CARBON AND ITS COMPOUNDS

TOPIC 1

COVALENT BONDING IN CARBON

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

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

Most carbon compounds are poor conductors of electricity and have low boiling and melting points, from which it can be concluded that the forces of attraction between these molecules are not very strong. Since these compounds are largely non conductors of electricity, we can conclude that the bonding in these compounds does not give rise to any ions.

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

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

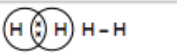
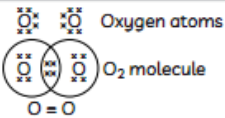
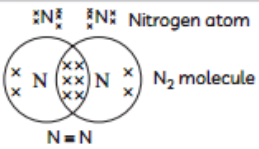
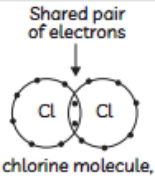
(2) It could lose four electrons forming C^{4+} cation. But a large amount of energy would be required to remove four electrons leaving behind a carbon cation with six protons in its nucleus holding on to just two electrons.

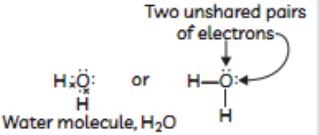
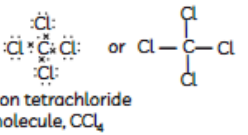
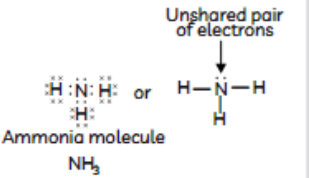
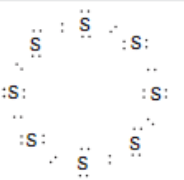
Carbon overcomes this problem by sharing its valence electrons with other atoms of carbon or with atoms of other elements. Apart from carbon, there are many other elements also which form molecules by sharing electrons in this manner. The shared electrons 'belong' to the outer shells of both the atoms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

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

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

Some Examples of Covalent Compounds

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

Water (H_2O)	Here, one atom of oxygen shares its two electrons with two hydrogen atoms.	
Carbon Tetrachloride (CCl_4)	The carbon atom shares its four valence electrons with four chlorine atoms to form carbon tetrachloride molecule.	
Ammonia (NH_3)	One atom of nitrogen shares its three valence electrons with three hydrogen atoms and forms ammonia molecule.	
Sulphur molecule (S_8)	A sulphur atom has 6 valence electrons. Eight sulphur atoms combine by sharing two electrons among themselves to form a ring like structure.	

Properties of Covalent Compounds

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

Differences between Ionic Bond and Covalent Bond

S.No.	Ionic Bond	Covalent Bond
(1)	An ionic bond is a chemical bond between two dissimilar (i.e. a metal and a non-metal) atoms in which one atom gives up an electron to another.	In a covalent bond the two atoms come together to share the electron, instead of an atom taking an electron from another
(2)	An ionic bond is formed between a metal and a non-metal.	A covalent bond is formed between two non-metals that have similar electronegativities.
(3)	Molecules have no definite shapes, as they have lattice structures	Molecules have a definite shape.
(4)	Electrical and thermal conductivity is high	No electrical conductivity but thermal conductivity is usually low

S.No.	Ionic Bond	Covalent Bond
(5)	Usually high melting point	Lower melting point
(6)	Usually highly soluble in water	Lower solubility
(7)	Usually solids at room temperature	Exists as solids, liquids, gases

Allotropes of Carbon

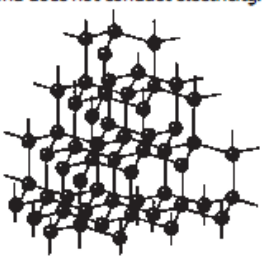
The various physical forms in which an element can exist are called allotropes of the element. Carbon exists in three solid forms called allotropes. The three allotropes of carbon are:

(1) Diamond
(2) Graphite
(3) Fullerenes

Diamond

(1) Diamonds are colourless, transparent, sparkle and reflect light, which is why they are described as lustrous.
(2) It is extremely hard and has a high melting point.
(3) It does not conduct electricity.

