Chemistry (Class - X)
Chapter 4 - Carbon and its Compounds

Introduction

- Carbon is an element. The symbol of carbon is C.
- It is a non-metal.
- The amount of carbon present in the earth's crust and in the atmosphere is very small.
- The earth crust has only 0.02% carbon in the form of minerals (like carbonates, hydrogen-carbonates, coal and petroleum etc.)
- The atmosphere has 0.03% of carbon dioxide.

In spite of this small amount of carbon in nature, carbon element has an immense importance in every sphere of life.

All the living things, plants and animals, are made up of carbon based compounds which are called organic compounds.

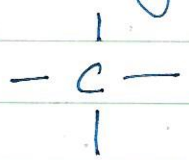
Thus carbon is present in all living things.

We can test the presence of carbon in a material on the basis of the fact that carbon and its compounds burn in air & give carbon dioxide gas which turns lime water milky.

Bonding in Carbon - The covalent bond

(1) Carbon always forms covalent Bonds. The electronic configuration carbon is (K-2, L-4) 2, 4. It is not possible possible to remove 4 electrons from a carbon atom. Also, it is not possible to add 4 electrons to a carbon atom due to energy consideration. Since carbon atoms can achieve the inert gas electron arrangement only by the sharing of electrons, therefore, carbon always forms covalent bonds.

(2) Since one carbon atom requires 4 electrons to achieve the eight-electron inert gas structure, therefore, the valency of carbon 4. That is carbon is tetravalent (tetra = four; valent = valency). The four valency of carbon is represented by :



(3) The most outstanding (or unique) property of carbon is its ability to combine with itself, atom to atom, to form long chains. This property give rise to an extremely large number of carbon compounds (or organic compounds).
The covalent bonds between the various carbon atoms are very strong and do not break easily.

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

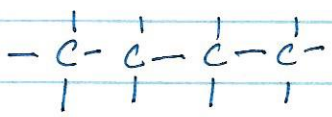
Versatile Nature of Carbon

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

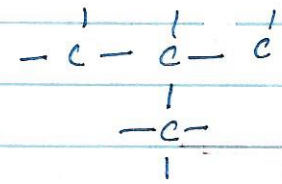
Q) What are the two properties of carbon which lead to the huge number of carbon compounds?

(i) **Catenation:**

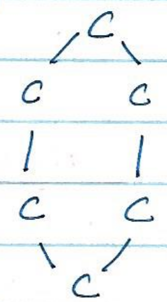
Carbon has the unique ability to form bonds with other atoms of carbon, giving rise to large molecules. This property is called catenation. These compounds may have long chains of carbon, branched chains of carbon or even carbon atoms arranged in rings.



Straight Chain



Branched Chain



Closed Chain (Ring Structure)

In addition, carbon atoms may be linked by single, double or triple bonds.

(ii) **Tetravalency:** Since the carbon has a valency of four, it is capable of bonding with four other atoms of carbon or atoms of other monovalent elements. (Tetra mean 4). Carbon can form double or triple bonds with other C-atoms or with oxygen, nitrogen also. Compounds of carbon are formed with oxygen, hydrogen, nitrogen, sulphur, chlorine and many other elements.

Organic Compounds

The compounds of carbon are known as organic compounds. Most of the organic compounds are hydrocarbon (containing only carbon and hydrogen). Examples : Methan (CH_4), Ethane (C_2H_6), Ethene (C_2H_4), Ethyne (C_2H_2) etc.

Organic compounds are covalent compounds having low melting points and boiling points.

Types of Organic Compounds :

1. Hydrocarbon
2. Haloalkanes
3. Alcohols
4. Aldehydes
5. Ketones
6. Carboxylic Acids. (Organic Acids)

Hydrocarbons

A compound made up of hydrogen and carbon only is called hydrocarbon. (Hydrogen + Carbon = Hydrocarbon).
Methane - CH_4, Ethane - C_2H_6, Ethene - C_2H_4, Ethyne - C_2H_2.

The most important natural source of hydrocarbons is petroleum (or crude oil).

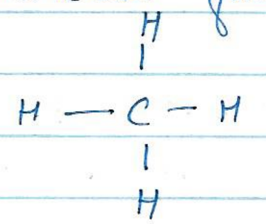
Types of Hydrocarbons : (i) Saturated Hydrocarbon (Alkanes)
(ii) Unsaturated hydrocarbon.

Saturated Hydrocarbons (Alkanes)

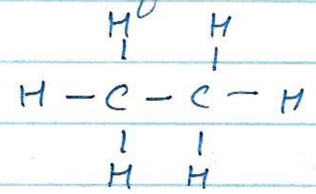
A hydrocarbon in which the carbon atoms are connected by only single bonds is called a saturated hydrocarbon.

The general formula of saturated hydrocarbons or alkanes is C_nH_{2n+2} where n is the number of carbon.

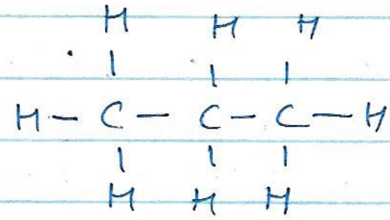
(i) If n = 1, then molecular formula be CH_4 (Methane)



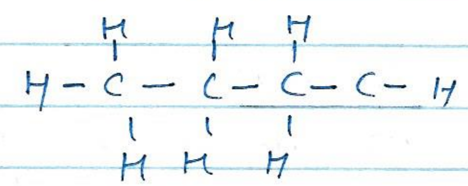
(ii) If n = 2, Molecular formula will be C_2H_6 (Ethane)



(iii) If n = 3, C_3H_8 (Propane)



(iv) If n = 4, C_4H_{10} (Butane)



These compounds are normally not very reactive.

