene

Question 7:

Name the simplest ketone.

Solution :

Propanone

Question 8:

What is the common name of propanone ?

Solution :

Acetone

Question 9:

Write the IUPAC names of the following :

(i) CH_3COCH_3 (ii) $CH_3COCH_2CH_3$

Solution :

(i) Propanone

(ii) Butanone

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Question 10:

Write the name and chemical formula of the simplest organic acid.

Solution :

Formic acid; HCOOH

Question 11:

Write the IUPAC names, common names and formulae of the first two members of the homologous series of carboxylic acids.

Solution :

IUPAC name	Common name	Formula
(i) Methanoic acid	Formic acid	HCOOH
(ii) Ethanoic acid	Acetic acid	CH_3COOH

Question 12:

What is the common name of : (a) methanoic acid, and (b) ethanoic acid ?

Solution :

(a) Methanoicacid – Formic acid

(b) Ethanoic acid – Acetic acid

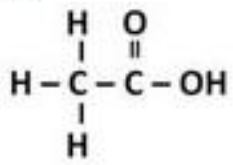
Question 13:

Draw the structures for the following compounds :

(a) Ethanoic acid (b) Propanoic acid

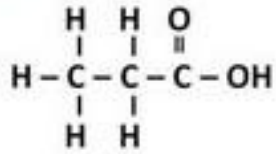
Solution :

(a)



Ethanoic acid

(b)



Propanoic acid

Question 14:

Give the common names and IUPAC names of the following compounds :

(a) HCOOH (b) CH_3COOH

Solution :

Formula	IUPAC name	Common name
(i) HCOOH	Methanoic acid	Formic acid
(ii) CH_3COOH	Ethanoic acid	Acetic acid

Question 15:

Give the name and structural formula of one homologue of HCOOH.

Solution :

Ethanoic acid; CH_3COOH

Question 16:

Write the formulae of: (a) methanoic acid, and (b) ethanoic acid.

Solution :

(a) Methanoic acid: HCOOH

(b) Ethanoic acid: CH_3COOH

Question 17:

Give the common name and IUPAC name of C_2H_5

Solution :

Common name: Ethyl alcohol

IUPAC name: Ethanol

Question 18:

Give the IUPAC name of the following compound :

C_3H_7OPI

Solution :

Propanol, C_3H_7OH

Question 19:

Give the name and structural formula of one member of the following :

Alcohols

Solution :

Ethanol; C_2H_5OH

Question 20:

Give IUPAC names of the following compounds :

(a) C_4H_9OH (b) C_5H_nOH

Solution :

(a) Butanol, C_4H_9OH

(b) Pentanol, $C_5H_{11}OH$

Question 21:

What is the common name of methanol ?

Solution :

Methyl alcohol

Question 22:

What is the difference between two consecutive homologues :

(i) in terms of molecular mass ?

(ii) in terms of number and kind of atoms per molecule ?

Solution :

(i) 14 u

(ii) Two consecutive homologues differ by 1 carbon atom and 2 hydrogen atoms in their molecular formulae.

Question 23:

What type of fuels :

(a) burn with a flame ?

(b) burn without a flame ?

Solution :

(a) Fuels which vaporise on heating, burn with a flame.

(b) Fuels which do not vaporise on heating, burn without a flame.

Question 24:

State whether the following statement is true or false :

The minimum number of carbon atoms in a ketone molecule is two.

Solution :

False

Question 25:

Fill in the following blanks with suitable words :

(a) The next higher homologue of ethanol is.....

(b) The next homologue of C_2H_5OH is.....

(c) The next higher homologue of ethane is.....

(d) The functional group present in ethanol is.....

(e) Organic compounds having $-\overset{\overset{O}{\|}}{C}-OH$ functional group are known as .....

Solution :

(a) Propanol

(b) C_3H_7OH
(c) Propane
(d) -OH (alcohol)
(e) Carboxylic acids

Question 26:

(a) Give the general name of the class of compounds having the general formula C_nH_{2n-2}.Write name of the first member of this homologous series.
(b) The general formula of a homologous series of carbon compounds is C_nH_{2n}. Write the molecular formulae of the second and fourth members of the series.
(c) Write the molecular formulae of the third and fifth members of homologous series of carbon compounds represented by the general formula C_nH_{2n+2}.

Solution :

(a) Alkynes, C_nH_{2n-2}
First member: Ethyne
(b) Second member: C_3H_6
Fourth member: C_5H_{10}
(c) Third member: C_3H_8
Fifth member: C_5H_{12}

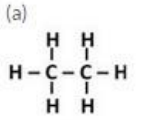
Question 27:

(a) Give the names and structural formulae of the next two higher homologues of methane.
(b) The molecular formula of a hydrocarbon is $C_{10}H_{18}$. Name its homologous series.
(c) Select the hydrocarbons which are members of the same homologous series. Give the name of each series.
C_5H_{10} ; C_3H_8; C_6H_{10}; C_4H_{10}; C_7H_{12}; C_8H_{16}

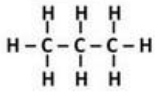
Solution :

(a)

(a)



Ethane



Propane

(b) Alkyne; C_nH_{2n-2}
(c) Alkanes: C_3H_8, C_4H_{10}
Alkenes: C_5H_{10}, C_8H_{16}
Alkynes: C_6H_{10}, C_7H_{12}

Question 28:

(a) Give the molecular formula of one homologue of each of the following :
(i) C_3H_6 (ii) C_2H_6 (iii) C_2H_2
(b) What is the difference in the molecular mass of any two adjacent homologues ?
(c) By how many carbon atoms and hydrogen atoms do any two adjacent homologues differ ?

Solution :

(a) (i) C_4H_8 (ii) C_3H_8
(iii) C_3H_4
(b) 14 u
(c) 1 carbon atom and 2 hydrogen atoms i.e. a CH_2 group.

Question 29:

(a) Write the formula of the functional group present in carboxylic acids.

(b) Name the functional group present in $CH_3—C \equiv CH$.

(c) Name the functional groups present in the following compounds :

(i) CH_3CHO (ii) CH_3CH_2COOH (iii) CH_3COCH_3 (iv) $CH_3CH_2CH_2OH$

Solution :

Question 30:

(a) Write the IUPAC name and common name of CH_3Cl

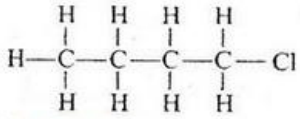
(b) Draw the structure of chlorobutane.

(c) Draw the structure for bromopentane. Are structural isomers possible for bromopentane ?

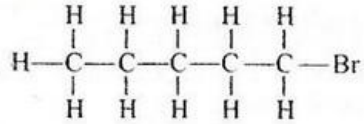
Solution :

(a) IUPAC name: Chloromethane
Common name: Methyl chloride

(b) Chlorobutane:



(c) Bromopentane:



Yes, structural isomers are possible for bromopentane.

Question 31:

(a) Write the name and formula of an organic compound containing a ketone functional group.

(b) Write the names and formulae for the first three members of the homologous series of chloroalkanes.

(c) How would you name the following compound ?

$CH_3—CH_2—Br$

Solution :

(a) Acetone – CH_3COCH_3

(b) (i) Chloromethane – CH_3Cl

(ii) Chloroethane – C_2H_5Cl

(iii) Chloropropane – C_3H_7Cl

(c) Ethylbromide

(a) Ketones

(b) CH_3COOH

(c) Formaldehyde

Question 33:

(a) Define a homologous series. Give the name and structural formula of one homologue of the following :

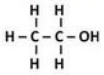
CH_3OH

(b) Write the molecular formula of the third member of the homologous series of carbon compounds with general formula $C_nH_{2n+1}OH$.

(c) Name any two fossil fuels.

Solution :

(a) A homologous series is a group of organic compounds having similar structures and similar chemical properties in which the successive compounds differ by CH_2 group.
Ethyl alcohol: C_2H_5OH



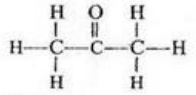
Ethyl Alcohol
(b) C_3H_7OH
(c) Coal and petroleum

Question 34:

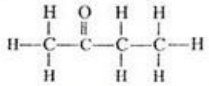
(a) Draw the structures for the following compounds :
(a) Propanone (b) Butanone
(b) Write the IUPAC names of the following :
(i) HCHO (ii) CH_3CHO (Hi) CH_3CH_2CHO (iv) $CH_3CH_2CH_2CHO$
(c) Which functional group is likely to be present in an organic compound having the molecular formula $C_4H_{10}O$? Write the formula of the organic compound.

Solution :

(a) (i) Propanone



(ii) Butanone



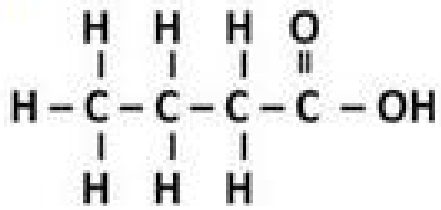
(b) (i) Methanal (ii) Ethanal (iii) Propanal (iv) Butanal
(c) Alcohol group, -OH; C_4H_9OH

Question 35:

(a) Match the formulae in group A with appropriate names from group B :
Group A : CH_3COOH, CH_3CHO, CH_3OH
Group B : Ethanol, Methanol, Ethanal, Ethanoic acid
(b) Draw the structure of butanoic acid.
(c) What is the IUPAC name of acetic acid ?

Solution :

(a) CH_3COOH: Ethanoic acid
CH_3CHO: Ethanal
CH_3OH: Methanol
(b)



Butanoic acid
(c) Ethanoic acid.