Structure of diamond: Diamond is one giant molecule of carbon atoms. Every atom in a diamond is bonded to its neighbours by four strong covalent bonds, leaving no free electrons and no ions. This explains why diamond does not conduct electricity.



The Structure of Diamond

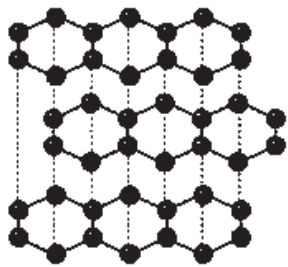
Uses of diamond:

(1) Diamond is used in cutting instruments like glass cutters and in rock drilling equipment, as it is extremely hard.
(2) Diamonds are used for making jewellery.
(3) Sharp-edged diamonds are used by eye-surgeons as a tool to remove cataract.

Graphite

(1) Graphite is black, shiny and opaque.
(2) It is a very slippery material.
(3) Graphite is insoluble in water.
(4) It has a high melting point and is a good conductor of electricity, which makes it a suitable material for the electrodes needed in electrolysis.

Structure of graphite : Graphite contains layers of carbon atoms.In graphite, each carbon atom is bonded to three other carbon atoms in the same plane giving a hexagonal array. One of these bonds is a double-bond, and thus the valency of carbon is satisfied. Graphite structure is formed by the hexagonal arrays being placed in layers one above the other.



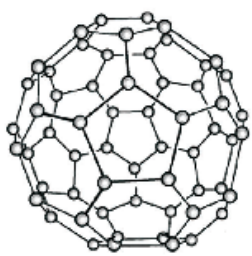
The Structure of Graphite

Uses of graphite:

(1) Powdered graphite is used as a lubricant for the fast moving parts of machinery.
(2) It is used for making electrodes in dry cells and electric arcs as it is a very good conductor of electricity.
(3) It is used for making core of pencils called 'pencil leads'.

Fullerenes

Fullerenes form another class of carbon allotropes. The first one to be identified was C-60 which has carbon atoms arranged in the shape of a football. Since this looked like the geodesic dome designed by the US architect Buckminster Fuller, the molecule was named fullerene.



Structure of C-60 Buckminster Fullerene

MOST LIKELY Questions

Short Answer Type-I Questions (SA-I)

[2 marks]

1. Which one of Sodium chloride (NaCl) and ethyl chloride (C_2H_5Cl) gas higher melting and boiling point and why?

Ans. Sodium chloride (NaCl). NaCl is an ionic compound and has strong inter-ionic forces so its melting and boiling points are higher whereas ethyl chloride (C_2H_5Cl) is a covalent compound and the force of attraction between the molecules are not very strong.

Short Answer Type-II Questions (SA-II)

[3 marks]

2. Why is carbon considered to be the most important element? Name two carbon compounds, which we use in our day to day life are made up of compounds of carbon.

Ans. Carbon is considered to be the most important element because if forms largest number of compounds which are useful in our daily life. The carbon compounds made up of compounds of carbon which we use in our day to day life are: Wooden furniture, newspapers, books, magazines, soaps, detergents, medicines, vitamins most of the food items, etc. (Any two).

TOPIC 2

VERSATILE NATURE OF CARBON

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

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

Catenation

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

Tetravalency

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

Strong Bonds due to Small Atomic Size

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

MOST LIKELY Questions

Short Answer Type-I Questions (SA-I)

[2 marks]

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

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

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

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

Example of compounds formed by carbon:

(1) Methane (CH_4)

(2) Ethene (C_2H_4)

(3) Propyne (C_3H_4)

(4) Ethanol (C_2H_5OH)

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

Related Theory

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

Short Answer Type-II Questions (SA-II)

[3 marks]

4. What is allotropy? Name the allotrope of carbon which is used:

(a) for making cores of lead pencils.