If the number of hydrogen atoms is "2 more" than double the number of carbon atoms, then it will be an alkane.

Unsaturated Hydrocarbon (Alkenes and Alkynes)

A hydrocarbon in which the two carbon atoms are connected by a 'double bond' or a 'triple bond' is called an unsaturated hydrocarbon. Ethene ($H_2C=CH_2$), Ethyne ($HC\equiv CH$) are two important unsaturated hydrocarbons.

Unsaturated hydrocarbons are of two types:

(i) Alkenes:

An unsaturated hydrocarbon in which the two carbon atoms are connected by a double bond is called an alkene. That is, an alkene contain the $>C=C<$ group. Ethene $H_2C=CH_2$ and propene $CH_3-CH=CH_2$ are two alkenes.

The general formula of an alkene is C_nH_{2n}.

When $n=2$, formula is C_2H_4 (Ethene)

When $n=3$, formula is C_3H_6 (Propene)

When $n=4$ formula is C_4H_8 (Butene).

(ii) Alkynes:

An unsaturated hydrocarbon in which the two carbon atoms are connected by a triple bond is called an alkyne. That is, an alkyne contain the $-C\equiv C-$ group. Ethyne $HC\equiv CH$, and propyne $CH_3-C\equiv CH$ are alkynes.

The general formula of alkynes is C_nH_{2n-2}.

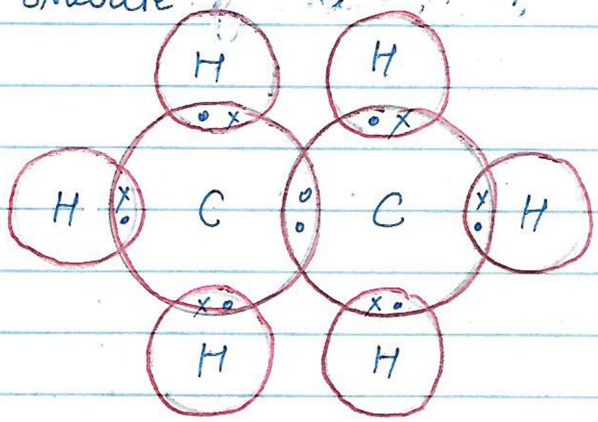
When $n=2$ formula is C_2H_2 (Ethyne)

When $n=3$ formula is C_3H_4 (Propyne)

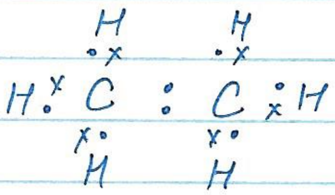
When $n=4$ formula is C_4H_6 (Butyne).

Ethane molecule (C_2H_6)

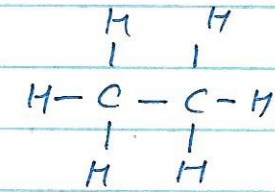
(a) Structure



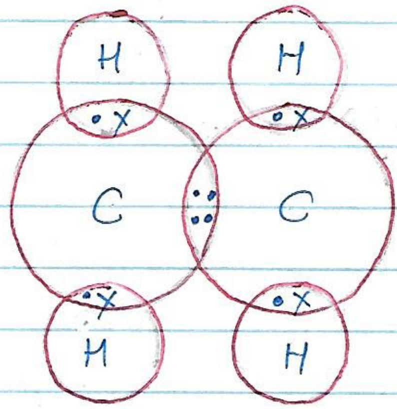
(b) dot-Structure



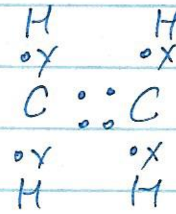
(c) Structural formula.



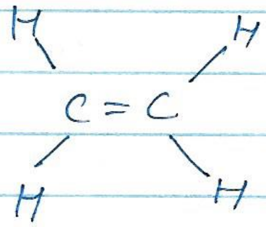
Ethene (C_2H_4)



Structure of ethene C_2H_4

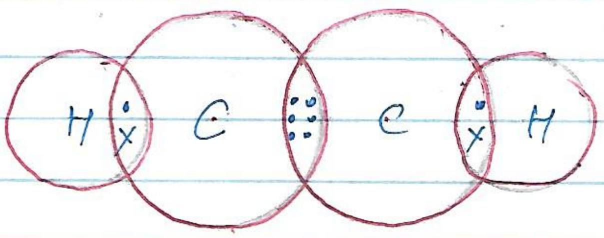


Electron dot structure



Structural formula.

Ethyne (C_2H_2)



Structure of C_2H_2

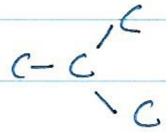
Electron-dot structure

H—C≡C—H

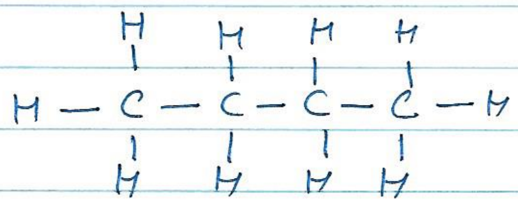
Structural formula.