Question 36:

(a) Which functional group do you think can be present in an organic compound having the molecular formula $C_5H_{10}O_2$? Write the formula of the organic compound.
(b) Give one example each of the compounds having the following functional groups :

(i) Aldehyde group (ii) Alcohol group (iii) Carboxylic acid group (iv) Halo group

(c) Give one example each of the compounds having the following functional groups :

(i) Alkene group (ii) Alkyne group

Solution :

(a) Carboxylic acid group, -COOH; C_4H_9COOH

(b) (i) Ethanal - CH_3CHO

(ii) Methanol - CH_3OH

(iii) Ethanoic acid - CH_3COOH

(iv) Chloromethane - CH_3Cl

(c) (i) Ethene: $CH_2 = CH_2$

(ii) Ethyne: $CH \equiv CH$

Question 37:

(a) What is the molecular formula and structure of the alcohol which can be thought to be derived from pentane ?

(b) Write the names of the following functional groups :

(*i*) —CHO (*ii*) —OH (*iii*) —COOH (*iv*) $>C=O$ (*v*) —X

(c) What makes the candle flame yellow and luminous ?

Solution :

(a) $C_5H_{12}O$ or $C_5H_{11}OH$

(b) (i) Aldehyde group

(ii) Alcohol group

(iii) Carboxylic acid group

(iv) Ketone group

(v) Halo group

(c) When a candle is lighted, the wax melts, rises up the wick and gets converted into vapours. In a candle, there is no provision for the proper mixing of oxygen (of air) for burning wax vapours. So, the wax vapours bum in an insufficient supply of oxygen (of air) which leads to incomplete combustion of wax. This incomplete combustion of wax produces small unburnt carbon particles. These solid carbon particles rise in the flame, get heated and glow to give out yellowish light. This makes the candle flame yellow and luminous.

Question 38:

(a) What is a homologous series ? Explain with an example.

(b) State two characteristics of a homologous series.

(c) The molecular formula of an organic compound is $C_{18}H_{36}$. Name its homologous series.

(d) Select the hydrocarbons which belong to the same homologous series. Give the name of each series.

CH_4, C_2H_2, C_2H_4, C_2H_6, C_4H_{10}, C_3H_4, C_3H_6

(e) What is meant by 'heteroatom'? Give examples. Write the names and formulae of two organic compounds containing different heteroatoms.

Solution :

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

Example of Homologous series: All the alkanes have similar structures with single covalent bonds and show similar chemical properties, so they can be grouped together in the form of a homologous series.

Homologous series of alkanes: Methane, CH_4; Ethane, C_2H_6; Propane, C_3H_8; Butane, C_4H_{10}; Pentane, C_5H_{12}

(b) (i) All the members of the homologous series can be represented by the same general formula.
(ii) Any two adjacent homologues differ by 1 carbon atom and 2 hydrogen atoms in their molecular formulae.
(c) Alkene, C_nH_{2n}
(d) Alkanes: CH_4, C_2H_6, $C_4H_{10?}$
Alkenes :C_2H_4, C_3H_6
Alkynes : C_2H_2, C_3H_4
(e) In an organic compound, any atom other than carbon and hydrogen is called a heteroatom.
Example: Chlorine (Cl), Bromine (Br), Oxygen (O)
Chloromethane – CH_3Cl and methanol – CH_3OH

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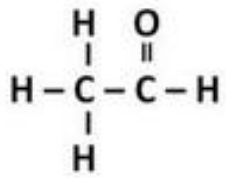
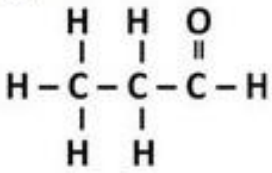
Question 39:
(a) What is meant by a functional group ? Explain with an example.
(b) Write three common functional groups present in organic compounds. Give their symbols/formulae.
(c) Name the functional groups present in the following compounds :
(i) CH_3COOH (ii) CH_3CH_2CHO (iii) C_2H_5OH (iv) $CH_3COCH_2CH_3$
(d) Name the functional group which always occurs in the middle of a carbon chain.
(e) Draw the structures for the following compounds :
(i) Ethanal (ii) Propanal (iii) Butanal (iv) Pentanal
Solution :
(a) An 'atom' or 'a group of atoms' which makes a carbon compound (or organic compound) reactive and decides its properties (or functions) is called a functional group. The alcohol group, -OH, present in ethanol, C_2H_5OH, is an example of a functional group.
(b) (i) Halo group: -X
(ii) Alcohol group: -OH
(iii) Aldehyde group: -CHO
(c) (i) Carboxylic acid group
(ii) Aldehyde group
(iii) Alcohol group
(iv) Ketone group
(d) Ketone group, -CO-

(e) (i)



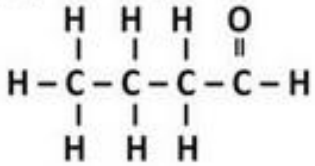
Ethanal

(ii)



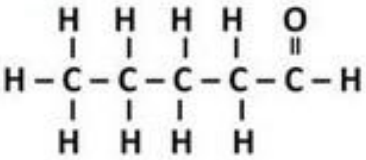
Propanal

(iii)



Butanal

(iv)



Pentanal

Question 40:

(a) What happens when carbon burns in air ? Write the chemical equation of the reaction which takes place.

(b) Why are coal and petroleum called fossil fuels ?

(c) Explain how coal was formed in the earth.

(d) Describe how petroleum was formed in the earth.

(e) Name a fossil fuel other than coal and petroleum.

Solution :

(a) When carbon is burned in air, it forms carbon dioxide gas and releases a large amount of heat and some light:

$C + O_2 \rightarrow CO_2 + Heat + Light$

(b) Coal and petroleum are called as fossil fuels because they were formed by the decomposition of the remains of the pre-historic plants and animals (fossils) buried under the earth long, long, ago.

(c) Coal was formed by the decomposition of large land plants and trees buried under the earth millions of years ago. It is believed that millions of years ago, due to earthquakes and volcanoes, etc., the forests were buried under the surface of the earth and got covered with sand, clay and water. Due to high temperature and high pressure inside the earth, and in the absence of air, wood was converted into coal.

(d) Petroleum oil (and natural gas) was formed by the decomposition of the remains of extremely small plants and animals buried under the sea millions of years ago. It is believed that millions of years ago, the microscopic plants and animals which lived in seas, died. Their bodies sank to the bottom of the sea and were soon covered with mud and sand. The chemical effects of pressure, heat and bacteria, converted the remains of microscopic plants and animals into petroleum oil and natural gas just as they converted forest trees into coal. This conversion took place in the absence of oxygen or air. The petroleum thus formed got trapped between two layers of impervious rocks (non-porous rocks) forming an oil trap.

(e) Natural gas.

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Question 56:

An organic compound having the molecular formula C_2H_60 can exist in the form of two isomers A and B having different functional groups. The isomer A is a liquid which is used as a

solvent for nail polish. The isomer B is also a liquid. An aqueous solution of one of the lower homologues of B is used for preserving biological specimens in the laboratory

(a) What is compound A ?

(b) Write the electron-dot structure of A.

(c) What is compound B ?

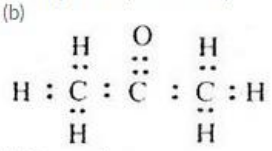
(d) Write the electron-dot structure of B.

(e) Name the lower homologue of compound B which is used in preserving biological specimens.

Solution :

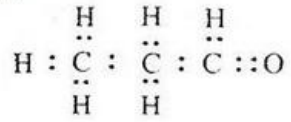
(a) Propanone (or Acetone)

(b)



(c) Propanal

(d)



(e) Methanal (or Formaldehyde) is used in preserving biological specimens.

Question 57:

A hard material X which is mined from the earth is used as a household fuel and also for the generation of electricity at Thermal Power Stations. A soft material Y is also used as a fuel in the form of candles. A gaseous material Z which occurs along with petroleum is increasingly being used as a fuel in running vehicles in its compressed form.

(a) What are materials, X, Y and Z ?

(b) When materials X, Y and Z are burned separately :

(i) Which material burns by producing a yellow, luminous flame ?

(ii) Which material ultimately burns without producing a flame ?

(iii) Which material can burn in a gas stove by producing a blue flame ?

Solution :

(a) X is coal; Y is wax; Z is natural gas

(b)(i) Y (wax)

(ii) X (coal)

(iii) Z (natural gas)

Question 58:

Three organic compounds A, B and C have the following molecular formulae :

A $C_4H_8O_2$

B $C_4H_{10}O$

C C_4H_8O

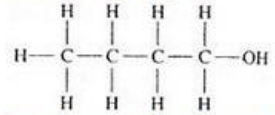
(a) Which compound contains an alcohol group ? Write its name and structural formula.

(b) Which compound contains a carboxyl group ? Write its name and structural formula.

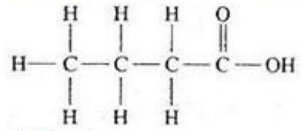
(c) Which molecular formula can represent an aldehyde as well as a ketone ? Write the names and structural formulae of the aldehyde and ketone represented by this molecular formula.

Solution :

(a) B; Butanol, C_4H_9OH

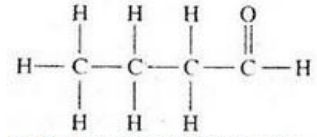


(b) A; Butanoic acid, C_3H_7COOH

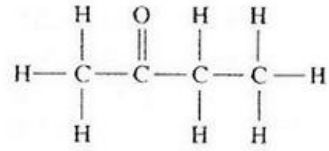


(c) C_4H_8O

Aldehyde : Butanal, C_3H_7CHO



Ketone: Butanone, $CH_3COCH_2CH_3$



Question 59:

A colourless organic liquid X of molecular formula $C_2H_4O_2$ turns blue litmus to red. Another colourless organic liquid Y of molecular formula C_2H_6O has no action on any litmus but it is used as a nail polish remover. A yet another colourless organic liquid Z of molecular formula C_2H_6O has also no action on litmus but it is used in tincture of iodine.