(b) in making expensive jewellery.

Ans. When an element has two or more different forms in the same state, they are called allotropes and the phenameno is known as allotropy.

The allotrope of carbon which is used:

(a) for making cores of lead pencils is graphite.

(b) in making expensive jewellery is diamond

Case Based Questions

[4 marks]

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

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

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

Identify the covalent compounds from the table given above.

(B) Whats is the percentage of carbon in earth's crust and in the atmosphere?

(C) Justify the following statements:

(i) As compared to ionic compounds, covalent compounds have low melting and boiling point

(ii) Covalent compounds are formed by sharing of electrons between its atoms.

Ans. (A) And B are covalent compounds.

Explanation: The melting and boiling point of ionic compounds is very high as they have strong forces of attraction between the oppositely charged ions. Whereas, covalent compounds have comparatively low melting and boiling point due to the weak forces of attraction between the atoms.

(B) Percentage of carbon in Earth's crust : 0.02%; Percentage of carbon in Almosphere : 0.03%.

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

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

(ii) When atoms share electron pairs, covalent bonds are formed. In order to gain stability, atoms will covalently bond with other atoms to form a complete electron shell.

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

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

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

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

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

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

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

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

(B) The bonds formed by carbon with other elements are strong as the size of carbon atom is quite small which enables its nucleus to hold on to the shared pairs of electrons strongly.

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

(ii) Catenation is the property of carbon element due to which its atoms can join or link with one another to form long carbon chains.

An element other than carbon which exhibits catenation is silicon.

TOPIC 3

HYDROCARBONS

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

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

(1) Saturated hydrocarbons

(2) Unsaturated hydrocarbons

Saturated Hydrocarbons or Alkanes

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

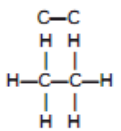
(2) The general formula of saturated hydrocarbons are alkanes is C_nH_{2n+2}, where *n* is the number of carbon atoms in one molecule. The first few alkanes are methane (CH_4), ethane (C_2H_6) and propane (C_3H_8).

(3) The saturated hydrocarbons are not very reactive.

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

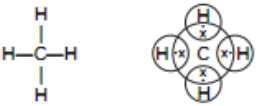
Structure of Saturated Hydrocarbons

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

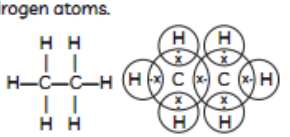


Methane: The simplest alkane is methane (CH_4). Hydrogen has a valency of 1. As carbon has four valence electrons, carbon shares these electrons with four atoms of hydrogen in order to achieve noble gas configuration.

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



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



Unsaturated Hydrocarbons (Alkenes and Alkynes)

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

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

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

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

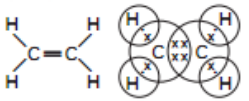
(6) These are more reactive than saturated hydrocarbons due to presence of double and triple bonds which are the sites of chemical reactivity.

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

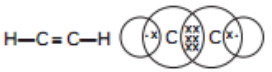
Structure of Unsaturated Hydrocarbons

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

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



Ethyne–The simplest alkyne: The simplest alkyne is ethyne having two carbon atoms and its molecular formula is C_2H_2. There is a triple bond between the two carbon atoms and two single bonds between carbon and hydrogen atoms.



Chains, Branches and Rings

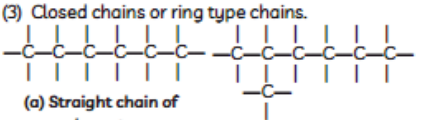
Carbon atoms can form long 'chains' containing tens of carbon atoms.

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

(1) Straight chains

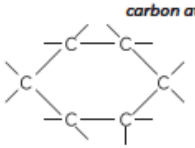
(2) Branched chains

(3) Closed chains or ring type chains.