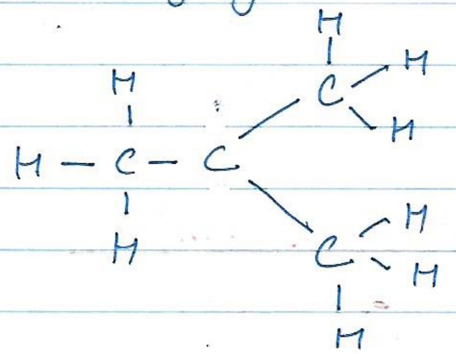
Chain, Branches and Rings.

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

Two possible carbon-skeletons: C – C – C – C (or) 

Filling the remaining valencies with hydrogen:

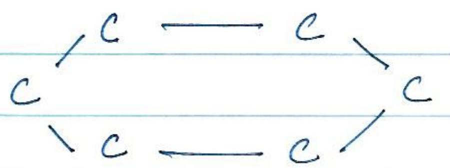


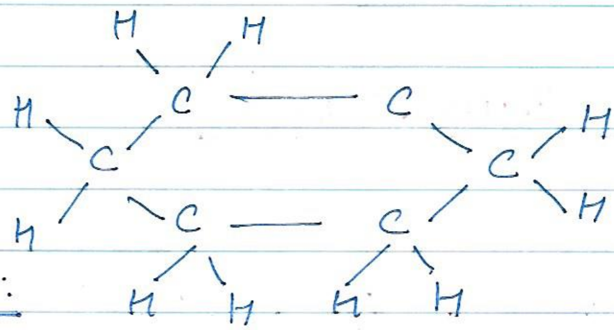


These are two isomers are butane, C_4H_{10}.

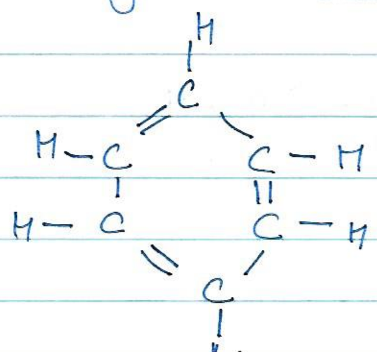
Since branching is not possible, isomers are not possible for the first three members of alkane series. (CH_4, C_2H_6, C_3H_8, Methane, Ethane and Propane).

Ring structure of cyclohexane: C_6H_{12}





Structure of Benzene (C_6H_6):



Functional Groups.

Carbon also forms bonds with other elements such as halogen, oxygen, nitrogen and sulphur. In hydrocarbon chain, one or more hydrocarbon can be replaced by these elements, such that the valency of carbon remains satisfied. In such compounds, the elements replacing hydrogen is referred to as a heteroatom.
These heteroatom which determine the chemical properties of an organic compound is called a functional group.

Hetero Atom	Functional Group	Formula of function Group.
Cl/Br	Halo - (Chloro / Bromo)	$-Cl$, $-Br$.
Oxygen	1) Alcohol	$-OH$
	2) Aldehyde	$-C(H)=O$
	3) Ketone	$-C(=O)-$
	4) Carboxylic Acid	$-C(=O)-OH$

Compound	Structural Formula	Functional Group
Ethanol	$H-CH_2-CH_2-OH$	$-OH$
Ethanoic Acid	$H-CH_2-C(=O)-OH$	$-C(=O)-OH$

Homologous Series

The presence of a functional group such as alcohol dictates the properties of the carbon compound, regardless of the length of the carbon chain. For example, the chemical properties of CH_3OH, C_2H_5OH, C_3H_7OH and C_4H_9OH are all very similar. Hence, such a series of compounds in which the same functional group substitutes for hydrogen in a carbon chain is called a homologous series.

Characteristics of homologous series:

(a) The molecular formulae of any two successive members of a homologous series differ by $-CH_2$

(b) There is a regular gradation in physical properties of members of a homologous series as the molecular mass increases. This is because the melting and boiling point increases with increasing molecular mass.

→ Thus, a group of organic compounds having the same functional group and similar structures in which the successive members differ by CH_2 group is called homologous series.

Alkynes : C_3H_4 , C_4H_6 , C_5H_8

Alkenes : C_3H_6 , C_4H_8 , C_5H_{10} .

But the chemical properties, which are determined solely by the functional group, remains similar in a homologous series.

Naming a Carbon Compound

(1) The number of carbon atoms in a hydrocarbon (or any other organic compound) is indicated by using the following stems :

One carbon atom – Meth
Two carbon atom – Eth
Three carbon atom – Prop
Four carbon atom – But (Read as Bute)
Five carbon atom – Pent
Six carbon atom – Hex
Seven carbon atom – Hept
Eight carbon atom – Oct
Nine carbon atom – Non
Ten carbon atoms – Dec (read as Dek)

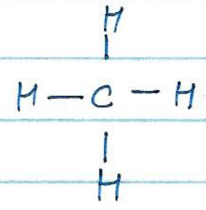
(2) A saturated hydrocarbon containing single bonds is indicated by writing the word 'ane' after the stem.

(3) An unsaturated hydrocarbon containing a double bond is indicated by writing the word 'ene' after the stem.