(a) Name the liquid X. To which homologous series does it belong ? Give the name of another member of this homologous series.

(b) Name the liquid Y. To which homologous series does it belong ? Write the name of another member of this homologous series.

(c) Can you name an organic compound having the same molecular formula as liquid Y but which belongs to a different homologous series ? What is this homologous series ?

(d) Name the liquid Z. To which homologous series does it belong ? Write the name of another member of this homologous series.

Solution :

(a) Liquid X is ethanoic acid; it belongs to homologous series of carboxylic acids. Methanoic acid is another member of this homologous series.

(b) Liquid Y is Propanone; it belongs to homologous series of ketones. Butanone is another member of this homologous series.

(c) Propanal; it belongs to homologous series of aldehydes.

(d) Liquid Z is ethanol; it belongs to homologous series of alcohols. Methanol is another member of this homologous series.

Question 60:

You are given an organic compound having the molecular formula C_2H_8. Give the name and formula of the compound formed :

(a) when one H atom of C_3H_8 is replaced by a Cl atom.

(b) when one H atom of C_3H_8 is replaced by OH group.

(c) when one H atom of C_3H_8 is replaced by a CHO group.

(d) when one H atom of C_3H_8 is replaced by a COOH group.

(e) when two H atoms joined to the middle carbon atom of C_3H_8 are replaced by one O atom.

Solution :

(a) Chloropropane, CH_3-CH_2-CH_2-Cl

(b) Propanol, CH_3-CH_2-CH_2-OH

(c) Butanal, CH_3-CH_2-CH_2-CHO
(d) Butanoic acid, CH_3-CH_2-CH_2-COOH
(e) Propanone, CH_3-CO-CH_3

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Question 1:
Name the gas evolved when ethanoic acid is added to sodium carbonate. How would you prove the presence of this gas ?
Solution :
Carbon dioxide (CO_2) gas is evolved in the reaction. When passed through lime water, it turns lime water milky.

Question 2:
Which of the following will give brisk effervescence with sodium hydrogencarbonate and why ?
CH_3COOH, CH_3CH_2OH
Solution :
CH_3COOH will give brick effervescence. Being acid, it reacts with sodium hydrogencarbonate to produce carbon dioxide gas.

Question 3:
Name the functional group present in an organic compound which gives brisk effervescence with $NaHC0_3$.
Solution :
Carboxylic acid group, -COOH gives brisk effervescence with $NaHCO_3$

Question 4:
Name the hydrocarbon formed when ethanol is heated with cone. H_2S0_4 at 170°C ? What is this reaction known as ?
Solution :
Ethene is formed when ethanol is heated with conc. H_2SO_4 at 170^oC. This reaction is called dehydration.

Question 5:
Why does ethyne (acetylene) burn with a sooty flame ?
Solution :
Ethyne (acetylene) burn with a sooty flame because ethyne is an unsaturated hydrocarbon and the percentage of carbon in these hydrocarbons is comparatively higher which does not get oxidised completely in oxygen of air.

Question 6:
Name the product formed when hydrogen is added to ethene.
Solution :
Ethane is formed when hydrogen is added to ethene.

Question 7:
Explain why, ethene decolourises bromine water whereas ethane does not.
Solution :
Ethene decolourises bromine water because ethene is an alkene. And all alkenes and alkynes are unsaturated compounds which decolourise bromine water. On the other hand, ethane being an alkane is a saturated compound which does not decolourise bromine water.

Question 8:

Name two catalysts which can be used in the hydrogenation of unsaturated compounds.

Solution :

Nickel or palladium can be used as catalyst in the hydrogenation of unsaturated compounds.

Question 9:

State two disadvantages of incomplete combustion.

Solution :

Disadvantages of incomplete combustion:

(i) It leads to the formation of soot which is nothing but unburnt carbon which pollutes the atmosphere, blackens cooking utensils.

(ii) It leads to the formation of an extremely poisonous gas called carbon monoxide.

Question 10:

What happens when (give chemical equation) :

Sodium reacts with ethanol (ethyl alcohol)

Solution :

When Sodium reacts with ethanol (ethyl alcohol), hydrogen gas is evolved.

$$2C_2H_5OH + 2Na \rightarrow 2C_2H_5O^-Na^+ + H_2$$

Question 11:

Describe one reaction of ethanol.

Solution :

Ethanol reacts with sodium metal to form sodium ethoxide and hydrogen gas. This reaction is used as a test for ethanol. When a small piece of sodium metal is put into ethanol in a dry test tube, rapid effervescence is produced due to evolution of hydrogen gas.

$2C_2H_5OH + 2Na \rightarrow 2C_2H_5O^-Na^+ + H_2$

Question 12:

Name one liquid carbon compound which is being used as an additive in petrol in some countries.

Solution :

Ethanol is used as an additive in petrol.

Question 13:

What are the raw materials required for making soap in a laboratory (or at home) ?

Solution :

(i) Vegetable oil (like castor oil, cottonseed oil or soyabean oil)

(ii) Sodium hydroxide (caustic soda)

(iii) Sodium chloride (common salt)

Question 14:

Would you be able to check whether water is hard by using a detergent ? Why ?

Solution :

No, we would not be able to check the hardness of water by using a detergent because a detergent forms lather easily even with hard water.

Question 15:

Describe a test for carboxylic acids.

Solution :

Litmus test: Some blue litmus solution is added to the organic compound (to be tested). If the blue litmus solution turns red, it shows that the organic compound is acidic in nature and hence it is a carboxylic acid.

Question 16:

Why is the conversion of ethanol into ethanoic acid an oxidation reaction ?

Solution :

Oxidation means controlled combustion. When ethanol is heated with alkaline potassium permanganate solution (or acidified potassium dichromate solution), it gets oxidised to ethanoic acid. It is called an oxidation reaction because oxygen is added to it during this conversion.

$$CH_3CH_2OH + 2[O] \xrightarrow[\text{or acidified } K_2Cr_2O_7]{\text{Alkaline } KMnO_4,\ \text{Heat}} CH_3COOH + H_2O$$

Question 17:

Explain why, alkanes are excellent fuels.

Solution :

Alkanes burn in air to produce a lot of heat due to which they are known to be excellent fuels.

Question 18:

Name one chemical compound which can be used to distinguish between ethanol and ethanoic acid.

Solution :

Sodium hydrogencarbonate can be used to distinguish between ethanol and ethanoic acid.

Question 19:

Complete the following equations :

$$(a)\ CH_3CH_2OH \xrightarrow[170^\circ C]{\text{Conc. } H_2SO_4}$$

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

Solution :

$$(a)\ CH_3CH_2OH \xrightarrow[170^0\,C]{\text{Conc } H_2SO_4} CH_2 = CH_2 + H_2O$$

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

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Question 20:

Complete and balance the following equations :

$$(a)\ CH_4 + O_2 \longrightarrow$$

$$(b)\ CH_4 + Cl_2 \xrightarrow{\text{Sunlight}}$$

Solution :

$$(a)\ CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{Heat} + \text{Light}$$

$$(b)\ CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$$

Question 21:

Fill in the following blanks with suitable words :

(a) The process of burning of a hydrocarbon in the presence of air to give CO_2, H_2O, heat and light is known as.....

(b) The sodium salt of a long chain fatty acid is called.....

(c) is better than soap for washing clothes when the water is hard.

(d) The organic acid present in vinegar is.....

Solution :

(a) Combustion

(b) Soap

(c) Detergent
(d) Ethanoic acid

Question 22:

Which of the following hydrocarbons will give substitution reactions and why ?
CH_4, C_3H_6, C_3H_8, C_4H_6, C_5H_{12}, C_5H_{10}

Solution :

CH_4, C_3H_8 and C_5H_{12}; all these are saturated hydrocarbons (Alkanes) and hence will give substitution reactions.

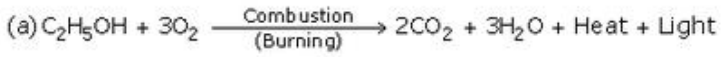
Solution 23

C_2H_4 and C_3H_4 will give addition reactions because these are unsaturated hydrocarbons (Alkene and Alkyne) and unsaturated hydrocarbons give addition reactions.

Question 24:

(a) Write the chemical equation of the reaction which takes place during the burning of ethanol in air.
(b) Why is ethanol used as a fuel ?
(c) State two uses of ethanol (other than as a fuel).

Solution :



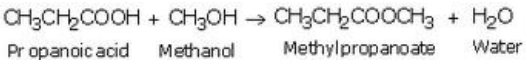
(b) Since, ethanol burns with a clear flame giving a lot of heat, therefore, it is used as a fuel.
(c) Uses of ethanol:
(i) It is used in the manufacture of paints, varnishes, lacquers, medicines, perfumes, dyes, soaps and synthetic rubber.
(ii) It is used as a solvent. Many organic compounds which are insoluble in water are soluble in ethyl alcohol.

Question 25:

(a) What happens when propanoic acid is warmed with methanol in the presence of a few drops of
concentrated sulphuric acid ? Write equation of the reaction involved.
(b) What change will you observe if you test soap solution with a litmus paper (red and blue) ? Give reason for your observation.
(c) What is meant by denatured alcohol ? What is the need to denature alcohol ?

Solution :

(a) Propanoic acid will react with the alcohol in the presence of concentrated sulphuric acid to form esters.



(b) Red litmus paper turns blue in soap solution and no change occurs on blue litmus paper because soap is basic in nature.
(c) Denatured alcohol is ethyl alcohol which has been made unfit for drinking purposes by adding small amounts of poisonous substances like methanol, pyridine, copper sulphate etc. This is done to prevent the misuse of industrial alcohol for drinking purposes or black marketing (as it is supplied duty free for industrial purposes by the government).