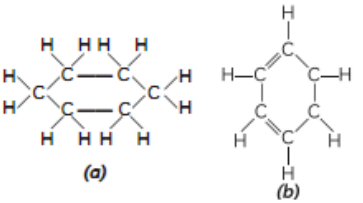
(a) Straight chain of carbon atoms

(b) Branched chain of carbon atoms



(c) Closed chain of carbon atoms

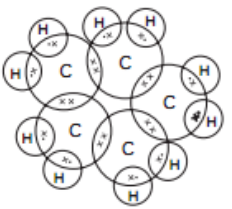
Some compounds have carbon atoms arrangedin the form of a ring as in the case of cyclohexane (C_6H_{12}). Its structure is shown below. Similarly, the structure of benzene (C_6H_6) is also shown alongside:



(a) (b)

Benzen —C_6H_6

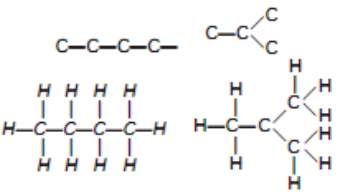
Electron dot structure:



Structural Isomerism

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

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



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

MOST LIKELY Questions

Short Answer Type-I Questions (SA-I)

[2 marks]

7. Which oils should be chosen for cooking to remain healthy?

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

8. Two carbon atoms cannot be linked to each other by more than three covalent bonds. Why?

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

Short Answer Type-II Questions (SA-II)

[3 marks]

9. The molecular formulae of some hydrocarbons are given below: C_3H_4, C_3H_6 and C_3H_8.

(A) Which out of three is a saturated compound and why?

(B) Which out of three is/are reactive and why?

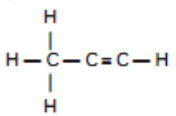
Ans. (A) Out of three C_3H_4, C_3H_6 and C_3H_8, the saturated hydrocarbons is C_3H_8.

C_3H_8 corresponds to the general formula of alkanes (K_nH_{2n+2}), where n = 3. Therefore, it is a saturated hydrocarbon. Whereas C_3H_4 corresponds to the general formula of alkynes (C_nH_{2n-2}) and C_3H_6 corrsponds to the general formula of alkene C_nH_{2n}) and hence C_3H_4 and C_3H_6 are unsaturated compounds.

(B) The compounds of carbon having double or triple bonds between the carbon atoms are unsaturated compounds and are more reactive than the saturated compounds.

Thus, C_3H_4 and C_3H_6 are more reactive as they contain triple and double bonds respectively.

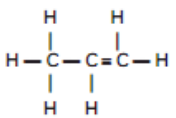
Explanation:



C_3H_4

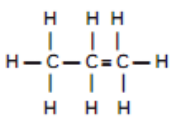
Alkyne (Propyne)

(a)



Alkene (Propene)

(b)



Alkene (Propene)

(c)

Case Based Questions

[4 marks]

10. *Hydrocarbons are a broad group of chemicals that contain hydrogen and carbon atoms. They can be saturated or unsaturated. They are found in every home.*

Hydrocarbons are very important for the modern economy. Globally, hydrocarbons are responsible for roughly 85% of energy consumption. This figure may actually understate the role of hydrocarbons in the economy by a significant margin because they are used in a wide range of applications aside from their use as a source of energy.

This is just a partial list of hydrocarbon containing products.

Cosmetics – Baby, hair and bath oils; sunscreen; nail enamel dryers and makeup removers.

Cleaning Products – Cleaners, spot remover and liquid furniture polish.

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

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

(B) Which hydrocarbon which is the main component of natural gas ?

(C) Two students recorded their observations on the difference in reactivities of butane and butene. What is the difference between their reactvities? Give reason for your answer.

Ans. (A) Saturated hydrocarbons are the compounds of carbon and hydrogen which have a single covalent bond between two carbon atoms. These are also known as alkanes and have the general formula given by C_nH_{2n+2}, where n is the number of carbon atoms.