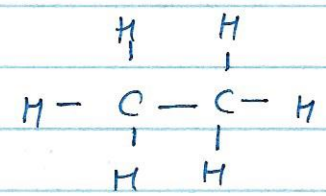
(4) An unsaturated hydrocarbon containing a triple bond is indicated by writing the word 'yne' after the stem.

Naming Saturated Hydrocarbon.

(1) Naming of CH_4 : One carbon atom so – 'meth'
Single bond, so saturated – 'ane'
∴ meth + ane = methane

CH_4 :  methane.

(2) Naming of C_2H_6 : Two carbon atom – 'eth'
Single bond, so saturated – 'ane'
eth + ane = ethane

C_2H_6 :  or $CH_3 - CH_3$ ($H_3C - CH_3$ in actual)

(3) Naming C_3H_8 – propane (prop + ane)

(4) Naming C_4H_{10} – but + ane = butane

(5) Naming C_5H_{12} – pent + ane = pentane

Nomenclature of Branched - Chain Saturated Hydrocarbon.

Example 1 : Name $CH_3 - CH_3 - CH_3$
$\quad\quad\quad\quad\quad\quad\quad\quad |$
$\quad\quad\quad\quad\quad\quad\quad CH_3$

(i) There are three carbon atoms in the longest chain. The alkane containing 3 carbon atoms is propane.

(ii) In above structure, one methyl group (CH_3 group) is present in the side chain of propane. So, the above compound is a methyl derivative of propane.

(iii) Number the carbon chain

$\overset{1}{CH_3} - \overset{2}{CH_3} - \overset{3}{CH_3}$ $\quad\quad$ $\overset{3}{CH_3} - \overset{2}{CH_3} - \overset{1}{CH_3}$
$\quad\quad\quad |\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad |$
$\quad\quad\; CH_3 \quad\quad\quad\quad\quad\quad\quad\quad CH_3$

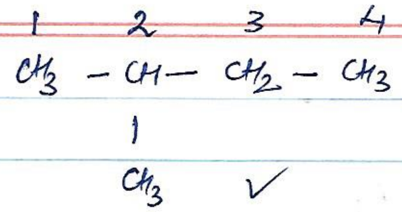
The methyl group falls on carbon number 2. So, it is actually a '2-methyl' group.

(iv) If we join '2-methyl' and 'proporane' hydrocarbon becomes '2-methyl propane'.

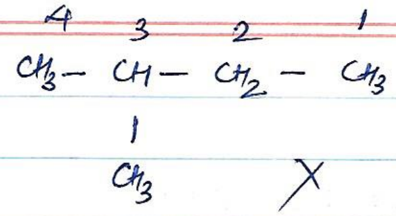
The common name of the hydrocarbon having the above structure is iso-butane.

Example 2 : $CH_3 - CH - CH_2 - CH_3$
$\quad\quad\quad\quad\quad\quad\quad |$
$\quad\quad\quad\quad\quad\quad CH_3$

(i) There are 4 carbon atoms in the longest carbon chain, so this compound is a derivative of butane.

(i) 

2- Methylbutane
(Correct)

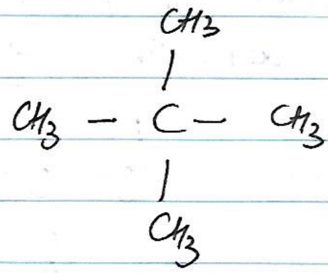


3- Methylbutane
(wrong)

(ii) The above chain hydrocarbon is 2- methylbutane.

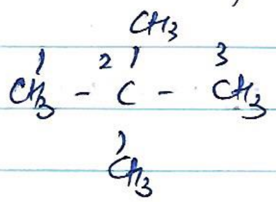
The common name of the above hydrocarbon is iso- pentane.

Example-3



(i) There are three carbon atoms in longest chain, so this compound is a derivative of propane.

(ii) But there are two extra methyl groups, so it is actually a dimethylpropane.

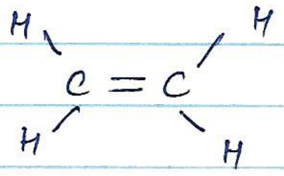
(iii)  2, 2 - dimethylpropane

Since both the methyl groups are on the same carbon atom.

The common name of above hydrocarbon is neo-pentane.

Naming of Unsaturated Hydrocarbons Containing a Double Bond.

① Naming of C_2H_4

C_2H_4  (or) $H_2C = CH_2$

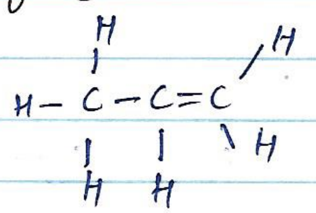
(i) This hydcarbon contain 2 carbon atoms which is indicated by 'eth'.

(ii) An unsaturated hydrocarbon containing a double bond, so it is indicated by 'ene'

(iii) Hydrocarbon name becomes eth + ene = ethene.

The common name of ethene ($CH_2 = CH_2$) is ethylene.

② Naming of C_3H_6

C_3H_6  (or) $CH_3 - CH = CH_2$

(i) This hydrocarbon has 3 carbon atoms in its molecule indicated by writing 'prop'.

(ii) It has a carbon-carbon double bond, so it is unsaturated. The double bond is indicated by using 'ene'

(iii) Join prop + ene = propene.

The common name of propene ($CH_3 - CH = CH_2$) is propylene.

Naming of Unsaturated Hydrocarbons Containing a Triple Bond.