Question 26:

(a) How would you test for an alcohol ?
(b) Give the harmful effects of drinking alcohol.
(c)Explain why, methanol is much more dangerous to drink than ethanol.

Solution :

(a) Sodium metal test: Add a small piece of sodium metal to the organic liquid (to be tested), taken in a dry test tube. If bubbles (or effervescence) of hydrogen gas are produced, it indicates that the given organic liquid is an alcohol.
(b) Harmful effects of drinking alcohol:
(i) Alcohol slows down the activity of the nervous system and brain due to which the judgement of a person is impaired and his reaction becomes slow.
(ii) Heavy drinking of alcohol on a particular occasion leads to staggered movement, slurred speech and vomiting.
(c) Unlike ethanol, drinking methanol, even in a small quantity can be fatal leading to permanent blindness and even death. Methanol damages the optic nerve causing permanent blindness in a person. This happens because methanol is oxidised to methanal in the liver of a person. This methanal reacts rapidly with the components of the cell causing coagulation of their protoplasm. Due to this, the cells stop functioning normally.

Question 27:

How would you convert:
(a) ethanol into ethene ?
(b) propanol into propanoic acid ?
Name the process in each case and write the equations of the reactions involved.

Solution :

(a) Dehydration: conversion of ethanol into ethene

$$CH_3 - CH_2OH \xrightarrow[\text{(Dehydration)}]{\text{Conc.}H_2SO_4;170^\circ C} CH_2 = CH_2 + H_2O$$

(b) Oxidation: conversion of propanol to propanoic acid

$$CH_3CH_2CH_2OH + 2[O] \xrightarrow[\text{or acidified}K_2Cr_2O_7]{\text{Alkaline}KMnO_4;\text{Heat}} CH_3CH_2COOH + H_2O$$

Question 28:

Give reasons for the following observations :
(a) Air holes of a gas burner have to be adjusted when the vessels being heated get blackened by the flame.
(b) Use of synthetic detergents causes pollution of water.

Solution :

(a) Air holes of a gas burner have to be adjusted b ecause blackening of vessels show that the air holes of the gas stove are getting blocked and hence the fuel is not burning completely (due to insufficient supply of oxygen).
(b) Some of the detergents (synthetic) are not bio-degradable, that is they cannot be decomposed by micro organisms like bacteria and hence cause water pollution.

Question 29:

(a) What would be observed on adding a 5% alkaline potassium permanganate solution drop by drop to
some warm ethanol in a test-tube ? Write the name of the compound formed during the chemical reaction. Also write chemical equation of the reaction which takes place.
(b) How would you distinguish experimentally between an alcohol and a carboxylic acid on the basis of a chemical property ?

Solution :

(a) On adding 5% alkaline potassium permanganate solution drop by drop to some warm ethanol, we would observe that the purple color of potassium permanganate starts disappearing; the product formed by this process; ethanoic acid can turn blue litmus red.

$$CH_3CH_2OH + 2[O] \xrightarrow[\text{or acidified}K_2Cr_2O_7]{\text{Alkaline}KMnO_4;\text{Heat}} CH_3COOH + H_2O$$

(b) A carboxylic acid reacts with sodium hydrogencarbonate to give brisk effervescence of carbon dioxide gas but an alcohol does not react with sodium hydrogencarbonate.

Question 30:

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

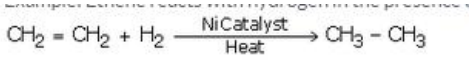
Solution :

Alkenes can be hydrogenated.

The addition of hydrogen to an unsaturated hydrocarbon to obtain a saturated hydrocarbon is called hydrogenation.

Example: Ethene reacts with hydrogen in the presence of finely divided nickel as catalyst to form ethane.

Liquid vegetable oils are hydrogenated into vegetable ghee (solid fat).



Question 31:

(a) Name the gas evolved when ethanol reacts with sodium.

(b) What type of compound is formed when a carboxylic acid reacts with an alcohol in the presence of cone. H_2SO_4 ?

(c) What will you observe when dilute ethanoic acid and dilute hydrochloric acid are put on universal indicator paper, one by one ? What does it show ?

Solution :

(a) Hydrogen gas is evolved when ethanol reacts with sodium.

(b) Esters are formed when a carboxylic acid reacts with an alcohol in the presence of conc. H_2SO_4.

(c) Dilute ethanoic acid turns universal indicator paper to orange, showing that its pH is about 4 which tell us that ethanoic acid is a weak acid. On the other hand, dilute hydrochloric acid turns universal indicator paper to red, showing that its pH is about 1. This shows us that hydrochloric acid is a strong acid.

Question 32:

(a) What type of compound is CH_3COOH ?

(b) What substance should be oxidised to prepare CH_3COOH ?

(c) What is the physical state of CH_3COOH ?

(d) State one advantage of soaps over detergents.

Solution :

(a) CH_3COOH is a c arboxylic acid.

(b) Ethanol, CH_3CH_2OH should be oxidised to prepare CH_3COOH.

(c) Liquid state

(d) Soaps are biodegradable whereas detergents are non-biodegradable.

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Question 33:

(a) What happens when ethanol reacts with ethanoic acid in the presence of a little of concentrated sulphuric acid ? Write equation of the reaction involved.

(b) What happens when ethanol is heated with concentrated sulphuric acid at 170°C ? Write the equation of the reaction which takes place.

Solution :

(a) When ethanol reacts with ethanoic acid in the presence of a little of concentrated sulphuric acid, a sweet smelling ester called ethyl ethanoate is formed.

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

(b) When ethanol is heated with concentrated sulphuric acid at 170°C, it gets dehydrated to form ethene.

$$CH_3 - CH_2OH \xrightarrow[(Dehydration)]{Conc.H_2SO_4;170°C} CH_2 = CH_2 + H_2O$$

Question 34:

(a) What happens when ethanol is oxidised with alkaline potassium permanganate (or acidified potassium dichromate) ? Write the equation of the reaction involved.

(b) Choose those compounds from the following which can turn blue litmus solution red : HCHO, CH_3COOH, CH_3OH, C_2H_5OH, HCOOH, CH_3CHO Give reasons for your choice.

Solution :

(a) When ethanol is oxidised with alkaline potassium permanganate (or acidified potassium dichromate), it gets oxidised to form ethanoic acid.

(b) CH_3COOH and HCOOH can turn blue litmus solution red. These are organic acids.

Question 35:

(a) Explain the process of preparation of soap in laboratory.

(b) Why is common salt (sodium chloride) added during the preparation of soap ?

(c) Why is soap not suitable for washing clothes when the water is hard ?

Solution :

(a) Soap can be prepared in the laboratory as follows:

1. Take about 20 ml of castor oil (cottonseed oil, linseed oil or soya bean oil) in a beaker.
2. Add 30 ml of 20% sodium hydroxide solution to it.
3. Heat the mixture with constant stirring till a paste of soap is formed.
4. Then add 5 to 10 grams of common salt (sodium chloride).
5. Stir the mixture well and allow it to cool. On cooling the solution, solid soap separates out.
6. When the soap sets, it can be cut into pieces called 'soap bars'.

(b) Common salt is added to the mixture to make the soap come out of solution. Though most of the soap separates out on its own but some of it remains in solution. Common salt is added to precipitate out all the soap from the aqueous solution.

(c) When soap is used for washing clothes with hard water, a large amount of soap in water is reacting with the calcium and magnesium ions of hard water to form an insoluble precipitate called scum, before it can be used for the real purpose of washing.

Question 36:

(a) What happens when methane (natural gas) burns in air ? Write the chemical equation of the reaction involved.

What happens when ethanoic acid reacts with sodium carbonate ? Write chemical equation of the reaction involved.

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

Solution :

(a) Carbon dioxide and water vapour are formed when methane burns in air.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + Heat + Light$$

(b) Ethanoic acid reacts with sodium carbonate to form sodium ethanoate and carbon dioxide.

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

(c) Add bromine water to a little of cooking oil and butter taken in separate test tubes:
(i) Cooking oil decolourises bromine water (showing that it is an unsaturated compound).
(ii) Butter does not decolourise bromine water (showing that it is a saturated compound).

Question 37:

(a) Describe, giving equation, a chemical reaction which is characteristic of saturated hydrocarbons (or alkanes).

What is an oxidising agent ? Name two oxidising agents which can oxidise ethanol to ethanoic acid.

Describe one reaction of a carboxylic acid.

Solution :

(a) Substitution reaction of methane with chlorine: Methane reacts with chlorine in the presence of sunlight to form chloromethane and hydrogen chloride.

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

(b) An oxidising agent is one which oxidises other substances by providing oxygen or removing hydrogen. Alkaline potassium permanganate and acidified potassium dichromate can be used as oxidising agents.

(c) Reaction with alcohols: Ethanoic acid reacts with alcohols in the presence of a little of conc. sulphuric acid to form esters.

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

Question 38:

(a) Write names and formulae of hydrocarbons containing a single and a double bond (one example for each). Give one characteristic chemical property of each.

(b) What is a detergent ? Name one detergent.

(c) Why have detergents replaced soap as a washing agent ?

Solution :

(a) (i) Single bond: Methane, CH_4. They are quite unreactive hence they undergo substitution reaction with chlorine in presence of sunlight.

(ii) Double bond: Ethene, CH_2=CH_2. They undergo addition reaction in the presence of a catalyst like nickel or palladium.

(b) A detergent is the sodium salt of long chain benzene sulphonic acid which has cleansing properties in water. Ex: Sodium n-dodecyl benzene sulphonate.

(c) Detergents are better cleansing agents than soaps because they do not form insoluble calcium and magnesium salts with hard water, and hence can be used for washing even with hard water.

Question 39:

(a) How does ethanoic acid react with sodium hydrogencarbonate ? Give equation of the reaction which takes place.