The first five members of the alkanes is given in the following table:

Name	Molecular Formula
Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}
Pentane	C_5H_{12}

(B) Methane is the main component of natural gas and is a naturally occurring hydrocarbon gas mixture consisting primarily of methane, but commonly including varying amounts of other higher alkanes, and sometimes a small percentage of carbon dioxide, nitrogen, hydrogen sulpride, or helium.

(C) Butane is a saturated hydrocarbon having molecular formula C_4H_{10} and structural formula CH_3-CH_2-CH_2-CH_3.

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

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

TOPIC 4

FUNCTIONAL GROUPS

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

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

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

Important Functional Groups

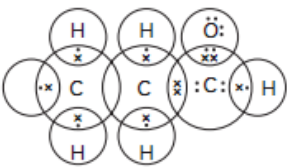
Some important functional groups are given in the Table below.

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

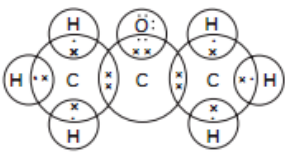
Hetero Atom	Functional Group	Formaula of Functinal group
Cl/Br	Halo-(Chloro/ bromo)	—Cl, —Br (substitutes for hydrogen atom
Oxygen	(1) Alcohol	—OH
	(2) Aldehyde	
	(3) Ketone	
	(4) Carboxylic acid	

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

Electron Dot Structure of Propanal



Electron Dot Structure of Propanone



Some More Examples of Functional Groups

Formula of Functional Group	Name of Functional Group	Formula of Compound Containing Functional Group	IUPAC name of Compound
- OH (ROH)	Alcoholic	CH_3OH	Methanol
		C_2H_5OH	Ethanol
		C_3H_7OH	Propanol
		C_4H_9OH	Butanol
- CHO (HCHO or RCHO)	Aldehydic	HCHO	Methanal
		CH_3CHO	Ethanal
		CH_3CH_2CHO	Propanal
		$CH_3CH_2CH_2CHO$	Butanal

Formula of Functional Group	Name of Functional Group	Formula of Compound Containing Functional Group	IUPAC name of Compound
>C=O (RCOR')	Ketonic	CH_3COCH_3	Propanone
		$CH_3COCH_2CH_3$	Butanone
		$CH_3COCH_2CH_2CH_3$	2-pentanone
		$CH_3COCH_2CH_2CH_2CH_3$	2-hexanone
-COOH (HCOOH or RCOOH)	Carboxylic acid	HCOOH	Methanoic acid
		CH_3COOH	Ethanoic acid
		C_2H_5COOH	Propanoic acid
		C_3H_7COOH	Butanoic acid
-X	Halogen	CH_3Cl	Chloromethane
		CH_3Br	Bromomethane
		C_2H_5I	Iodoethane
		C_3H_7Br	Bromopropane
$-NH_2$	Amine	CH_3NH_2	Methanamine
		$C_2H_5NH_2$	Ethanamine
$-NO_2$	Nitro	CH_3NO_2	Nitromethane
		$C_2H_5NO_2$	Nitroethane
-COOR	Ester	$HCOOCH_3$	Methyl methanoate
		$HCOOC_2H_5$	Ethyl methanoate
		CH_3COOCH_3	Methyl ethanoate
		$CH_3COOC_2H_5$	Ethyl ethanoate

MOST LIKELY Questions

Short Answer Type-I Questions (SA-I)

[2 marks]

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

(A) $CH_3COCH_2CH_2CH_2CH_3$

(B) $CH_3CH_2CH_2COOH$

(C) $CH_3CH_2CH_2CH_2CHO$

(D) CH_3CH_2OH

Ans. (A) $CH_3COCH_2CH_2CH_2CH_3$ – Ketone (>C=O)

or $-\overset{\overset{O}{\|}}{C}-$

(B) $CH_3CH_2CH_2COOH$ – Carboxylic acid (—COOH) or

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

(C) $CH_3CH_2CH_2CH_2CHO$ – Aldehyde (—CHO)

or $-\overset{\overset{O}{\|}}{C}-H$

(D) CH_3CH_2OH – Alcohol (—OH)

Short Answer Type-II Questions (SA-II)

[3 marks]

12. Two non-metals A having atomic number 7 and B having atomic number 1 combine with each other by sharing of electrons to form compounds C.