① Naming of C_2H_2

C_2H_2 $H-C\equiv C-H$ (or) $HC\equiv CH$

(i) This hydrocarbon contain 2 carbon atoms indicated by writing 'eth'.

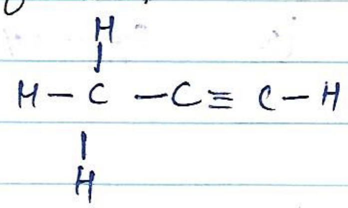
(ii) This hydrocarbon has a carbon-carbon triple bond in it is so it is unsaturated. Triple bond is indicated by 'yne'.

(iii) Join eth + yne = ethyne.

The common name of ethyne ($CH\equiv CH$) is acetylene.

(2) Naming of C_3H_4

C_3H_4



(or) $CH_3-C\equiv CH$

(i) This hydrocarbon has 3 carbon atom, so indicated by 'prop'

(ii) Triple bond is represented by 'yne'

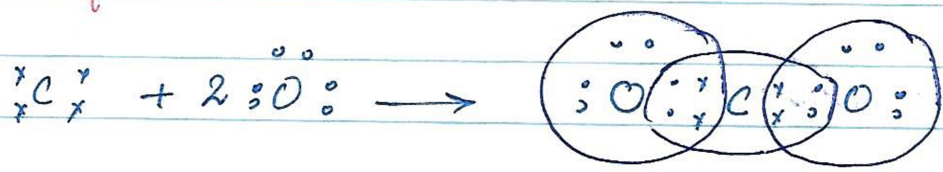
(iii) Join prop + yne = propyne.

The common name of propyne ($CH_3-C\equiv CH$) is methyl acetylene.

Question

(1) What would be the electron dot structure dioxide which has the formula CO_2?

ANS

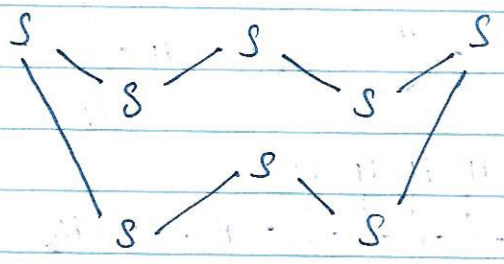


or O = C = O

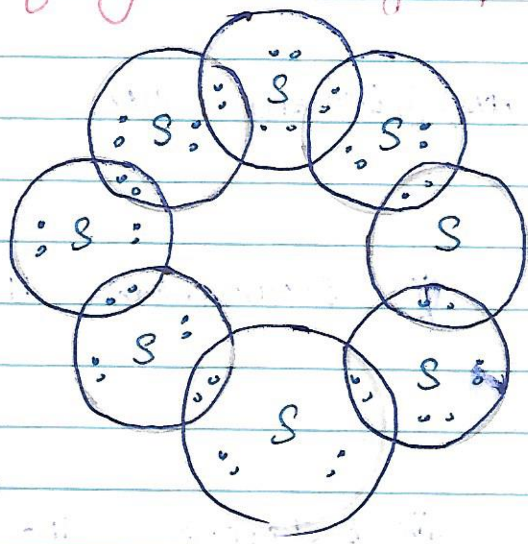
Valencies of C is 4 and O is 2.

(2) What would be the electron dot structure of a molecule of sulphure which is made up of eight atoms of sulphur?

ANS)

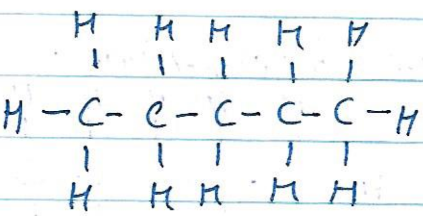


Sulphur(16) 2,8,6



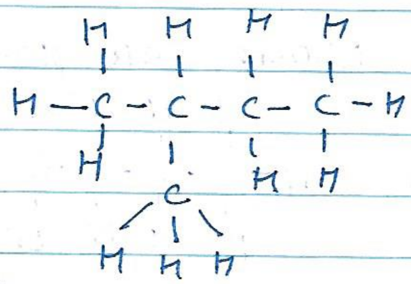
(3) How many structure isomers can you draw for pentane?

ANS) The five carbon atoms in pentane, C_5H_{12} can be arranged in three different ways to give three structure isomers:

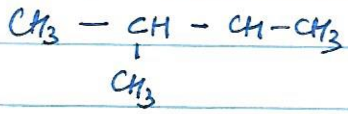


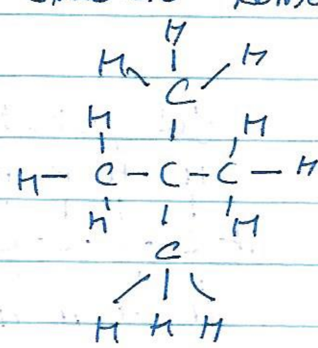
n-pentane

$CH_3-CH_2-CH_2-CH_2-CH_3$

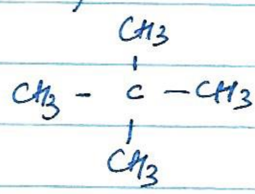


iso pentane





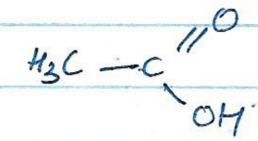
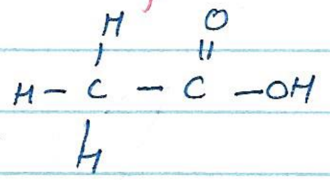
neo pentane