(b) Why are carbon and its compounds used as fuels for most applications ?

Which of the two is better for washing clothes when the water is hard : soap or detergent ? Give reason for your answer.

Solution :

(a) Ethanoic acid reacts with sodium hydrogencarbonate to evolve brisk effervescence of carbon dioxide gas.

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

(b) Carbon and its compounds used as fuels because they burn in air releasing a lot of heat energy.

(c) Detergent is better for washing clothes with hard water. They are better cleansing agents than soaps because they do not form insoluble calcium and magnesium salts with hard water, and hence can be used for washing even with hard water.

Question 40:

(a) What is meant by a substitution reaction ? Give an example (with equation) of the substitution reaction of, an alkane.

(b) How is soap made ? Write a word equation involved in soap making.

Solution :

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

Example: Substitution reaction of methane with chlorine:-

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

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

(b) Soap is made by heating animal fat or vegetable oil with concentrated sodium hydroxide solution.

$$\text{Fat or oil} + \text{Sodium hydroxide} \xrightarrow{\text{Heat}} \text{Soap} + \text{Glycerol}$$

Question 41:

(a) How is ethanoic acid obtained from ethanol ? Write down the chemical equation of the reaction involved.

(b) How would you distinguish between ethanol and ethanoic acid by chemical test ?

(c) Explain the formation of scum when hard water is treated with soap.

Solution :

(a) Ethanoic acid is obtained from ethanol by the means of oxidation reaction. When ethanol is heated with alkaline potassium permanganate solution (or acidified potassium dichromate solution), it gets oxidised to ethanoic acid. It is called an oxidation reaction because oxygen is added to it during this conversion.

$$CH_3CH_2OH + 2[O] \xrightarrow[\text{or acidified } K_2Cr_2O_7]{\text{Alkaline } KMnO_4;\text{Heat}} CH_3COOH + H_2O$$

(b) Litmus test: Some blue litmus solution is added to the organic compound (to be tested). If the blue litmus solution turns red, it shows that the organic compound is acidic in nature and hence it is a carboxylic acid (ethanoic acid). Ethanol has no effect on any litmus solution.
(c) When soap is used for washing clothes with hard water, a large amount of soap in water reacts with the calcium and magnesium ions of hard water to form an insoluble precipitate called scum. This makes the cleaning of clothes difficult.

Question 42:

(a) What happens when methane reacts with chlorine ? Give equation of the reaction which takes place.

(b) What is hydrogenation ? What is its industrial application ?

(c) Give any two differences between soaps and detergents.

Solution :

(a) Methane reacts with chlorine in the presence of sunlight to form chloromethane and hydrogen chloride. This reaction is called substitution reaction.

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

(b) The addition of hydrogen to an unsaturated hydrocarbon to obtain a saturated hydrocarbon is called hydrogenation.
Application: Vegetable oils are hydrogenated to form vegetable ghee (or vanasapati ghee).
(c)

Soaps	Detergents
(i)Soaps are biodegradable. (ii)Soaps have relatively weak cleansing action.	(i) Detergents are not biodegradable. (ii) Detergents have a strong cleansing action.

Question 43:

(a) What happens when ethanoic acid reacts with sodium hydroxide ? Write equation of the reaction involved.

(b) What happens when vegetable oils are hydrogenated ? Name the catalyst used.

(c) What is the advantage of detergents over soaps for washing clothes ? Also state one disadvantage.

Solution :

(a) Ethanoic acid reacts with sodium hydroxide to form a salt called sodium ethanoate and water.

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

(b) On hydrogenation, the liquid vegetable oils change into solid fat (vanasapati ghee). Nickel or palladium can be used as the catalyst.
(c) Advantage: Detergents can be used even with hard water and have stronger cleaning action.
Disadvantage: Detergents are not biodegradable and hence cause water pollution.

Question 44:

(a) An organic compound X of molecular formula $C_2H_4O_2$ gives brisk effervescence with sodium hydrogencarbonate. Give the name and formula of X.

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

(c) Name a chemical reaction which is characteristic of unsaturated hydrocarbons (like alkenes and alkynes).

Solution :

(a) Ethanoic acid, CH_3COOH gives brisk effervescence with sodium hydrogencarbonate.

(b) 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.

(c) Addition reactions are a characteristic of unsaturated hydrocarbons.

Question 45:

(a) What is meant by an addition reaction ? Give an example (with equation) of an addition reaction of an alkene.

(b) What is added to groundnut oil when it is to be converted to vanaspati ghee ?

(c) Which of the two is better for our health : butter or vegetable oil ? Why ?

Solution :

(a) The reaction in which an unsaturated hydrocarbon combines with another substance to give a single product is called an addition reaction.
Example: Ethene reacts with hydrogen when heated in the presence of nickel catalyst to form ethane:

$$CH_2 = CH_2 + H_2 \xrightarrow[\text{Heat}]{\text{Ni Catalyst}} CH_3 - CH_3$$

(b) Hydrogen is added to groundnut oil when it is to be converted to vanaspati ghee.
(c) Vegetable oil is better because it has unsaturated fatty acids which are good for our health.

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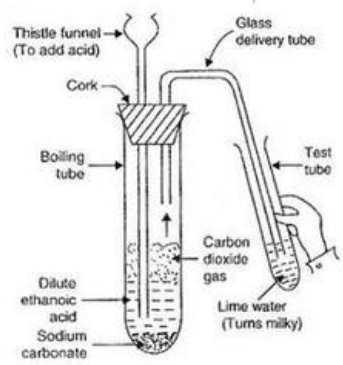
Question 46:

(a) When ethanoic acid reacts with sodium hydrogencarbonate, then a salt X is formed and a gas Y is evolved.
Name the salt X and gas Y. Describe an activity with the help of a labelled diagram of the apparatus used to prove that the evolved gas is the one which you have named. Also write the chemical equation of the reaction involved.
(b) Give any two uses of ethanoic acid.

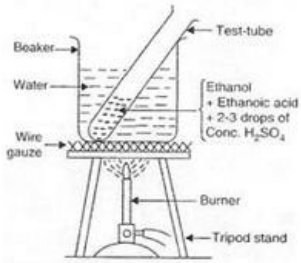
Solution :

(a)Salt X is sodium ethanoate, CH_3COONa; Gas Y is carbon dioxide, CO_2
Activity: Take a boiling tube and put about 0.5 g of sodium carbonate in it. Add 2 ml of dilute ethanoic acid to the boiling tube (through a thistle funnel). We will observe that brisk effervescence of carbon dioxide gas is produced. Let us pass this gas through lime water taken in a test tube. We will find that lime water turns milky. Only carbon dioxide gas can turn lime water milky. So, this experiment proves that when ethanoic acid reacts with sodium carbonate, then carbon dioxide gas is evolved.



$$CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + CO_2 \uparrow + H_2O$$

(b)(i) Dilute ethanoic acid (in the form of vinegar) is used as a food preservative in the preparation of pickles and sauces.
(ii) It is used in the manufacture of acetone and esters used in perfumes.
(a) Activity:
(i) Take 1 ml of pure ethanol (absolute alcohol) in a test-tube and add 1 ml of glacial ethanoic acid to it. Then add 2 or 3 drops of concentrated sulphuric acid to the mixture.
(ii) Warm the test-tube containing above reaction mixture in hot water bath (a beaker containing hot water) for about 5 minutes.
(iii) Pour the contents of the test-tube in about 50 ml of water taken in another beaker and smell it.
(iv) A sweet smell is obtained indicating the formation of an ester.
Reaction:
(c) Uses of esters:
(i) Esters are used in making artificial flavours and essences. These are used in cold drinks, ice-creams, sweets and perfumes.
(ii) Esters are used as solvents for oils, fats, gums, resins, cellulose, paints, varnishes, etc.



(iii) Pour the contents of the test-tube in about 50 ml of water taken in another beaker and smell it.
(iv) A sweet smell is obtained indicating the formation of an ester.
Reaction:

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

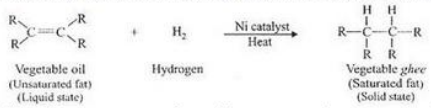
Ethanoic acid	Ethanol	Ethyl ethanoate	Water
(Acetic acid)	(Ethyl alcohol)	(Ethyl acetate – ester)	

Question 48:

(a) Name the reaction which is usually used in the conversion of vegetable oils to fats. Explain the reaction
involved in detail. Write a chemical equation to illustrate your answer.
(b) What is saponification ? Write the chemical equation of the reaction involved in this process. Name all the substances which take part in this process and also those which are formed.
(c) Why does micelle formation take place when soap is added to water ? Will a micelle be formed in other solvents like ethanol also ?

Solution :

(a) Catalytic hydrogenation is usually used in conversion of vegetable oils to fats.
Hydrogenation of oils: Vegetable oils are unsaturated fats having double bonds between some of their carbon atoms and can undergo addition reactions. When a vegetable oil (like groundnut oil) is heated with hydrogen in the presence of finely divided nickel as catalyst, then a saturated fat called vegetable ghee (or vanaspati ghee) is formed. This reaction is called hydrogenation of oils and it can be represented as follows:



Vegetable oil (Unsaturated fat) (Liquid state) + Hydrogen → Vegetable *ghee* (Saturated fat) (Solid state)

(b) The process of making soap by the hydrolysis of fats and oils with alkalis is called saponification.

$$\underset{\text{(An ester)}}{\text{Fat or Oil}} + \underset{\text{(An alkali)}}{\text{Sodium hydroxide}} \xrightarrow{\text{Heat}} \underset{\text{(Sodium salt of fatty acid)}}{\text{Soap}} + \underset{\text{(An alcohol)}}{\text{Glycerol}}$$

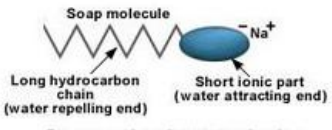
(c) Soap are sodium or potassium salts of long-chain carboxylic acids. When soap is added to the water, the hydrophilic end (acid end) will align along the surface of water and the hydrophobic tail (carbon chain) remains out of water.
When a soap is dissolved in water, it forms a colloidal suspension in water in which the soap molecules cluster together to form spherical aggregates called micelles. In a soap micelle, soap molecules are arranged radially with hydrocarbon ends directed towards the centre and ionic ends directed outwards.
No, micelle will not be formed in other solvents such as ethanol because hydrocarbon chains of soap molecules are soluble in organic solvents like ethanol.