(A) What is the nature of compound C?

(B) Will it dissolve in water or organic solvents?

(C) Will it be a good or bad conductor of electricity?

Ans. (A) The nature of compound C is covalent.

(B) Covalent compounds do not dissolve in wear but are soluble in organic solvents hence it is soluble in organic solvents.

(C) Covalent compounds do not conduct electricity so compound C is a bad coductor of electricity.

TOPIC 5

HOMOLOGOUS SERIES

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

Characteristics of Homologous Series

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

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

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

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

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

MOST LIKELY Questions

Short Answer Type-I Questions (SA-I)

[2 marks]

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

(A) C_2H_4 **(B) C_4H_6**

Ans. (A) C_3H_6

(B) C_5H_8

Related Theory

- *A series of compounds in which the same functional group substitutes for hydrogen in a carbon chain is called homologous series.*
- *The homologue of C_2H_6 is C_3H_6 which differs by —CH_2 unit and molecular mass 14 u (1 × 12 + 2 × 1)*
- *As the molecular mass increases is any homologous series, a gradation in physical properties (like melting pouts, boiling points) is seen.*
- *The chemical properties remain similar in a homologous series.*

Case Based Questions

[4 marks]

14. *A strong force of attraction fitting atoms together in a molecule or crystal which is formed by either sharing or transfer of electrons. Carbon is an important element which is known to have the unique ability to form bonds with other similar atoms or atoms of other elements. In this way carbon forms a large number of carbon compounds. The number of carbon compounds whose formulae are known to chemists was recently estimated more than millions.*

(A) What type of chemical bond is found between carbon-carbon atoms and how is this formed?

(B) Why carbon forms a large number of compounds?

(C) (i) Why are the compounds formed by carbon are stable?

(ii) Which atom of an element has the ability to form bonds with other atoms of the same element other than carbon?

Ans. (A) The type of chemical bond found between carbon – carbon atoms is **covalent bond** and is formed by **sharing of electrons.**

(B) Carbon forms a large number of compounds due to the following factors due to the following factors. Catenation and tetra valency.

(C) (i) The formation of strong bonds in the carbon compounds is due to the small size of carbon. Due to its small size, the nucleus holds the shared pairs of electrons strongly.

(ii) Silicon has the ability to form bonds with other atoms Si–Si bonds are comparatively whether than carbon due to its large size.

15. *Carbon atoms can be linked together to form chains of varying length. These chains can be branched also. In addition, hydrogen atom or other atoms of these carbon chains can be replaced by some other elements also called hetero atoms or a group of elements. The heteroatoms or a group containing these confer specific to these compounds.*

Look at the given table and find out the difference in the formulae and molecular mass.

Formula	Hydrocarbon
C_2H_4	Ethene
C_3H_6	Propene
C_4H_8	Butene
C_5H_{10}	Pentene

(A) Write the successive homologue of C_2H_5OH.

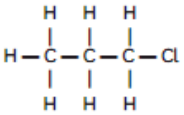
(B) Carbon also forms bonds with other elements like halogens, oxygen, nitrogen and sulphur. Write the formula of a hydrocarbon having halogen (–Cl).

(C) (i) What is the general formula of an homologous series of alcohols?

(ii) What is the importance of hetero atoms and functional groups?

Ans. (A) The next homologue of C_2H_5OH is C_3H_7OH.

(B) The formula of C_3H_8 with halogen (–Cl) would bl C_3H_7Cl.



(C) (i) The general formula of the homologous series of alcohols is R —OH

Explanation: R is alkyl group or C_nH_{2n+1}

Where n = 1, 2, 3, 4 .....

(ii) Hetero atoms and functional groups impart specific properties to the molecules.