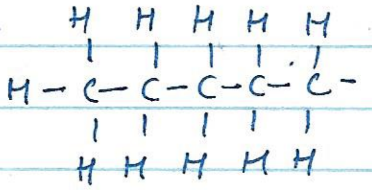


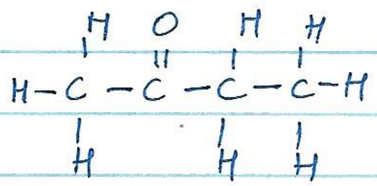
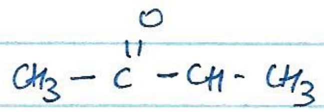
(4) What are the two properties of carbon which lead to the huge number of carbon compounds we see around us?

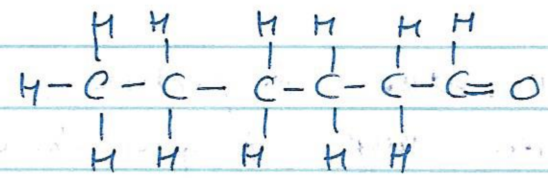
Ans - Refer to notes.

(5) Draw the structure for the following compounds :
(i) Ethanoic acid (ii) Bromopentane (iii) Butanone
(iv) Hexanal
Are structural isomers possible for bromopentane?

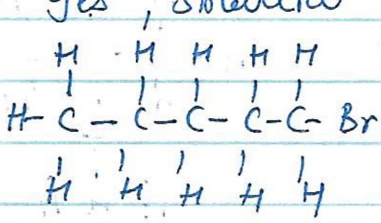
Ans) (i) Ethanoic acid  (or) 

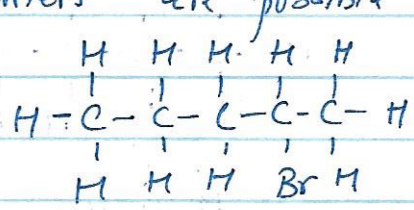
(ii) Bromopentane  (or) $CH_3-CH-CH-CH-CH-Br$

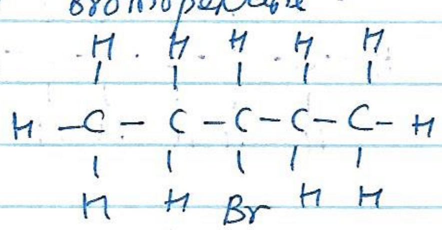
(iii) Butanone  (or) 

(iv) Hexanal 

Yes, structural isomers are possible for bromopentane.

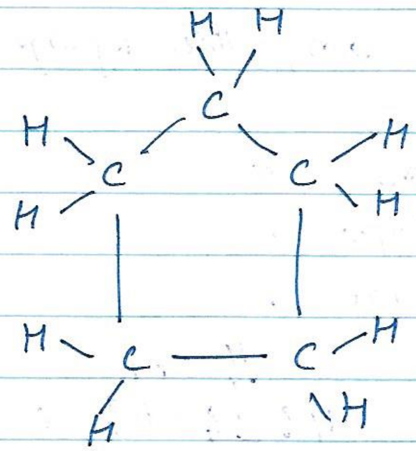

(1, Bromopentane)


(2, Bromopentane)

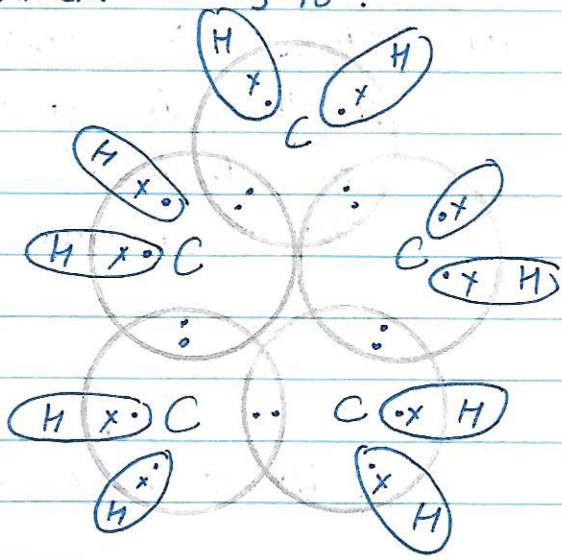

(3, Bromopentane)

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

ANS) The molecular formula of cyclopentane is C_5H_{10}.



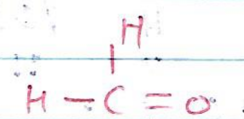
Structural formula
C_5H_{10}

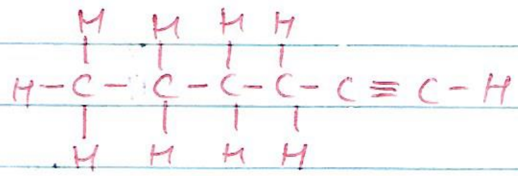


Electron dot structure
C_5H_{10}.