Question 49:

(a) What is a soap ? Name one soap.
(b) Describe the structure of a soap molecule with the help of a diagram.
(c) Explain the cleansing action of soap. Draw diagrams to illustrate your answer.

Solution :

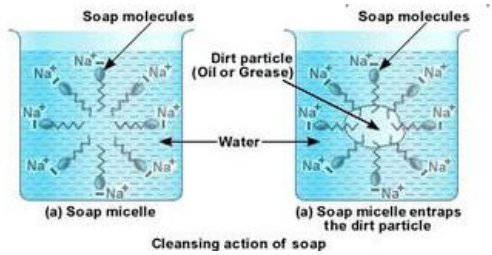
(a) A soap is the sodium salt (or potassium salt) of a long chain carboxylic acid (fatty acid) which has cleansing properties in water.
Example: Sodium stearate, $C_{17}H_{35}COO^-Na^+$



Representation of a soap molecule.

(b) A soap molecule has two parts: the long chain organic part and the ionic part containing the $-COO^-Na^+$ group. It has to be remembered that this is not an ion, the atoms are all covalently bonded, the electrical charges show how the charges get polarized in the group. A soap molecule has a tadpole like structure shown below:
(c) Cleaning action of soap has been explained with the help of the image below:

Soaps are molecules in which the two ends have differing properties, one is hydrophilic, that is it dissolves in water, while the other end is hydrophobic, that is it dissolves in hydrocarbons. When soap is at the surface of water, the hydrophobic 'tail' of soap will not be soluble in water and the soap will align along the surface of water with the ionic end in water and the hydrocarbon 'tail' protruding out of water.



Cleansing action of soap

Inside water, these molecules have a unique orientation that keeps the hydrocarbon portion inside the water. This is achieved by forming clusters of molecules in which the hydrophobic tails are in the interior of the cluster and the ionic ends are on the surface of the cluster. This formation is called a micelle. When a dirty cloth is put in water containing dissolved soap, then soap in the form of a micelle is able to clean. The hydrocarbon ends of the soap attach to the oily dirt particles and entrap them at the centre of the micelle. the ionic ends in the micelles remain attached to water. When the dirty cloth is agitated in soap solution, the oily dirt particles entrapped by soap micelles get dispersed in water and the cloth gets cleaned.

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Question 66:

A neutral organic compound X of molecular formula C_2H_6O on oxidation with acidified potassium dichromate gives an acidic compound Y. Compound X reacts with Y on warming in the presence of cone. H_2S0_4 to give a sweet smelling substance Z. What are X, Y and Z ?

Solution :

X is ethanol

Y is ethanoic acid

Z is ethyl ethanoate

Ethanol reacts with ethanoic acid to form ethyl ethanoate ester.

Question 67:

Consider the following organic compounds :

HCHO, C_2H_5OH, C_2H_6, CH_3COOH, C_2H_5C1

Choose two compounds which can react in the presence of cone. H_2S0_4 to form an ester. Give the name and formula of the ester formed.

Solution :

C_2H_5OH and CH_3COOH react in the presence of conc. H_2SO_4 to form an ester. Ethyl ethanoate, $CH_3COOC_2H_5$ is formed in the reaction.

Question 68:

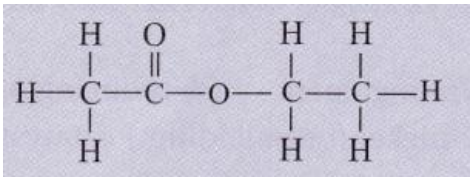
A neutral organic compound is warmed with some ethanoic acid and a little of cone. H_2S0_4. Vapours having sweet smell (fruity smell) are evolved. What type of functional group is present in this organic compound ? The structural formula of an ester is :

Solution :

Alcohol group, -OH. Acids react with alcohols to form sweet smelling esters.

Question 69:

The structural formula of an ester is :



Write the formula of the acid and the alcohol from which it is formed.

Solution :

Acid: Ethanoic acid

$CH_3-\overset{\overset{O}{\|}}{C}-OH$

Alcohol: Ethanol

CH_3-CH_2-OH

Question 70:

Consider the following organic compounds :

CH3OH, C_2H_5OH, CH3COCH3, CH3COOH, C_2H_5COOH, $C_4H_9COOC_2H_5$, CH_4, C_2H_6, CH3CHO, HCHO Out of these compounds :

(a) Which compound is most likely to be sweet-smelling ?

(b) Which compound on treatment with cone. H_2S0_4 at 170°C forms an alkene ?

(c) Which compound on repeated chlorination forms chloroform ?

(d) Which compound is added to alcohol to denature it ?

(e) Which compound is a constituent of vinegar ?

(f) Which compound is used to sterilise wounds and syringes ?

Solution :

(a) $C_4H_9COOC_2H_5$; Ester

(b) C_2H_5OH; Alcohol forms ethene, C_2H_4

(c) CH_4; Methane

(d) CH_3OH; Methanol

(e) CH_3COOH; Acetic acid

(f) C_2H_5OH; Ethanol

Question 71:

An organic acid X is a liquid, Which often freezes during winter time in cold countries, having the molecular formula $C_2H_4O_2$. On warming it with methanol in the presence of a few drops of concentrated sulphuric acid, a compound Y with a sweet smell is formed.

(a) Identify X and Y. Also write their formulae showing the functional group present in them.

(b) Write a chemical equation for the reaction involved.

Solution :

(a) X is ethanoic acid, $CH_3-\overset{\overset{O}{\|}}{C}-OH$; Y is methyl ethanoate, $CH_3-\overset{\overset{O}{\|}}{C}-O-CH_3$

(b) $CH_3COOH + CH_3OH \xrightarrow{\text{conc.}H_2SO_4} CH_3COOCH_3 + H_2O$

Question 72:

An organic compound A having the molecular formula C_3H_8O is a liquid at room temperature. The organic liquid A reacts with sodium metal to evolve a gas which burns causing a little explosion. When the organic liquid A is heated with concentrated sulphuric acid at 170°C, it forms a compound B which decolourises bromine water. The compound B adds on one molecule of hydrogen in the presence of Ni as catalyst to form compound C which gives substitution reactions with chlorine.

(a) What is compound A ?

(b) What is compound B ?

(c) What type of reaction occurs when A is converted into B ?

(d) What is compound C ?
(e) What type of reaction takes place when B is converted into C ?

Solution :

(a) A is propanol, CH3-CH_2-CH_2OH
(b) B is propene, $CH_3CH=CH_2$
(c) Dehydration reaction
(d) C is propane, CH_3CH_2-CH_3
(e) Addition reaction

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Question 73:

An organic compound A (molecular formula $C_2H_40_2$) reacts with Na metal to form a compound B and evolves a gas which burns with a pop sound. Compound A on treatment with an alcohol C in the presence of a little of concentrated sulphuric acid forms a sweet-smelling compound D (molecular formula $C_3H_60_2$). Compound D on treatment with NaOH solution gives back B and C. Identify A, B, C and D.

Solution :

A is ethanoic acid, CH_3COOH
B is sodium ethanoate, CH_3COONa
C is methanol, CH_3OH
D is methyl ethanoate, CH_3COOCH_3

Question 74:

Which of the following hydrocarbons can decolourise bromine water and which cannot ? Why ?
C_6H_{12}, C_6H_{14}, C_6H_{10}

Solution :

C_6H_{12} and C_6H_{10} c an decolourise bromine water since these are unsaturated hydrocabons.
C_6H_{14} cannot decolourise bromine water since it is a saturated hydrocarbon.

Question 75:

A four carbon atoms containing neutral organic compound X reacts with sodium metal to evolve a gas which burns with a 'pop' sound. Another four carbon atoms containing carbon compound reacts with sodium hydrogencarbonate to evolve a gas which turns lime water milky. When compounds X and Y are heated together in the presence of a little of concentrated sulphuric acid, then a new compound Z is formed.
(a) What is compound X ? Also write its formula.
(b) What is compound Y ? Also write its formula,.
(c) What is compound Z ? Also write its formula.
(d) What type of smell is given by compound Z ?
(e) What is the general name of compounds like Z ?
(f) What is the general name of the reaction which takes place between X and Y to form Z ?

Solution :

(a) X is butanol, C_4H_9OH
(b) Y is butanoic acid, C_3H_7COOH
(c) Z is butyl butanoate, $C_3H_7COOC_4H_9$
(d) Sweet smell is given by the compound Z.
(e) Esters
(f) Esterification reaction.

Alkanes-Chemical properties

Reaction with Halogens

Alkanes undergo substitution reaction (substitution starts with one of the hydrogen and continues till all the hydrogen present is substituted) All alkanes undergo substitution reaction.

Alkanes + Halogens **Haloalkanes + Hydrogen Halide**

$Ch_4 + Cl_2 \longrightarrow CH_3Cl + HCl$

$CH_3Cl + Cl_2 \longrightarrow CH_2Cl_2 + HCl$

$CH_2Cl_2 + Cl_2 \longrightarrow CHCl_3 + HCl$

$CHCl_3 + Cl_2 \longrightarrow CCl_4 + HCl$

No more substitution happens once all the hydrogen are substituted.

Reaction with Oxygen

1.Sufficient supply of air : Alkane + Oxygen -----> Carbon dioxide + water

$CH_4 + 2O_2 \text{ ----> } CO_2 + 2H_2O$

2.Insufficient supply of air : Alkane + Oxygen -----> Carbon monoxide + Water

$2CH_4 + 3O_2 \text{ ----> } 2CO + 4H_2O$

3.If oxygen is still less : $CH_4 + O_2 \text{ ----> } C + 2H_2O$

Soot (used in manufacture of printing inks and tyres)

Decomposition of Alkanes (Cracking or Pyrolysis)

The decomposition of a compound by heat in the absence of air is called Pyrolysis.

Pyrolysis for alkanes is called Cracking.

$C_5H_{12} \xrightarrow[\text{Alumina/Silica}]{400\text{-}600^\circ C} C_3H_8 + C_2H_4$

Pentane — Propane — Ethene

Alkanes-Chemical properties

Catalytic Oxidation of Alkanes :

On controlled oxidation or catalytic oxidation, alkanes give alcohols or aldehydes or carboxylic acids, depending upon the reaction conditions.

Methane + Oxygen — 475 K, 120 atm; Ratio 9:1, In Cu tube; Molybdenum oxide; Manganese based catalyst, 100°C

Methyl alcohol CH_3OH : $2CH_4 + O_2 \text{-------> } 2CH_3OH$

Formaldehyde $HCHO$: $CH_4 + O_2 \text{-------> } HCHO + H_2O$

Formic acid $HCOOH$: $2CH_4 + 3O_2 \downarrow \quad 2HCOOH + 2H_2O$

NOTE : Similarly ethane oxidizes.

Slow Combustion : Methane and Ethane can be treated with oxidizing agents at high pressure and comparatively low temperature.

$\text{Alkane} \xrightarrow[K_2Cr_2O_7]{[O]} \text{Alcohol} \xrightarrow[K_2Cr_2O_7]{[O]} \text{Aldehyde} \xrightarrow[K_2Cr_2O_7]{[O]} \text{Carboxylic Acid} \longrightarrow \text{Carbon dioxide and water vapor}$

$CH_4 \xrightarrow[K_2Cr_2O_7]{[O]} CH_3OH \xrightarrow[K_2Cr_2O_7]{[O]} HCHO \xrightarrow[K_2Cr_2O_7]{[O]} HCOOH \longrightarrow CO + H_2O$

Alkanes-Physical properties

Alkanes are saturated open chain hydrocarbons in which the carbon atoms are bonded to each other by single covalent bonds and each carbon atom is bonded to carbon or hydrogen atom to give maximum covalency of four.

Physical Properties

Physical States	C_1 - C_4 – Colorless, odorless gases C_5 - C_{15} – Colorless, odorless liquids C_{18} onwards — Colorless, odorless and waxy solids
Boiling points	B.P. rises by about 20-30°C for each addition of CH_2 group.
Melting Point	M.P. rises with increase in carbon atoms, but variation is not regular.
Solubility	Soluble in alcohol, ether. Insoluble in water.
Density	Less denser than air.

Carbon And Its Compounds

- Organic chemistry deals with the compounds of carbon.
- The compounds derived from plants and animals were known as organic and those derived from non-living sources were called inorganic.
- In 1828, Friedrich Wohler showed that synthesis of organic compounds is possible in laboratory. Wohler prepared urea.

Organic Chemistry excludes oxides of carbon, metallic carbonates and related compounds like metal cyanides, metal carbides

Unique Nature of Carbon

Carbon has a unique nature of making compounds with high molecular weight.
Reason:

1. Tetravalency of the carbon atom : Carbon forms covalent bonds. The characteristic of the carbon atom, with the virtue of which it forms four covalent bonds, is called the tetravalency of carbon.
2. Catenation : The property of self-linking of atoms of an element through covalent bonds in order to form straight chains, branched chains and cyclic chains of different sizes is known as catenation.
3. Formation of both organic and inorganic compounds.

Carbon And Its Compounds

Chemical Symbol – C ; Atomic Number - 6

- **Occurrence**
  - Combined states of carbon
    - Solid State e.g. lime, marble calamine
    - Liquid State e.g. petroleum
    - Gaseous State e.g. carbon dioxide
  - Free states of carbon. e.g. diamond, graphite, coal

Allotropy: The phenomenon due to which an element exhibits different physical forms.
Allotropes are the various physical forms of an element.

- **Carbon**
  - Crystalline form
    - Diamond
    - Graphite
  - Amorphous form
    - Charcoal
      - Sugar charcoal
      - Bone charcoal
      - Wood charcoal
    - Lamp black
    - Coke
    - Carbon gas

Carboxylic Acid

- An organic compound containing the carboxyl group (--COOH) is called carboxylic acid.
- These compounds are acidic in nature.

General Formula : C_nH_{2n+1} COOH (or RCOOH)

Functional group :: H -- C(=O) —OH

Ethanoic Acid (Acetic Acid) is the second member of homologous series of Carboxylic Acid.

Properties	Acetic Acid
Physical State	Colorless liquid with characteristic odor.
Boiling Point Melting Point	B.P = 118 °C, M.P. = 17 °C
Solubility	Soluble in water and organic solvents.
Nature	It is hygroscopic liquid
Combustion	Burns with pale blue flame.
Solvent Nature	It's a good solvent for P_4, S_8 and many other organic solvents.
Corrosive Nature	Forms blisters in contact with skin.

Test for Acetic Acid:
- On adding acetic acid to carbonates and bicarbonates, carbon dioxide is evolved.
- When warmed with ethyl alcohol and conc. Sulphuric acid, a pleasant fruity smell is produced.
- On adding neutral iron (III) chloride, wine color is produced.

Carboxylic Acid

1. It's a weak acid, hence
   a) Turns blue litmus red.
   b) Reaction with metal oxides
   $$2CH_3COOH + CaO \longrightarrow (CH_3COOH)_2Ca + H_2O$$
   c) Forms salt and water with base
   $$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$
   d) Liberates carbon dioxide with carbonates or bicarbonates
   $$2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + H_2O + CO_2$$
   $$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + H_2O + CO_2$$
2. Acetic acid forms ester on reacting with alcohol :
   $$CH_3OH + CH_3COOH \longrightarrow CH_3COOCH_3 + H_2O$$
3. Reacts with phosphorous pentachloride to give acetylchloride
   $$CH_3COOH + PCl_5 \longrightarrow CH_3COCl + POCl_3 + HCl$$
4. Reacts with phosphorous pentoxide to give acid anhydride
   $$2CH_3COOH \xrightarrow{P_2O_5} (CH_3CO)_2O + H_2O$$
5. Reduction : Carboxylic acids reduce to alcohol in presence of a strong reducing agent Lithium aluminium hydride ($LiAlH_4$)
   $$CH_3COOH + 4[H] \longrightarrow C_2H_5OH + H_2O$$
6. Reacts with active metals evolving hydrogen.
   $$2CH_3COOH + Zn \longrightarrow (CH_3COO)_2.Zn + H_2$$

Cleaning Action Of Soap

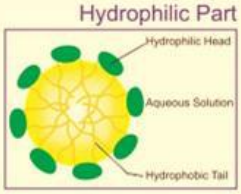
Each molecule of soap has two parts :

Hydrophobic part : it tries to get away from Water Hydrophilic part : it is attached to water

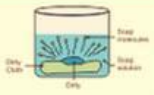
The hydrocarbon chain dissolves in oil while ionic end dissolves in water.

The soap molecule form a micelle.

Hydrophilic Part



1. Soap molecule Cloth



2. Due to action of soap molecules, dirt or grease comes out to the surface of cloth

3. Dirt or grease is entrapped at the center of soap micelle.

4. Dirt or grease suspended in the soap micelle is washed away with water.

Covalent Bond

- The chemical bond formed between **two combining atoms by mutual sharing** of one or more pairs of electrons
- The compound formed due to covalent bond is called covalent compounds.
- Elements with 5, 6 or 7 electrons in outermost shells tend to mutually share electrons to complete its octet.
- Each atom contributes equal number of electron(s).
- The covalency of an atom is the number of its electrons taking part in the formation of shared pairs. E.g. covalency of H is 1, O is 2, N is 3 and C is 4.

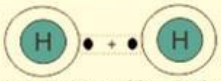
Types of Covalent Bond	No of pair of electrons shared
Single Covalent Bond	1
Double Covalent Bond	2
Triple Covalent Bond	3

Hydrogen Bond :

- Hydrogen has only 1 electron.
- To become stable, it needs one more electron.
- It shares the electron with another hydrogen atom, making a covalent bond.

Formation of Hydrogen molecule

1. Before Combination

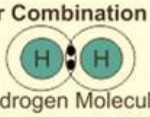


Hydrogen atom with - 1 electron

Electron dot structure

H• + •H

2. After Combination



Hydrogen Molecule

To become stable, H needs 1 more electron. It shares the electron with another H atom, making a covalent bond.

Hydrogen Molecule

H : H

One shared pair of electrons

H -- H --> H_2

Single covalent bond

Covalent Compounds

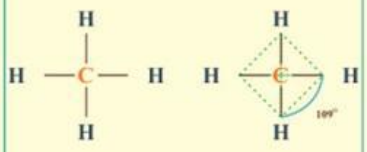
Property	Reason
Nature 1. Their constituents particles are molecules. 2. These are gases or liquids or soft solids.	They have weak forces of attraction between their molecules.
Boiling points and melting points These are volatile, with low boiling and low melting points.	They have weak forces of attraction between the binding molecules, thus less energy is required to break the force of bonding.
Ionisation in solution : On passing electricity, non-polar covalent compounds do not ionise. Some of the covalent compounds are polar in nature. They ionise in their solutions and can act as an electrolyte. e.g. $HCl + H_2O$ $H_3O^+ + Cl^-$	Covalent compounds do not have ions. Polar covalent molecules form ions in their solutions.
Dissociation : The dissociation of molecules into ions does not take place.	Covalent compounds do not have ions, so they do not dissociate.
Solubility : These are insoluble in water but dissolve in organic solvents.	As organic solvents are non-polar, hence, these dissolve in non-polar covalent compounds.
Rate of reaction They show slow speed of chemical reactions in aqueous solutions.	In covalent molecules, old bonds are broken and new bonds are formed, thus the reaction is slow between covalent compounds.