7) What are the names of following compound:

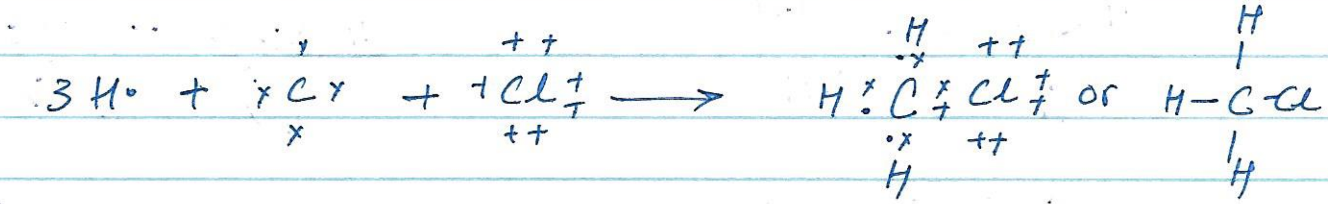
(i) $CH_3 - CH_2 - Br$ Bromoethane or ethyl bromide

(ii)  Methanal or formaldehyde.

(iii)  Hexyne.

(8) Explain the nature of covalent bond using the bond formation in CH_3Cl.

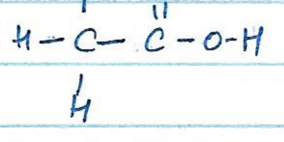
Ans) CH_3Cl is chloromethane.
It is made up of one carbon atom, three Hydrogen and one chlorine.
No. of valence electrons : carbon - 4
Hydrogen - 1
Chlorine - 7

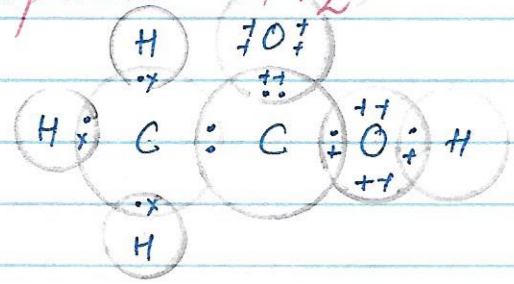


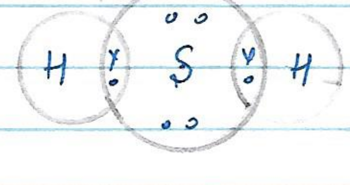
Each atom in CH_3Cl has a nobble gas electron arrangement.

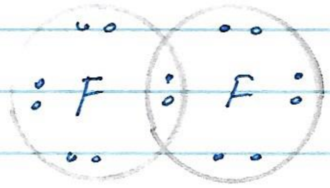
Chloromethane contain three C-H and one C-Cl covalent bonds.

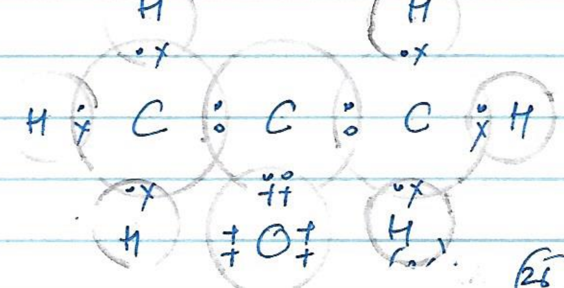
9) Draw the electron dot structures for :
(a) ethanoic acid (b) H_2S (c) propanone (d) F_2

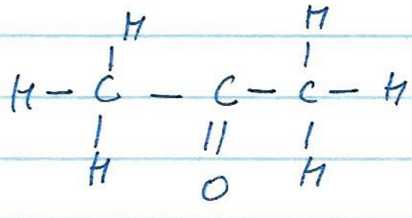
Ans) (a) ethanoic acid: 



(b) H_2S 

(d) F_2 

(c) 



Chemical Properties of Carbon Compounds

(1) Combustion:

"The process of burning of a carbon compound in air to give carbon dioxide, water, heat and light, is known as combustion."

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

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

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

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

The saturated hydrocarbons (alkanes) generally burn in air with a blue, non-sooty flame.

The unsaturated hydrocarbons (alkenes and alkynes) burn in air with a yellow, sooty flame (producing black smoke).

But if unsaturated hydrocarbons are burned in pure oxygen, then they will burn completely producing a blue flame (without any smoke at all).

The gas stove (and kerosene stove) used in our homes have tiny holes (or inlets) for air so that sufficient oxygen of air is available for the complete burning of fuel to produce a smokeless blue flame.

If the bottom of the cooking utensils in our homes are getting blackened, it shows that the air holes of the gas stove (or kerosene stove) are getting blocked and the fuel is not burning completely.

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

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

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

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

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

$$C + O_2 \longrightarrow CO_2 + Heat$$

$$CH_4 + 2O_2 \longrightarrow CO_2 + H_2O + Heat$$

Oxidation

The addition of oxygen to a substance is called oxidation and removal of hydrogen from a substance is also called oxidation.

Substances which are capable of adding oxygen to others are called as oxidising agent.

following reaction in which alcohols are converted to carboxylic acids :-

$$CH_3-CH_2OH \xrightarrow[\text{or acidic } K_2Cr_2O_7 + \text{Heat}]{\text{Alkaline } KMnO_4 + \text{Heat}} CH_3COOH$$

Alkaline potassium permanganate or acidic potassium dichromate are oxidising alcohols to acids, that is, adding oxygen to the starting material. Hence they are known as oxidising agents.

Addition Reaction

The reaction in which an unsaturated hydrocarbon combines with another substance to give a single product is called an addition reaction.

Addition reactions (like the addition of hydrogen, chlorine or bromine) are a characteristic property of unsaturated hydrocarbons. Addition reactions are given by all the alkenes and alkynes.

Unsaturated hydrocarbon add hydrogen in the presence of catalysts such as palladium or nickel to give saturated hydrocarbon. Catalysts are substances that causes a reaction to occur or proceed at a different rate without the reaction itself being affected.

Addition Reaction of Ethene with Hydrogen:

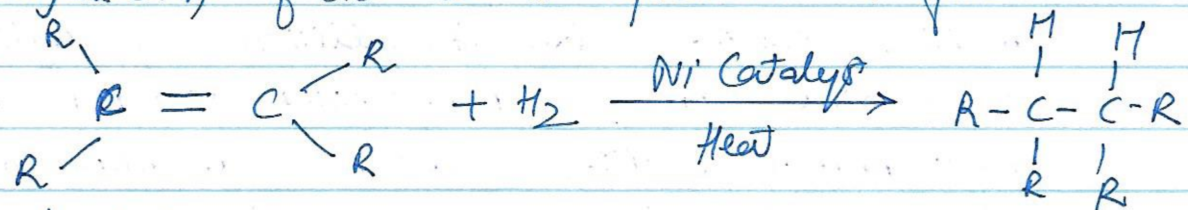
$$\underset{\substack{\text{Ethene} \\ \text{(Unsaturated)}}}{CH_2 = CH_2} + \underset{\text{Hydrogen}}{H_2} \xrightarrow[\text{Heat}]{\text{Ni Catalyst}} \underset{\substack{\text{Ethane} \\ \text{(Saturated)}}}{CH_3 - CH_3}$$

In above reaction, one H atom adds to each C atom of ethene due to which the double bonds open up to form a single bond in ethene.

The addition of hydrogen to an unsaturated hydrocarbon to obtain a saturated hydrocarbon is called hydrogenation. The process of hydrogeneration takes place in the presence of nickel or palladium metals as catalyst.
It is used to prepare vegetable ghee (vanaspati ghee) from vegetable oils.

Oils containing unsaturated fatty acids should be chosen for cooking.

Hydrogenation of oils can be represented as follows:



Vegetable Oil
(Unsaturated fat)
(Liquid State)

Vegetable Ghee
(Saturated fat)
(Solid State)

Properties of Ethanol

Physical Properties of ethanol:

(i) Ethanol is a colourless liquid having a pleasant smell and a burning taste.
(ii) Ethanol is a liquid at room temperature.
(iii) Ethanol is lighter than air.
(iv) Ethanol is miscible with water (Good Solvent)
(v) Ethanol is a covalent compound.
(vi) Ethanol has no effect on litmus solution.

Ethanol is commonly called alcohol and is the active ingredient of all alcoholic drinks.

Since it is good solvent, it is also used in medicines such as tincture iodine, cough syrups, and many tonics.

Reactions of Ethanol:

(i) Reaction with Sodium:

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

(Sodium ethoxide)

Alcohols react with sodium leading to the evolution of hydrogen. With ethanol, the other product is sodium ethoxide

(ii) Reaction to give unsaturated hydrocarbon:

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

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

The concentrated sulphuric acid can be regarded as a dehydrating agent which removes water from ethanol.

Properties of Ethanoic acid:

- Ethanoic acid is commonly called acetic acid and belongs to a group of acids called carboxylic acids.

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

- The melting point of pure ethanoic acid is 290 K and hence it often freezes during winter in cold climates. This gave rise to its name glacial acetic acid.

Physical properties of ethanoic acid:

(i) It is a colourless liquid
(ii) It is sour in taste
(iii) It has a characteristic smell
(iv) It is soluble in water.

Reactions of ethanoic acid :

(i) Esterification reaction :

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

$$CH_3COOH + C_2H_5OH \xrightarrow[\text{(catalyst)}]{\text{Conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$$

(Ethanoic Acid) (Ethanol) (Ester)

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

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

(ii) Reaction with a base:

Like minerals acids, ethanoic acid reacts with a base such as sodium hydroxide to give a salt (sodium ethanoate or commonly called sodium acetate) and water :

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

(iii) Reaction with carbonates and hydrogencarbonates:

Ethanoic acid reacts with carbonates and hydrogencarbonates to give rise to a salt, carbon dioxide and water. The salt produced is commonly called sodium acetate.

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

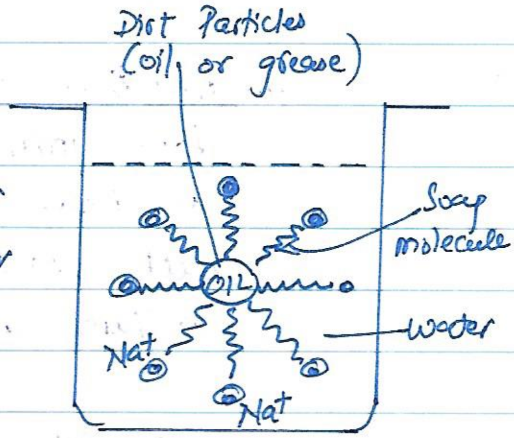
$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + H_2O + CO_2$$

SOAPS AND DETERGENTS

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

Cleansing action of soaps:

A soap molecule consists of two dissimilar parts:



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

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

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

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

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

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

Q) Why are detergents better cleansing agents than soaps?

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

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

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

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