Ethane And Methane

Occurrence :

- Methane is found at the bottom of marshes due to fermentation of cellulose by a special type of bacteria. So its also called Marsh gas.
- Its also present in air exhaled by animals whose food contains cellulose.
- Cavities in coal contain 90% methane.
- Ethane occurs 10-20 percent along with methane.

Structure of Methane

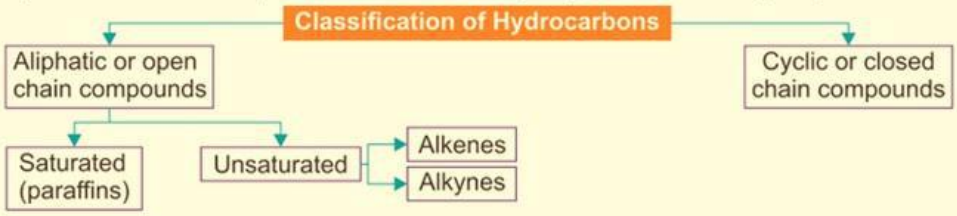


Physical Properties :

Properties	Methane	Ethane
Physical state	Colorless and odorless gas	Colorless and odorless non-poisonous gas
Boiling Point **Melting point**	B.P. -162°C M.P. -183°C	B.P. -89°C M.P. -172°C
Solubility	Negligibly soluble in water Soluble in organic solvents.	Sparingly soluble in water Completely soluble in organic solvents like alcohols.

Hydrocarbons

Hydrocarbons are compounds that are made up only of carbon and hydrogen atoms.



Saturated Compounds :

1. The simplest open chain hydrocarbon is alkane. Its represented by formula C_nH_{2n+2} , where n represents natural numbers.
2. In saturated hydrocarbon, all the four valencies of carbon are satisfied by a single covalent bond.

Unsaturated Compounds :

1. Open chain compounds where all the four valencies are not satisfied by single covalent bond.
2. Double or triple bonds are required in between carbon atoms to satisfy the valency.

Manufacture Of Soap

Raw materials needed for manufacture of soap :

1. Vegetable oil or animal fat.
2. Sodium hydroxide.
3. Common salt
4. Talc (as filler)

Ittner and Twitchell Process:

Vegetable oil + H_2O (steam)---> Fatty acids + Glycerol

Fatty acids + NaOH---> Soaps + H_2O

Hot Process

Vegetable Oil + 20% solution of NaOH (constant stirring)

↓ Heat externally

Soap as suspension is formed

↓

Soap is precipitated by adding sodium chloride — This process is called Salting of Soap

↓

PPt is washed with water.
Add talc, desired color and perfume

↓

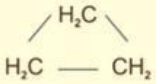
Soap solidifies and is cut into bars

After the removal of soap, the solution left behind contains glycerol, sodium chloride, unused sodium hydroxide and some soluble soap. This solution is called spent lye

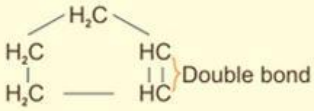
Saturated and Unsaturated Compounds

Saturated Organic compounds	Unsaturated Organic Compounds
Carbon atoms are joined only by a single covalent bond. 	Carbon atoms are joined by double covalent bonds or triple covalent bond. >C= C< -C≡C-
They are less reactive due to the non-availability of electrons in the single covalent bond, and therefore undergo substitution reaction.	They are more reactive due to the presence of electrons in the double or the triple bond, and therefore undergo addition reaction.

Cyclopropane



Cyclopentene



Nomenclature of Organic Compounds

The name of an organic compound consists of three parts Root word, suffix, prefix.

- Root word depends on the number of carbon atoms present in the longest selected carbon chain.C_1-meth, C_2- Eth.
- Suffix, represents the nature of the bond in a carbon-carbon atom. single bond-ane(hexane)
- Prefix denotes the substituent, alkyl or functional group and its position in the carbon chain.

Soaps And Detergents

Saponification is the reaction of caustic soda(NaOH) with oil or fat. A soap molecule consists of an anion $RCOO^-$ (R is a long hydrocarbon chain) and cation Na^+ or K^+.

Long Chain hydrocarbon  $COO^- Na^+$ Soap Molecule

Detergents
- Prepared from alkyl benzene and oleum, the process is known as sulphonation.
- Detergents have better cleansing action than soaps. They make lather even in hard water.

Hard Soaps	• Sodium salts of long chain fatty acids . • Contain higher proportion of salts of saturated fatty acids (stearic acid, palmitic acid) • Lower proportion of salts of unsaturated fatty acid • Contains free alkali, is slippery. • Used as laundry soaps.
Soft Soaps	• Potassium salts of long chain fatty acids . • Contain higher proportion of salts of unsaturated fatty acids (oleic acid) • Lower proportion of salts of saturated fatty acid (stearic acid, palmitic acid) • Used as toilet soaps and shaving soaps. • Are alkaline and hence slippery.
Transpa -rent Soaps	• Made by dissolving the soft soaps in ethanol followed by filtration and evaporation of ethanol. • Contain small amount of glycerol. • Also called glycerine soaps.

Uses Of Ethane And Methane

Methane	Ethane
Source of carbon monoxide and hydrogen	Used in preparation of ethene, ethanol, ethanal etc.
Used in preparation of ethyne, methanal, methanol, chloromethane etc.	Forms ethyl chloride, which is used to make tetraethyllead.
Used as domestic fuel.	Its also a good fuel.

Greenhouse Effect Due To Methane :
The heating of the earth and its environment due to radiation of the Sun trapped by carbon dioxide and water vapors in the atmosphere is called greenhouse effect.
Global warming is the rise in the average temperature of Earth's atmosphere and oceans since the late 19th century and its projected continuation.

Green House Gases : The various gases that contribute to green house effect.

Gases	CO_2	CH_4	CFC	O_3	N_2O	H_2O
% contribution	50	19	17	8	4	2

Alcohols

- Alcohols are hydroxyl derivative of alkanes.
- They do not occur naturally, they are synthesized.
- One or more hydrogen atom of alkane is replaced by OH group to give alcohols.

Monohydric alcohol	1 OH group
Dihydric alcohol	2 OH group
Trihydric alcohol	3 OH group

Uses of Alcohol :
- It's a good solvent for gums and resins.
- Used in thermometers.
- Its used in manufacture of chemicals and synthetic products like dyes, perfumes, antiseptics

Denatured Alcohol : In order to make ethanol undrinkable, pyridine, methanol and copper sulphate is added. This alcohol is called denatured alcohol.
Spurious Alcohol : Illicit liquor made by improper distillation, its fatal for human consumption.

Physical Properties :

Properties	Alcohol
Physical state	Inflammable volatile liquid which is toxic for humans.
Boiling Point Melting point	Boiling point increases with increase in molecular weight. CH_3OH = 64.5°C, C_2H_5OH = 78.3°C
Solubility	Soluble in water and organic solvents.
Density	Ethanol's density is 0.79 gm/c.c.

Note : Ethanol affects that part of our brain which controls the muscular movements and then gives temporary relief from tiredness. It damages liver and kidney.

Alcohols

1. Oxidation : Alcohol is oxidized with alkaline $K_2Cr_2O_7$ at room temperature

$CH_3OH \xrightarrow[K_2Cr_2O_7]{[O]} HCHO + H_2O \xrightarrow[K_2Cr_2O_7]{[O]} HCOOH$

3. Reaction with Acetic Acid (esterification) :
alcohol + carboxylic acid ---> ester + water

$CH_3OH + CH_3COOH + CH_3COOCH_3 + H_2O$
Methyl Acetate

5. Halogenation (haloalkanes are produced):

$3CH_3OH + PCl_3 \text{ -------> } 3CH_3Cl + H_3PO_3$
Chloromethane

7. Reduction :
Alcohol + HI ---> Alkane + water + I_2
$CH_3OH + HI$ ---> $CH_4 + H_2O + I_2$

9. Reaction of Sodalime :
Alcohol + Sodalime ---> Sodium Ethanoate + Hydrogen

$C_2H_5OH + NaOH$ ---> $CH_3COONa + 2H_2$

2. Combustion of Ethanol : Ethanol burns with a sooty flame.

$C_2H_5OH + 3O_2 \text{ ------>} 2CO_2 + 3H_2O + \text{Heat}$

4. Dehydration with conc. Sulphuric acid :
Alcohol + H_2SO_4 -----> alkene + H_2O

$C_2H_5OH \xrightarrow[\text{Heat}]{H_2SO_4} CH_2 = CH_2 + H_2O$

6. Reaction with Halogen Acids (haloalkanes are produced):
Alcohol + Haloacid ----> Haloalkane + water

$CH_3OH + HCl \text{ -------> } 3CH_3Cl + H_2O$

8. Reaction with Sodium :
Alcohol + Sodium ---> Sodium alkoxide + H_2

$CH_3OH + Na \text{ -------> } CH_3ONa + H_2$

Dehydrogenation :Alcohol $\xrightarrow[-H_2]{Cu,300^\circ C}$ Aldehyde

$C_2H_5OH \xrightarrow[-H_2]{Cu,300^\circ C} CH_3CHO$