

CARBON AND ITS COMPOUNDS

Gist of the Lesson:

Versatility of Carbon: Carbon is known metal and occurs in free as well combined state in nature.

Free State: Diamond, graphite and coal.

Combined State:

1. **Solid state:** All animals and plants products.
2. **Liquid state:** Petroleum and vegetable oil.
3. **Gaseous state:** In air has CO_2 .

Carbon has 4 valence electrons carbon can form an anion C^{-4} by gain of electrons. It can also form of actions C^{+4} by loss of electron. It can share its balanced electrons with other carbon atoms or atoms of non metal and forms covalent bonding. Compounds of carbon: Simplest compounds of carbon are hydro carbon and simplest hydro carbon is methane.

Classification of hydro carbon:

Saturated hydro carbon:

Unsaturated hydro carbon:

$(\text{C}_n\text{H}_{2n+2})$ Compounds having single bond compounds hydro having double and triple bonds.

ALKANES

e.g

ethane (C_2H_6)

ALKENES AND ALKYNES.

alkenes(C_nH_{2n})

Ehene C_2H_4

alkynes. ($\text{C}_n\text{H}_{2n-2}$)

Ethyne C_2H_2

S.No.	Hydro Carbons	Definitions	Examples
1	Straight chain	All carbons are in form of straight chain	Butane
2	Branched Chain	One or more carbon atoms are attached to main straight Chain	Isobutane.
3	Right or cycle hydro carbon	Carbon atoms are in form of ring and bonded by single covalent bond.	Cyclohexane
a	Saturated	Carbon atoms are bonded by one or more double covalent bond.	Benzene
b	Unsaturated		

- **Isomerism:** The phenomenon of existence of compounds in two or more forms with same molecular formula but different structure.(Example-Glucose and Fructose)
- **Functional Group:** An atom or groups of atoms which makes a carbon compounds reactive and decide its properties.

S.No.	Hetero atoms	Functional groups	Formula of functional group	Example
1.	Cl/Br	Halo-	-Cl, -Br	Chloromethane (CH ₃ Cl)
2.	Oxygen	1. Alcohol 2. Aldehyde 3. Ketone 4. Carboxylic acid	-OH -CHO >C=O -COOH	Ethanol C ₂ H ₅ OH Methanal HCHO Propanone CH ₃ COCH ₃ Ethanoic acid CH ₃ COOH

- **Homologous Series:** A series of compounds in which the same functional group substitutes for hydrogen in a carbon chain, such that successive compounds differ by CH₂ groups.

E.g CH₄, C₂H₆, C₃H₈ etc.

Nomenclature of Carbon Compounds:

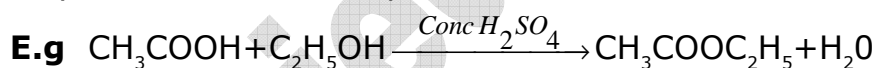
Prefix word root+suffix+Functional group.

Carbon Compounds:

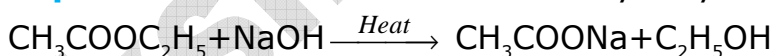
ETHANOL -C₂H₅OH common name ethyl alcohol

ETHANOIC ACID- CH₃COOH. Common name acetic acid.

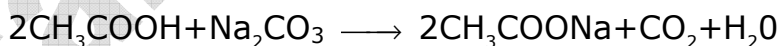
Esterification Reaction: The reaction between carboxylic acid and an alcohol in the presence of con. Sulphuric acid to form a sweet smelling substance ester.



Saponification Reaction: Alkaline hydrolysis of ester produces soaps.



Reaction with carbonates and hydrogen carbonates: Reaction of ethanoic acid with carbonates or bi carbonate evolves carbondioxide gas.



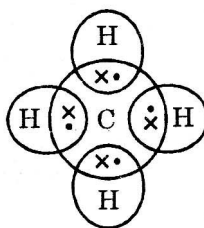
Soap and Detergent: Soap is sodium and potassium salts of long chain of carboxylic acid .They form lather with soft water only.

Detergents are ammonium or sulphonate salts of long chain carboxylic acid they even produce lather and remain effective in hard water.

One Mark Questions (One word or one sentence)

1. Draw the electron dot and cross structure of the main covalent compound present in Compressed Natural Gas (CNG)?

A. Methane (CH_4) is major component of CNG.



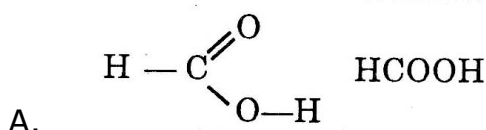
2. State the reason why covalent compounds are generally poor conductor of electricity?

A. The bonding of covalent compounds is formed by sharing their valence electrons between two atoms, so it does not give rise to any ions and thus such compounds are poor conductors of electricity.

3. Write molecular formula of alcohol which can be derived from butane?

A. $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{OH}$ (Butanol)

4. Draw the structural formula of methanoic acid?



5. Identify saturated hydrocarbons from the following compounds:



A. CH_4 and C_4H_{10} .

6. Write the name and structure of an aldehyde with four carbon atoms?

A. Butanal, $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CHO}$

7. Name the products obtained on complete combustion of ethoanol?

A. $\text{CH}_3\text{CH}_2\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O} + \text{Heat and light}$

8. Unsaturated hydrocarbon gives a yellow flame with lots of black smoke when burnt in oxygen. Give reason?

A. Unsaturated hydrocarbons burn with yellow sooty flame with lots of black smoke due to the presence of higher carbon content than hydrogen.

9. Give any two tests to identify whether a compound with formula $C_2H_4O_2$ is an acid?

- A. (a) (i) Litmus paper test: Blue Red.
 (ii) Production of brisk effervescence on treating with sodium bicarbonate, i.e., CO_2 gas is produced.

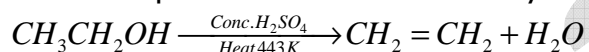
10. Write balanced chemical equation of the reaction of ethanoic acid with
(i) Sodium carbonate
(ii) Sodium hydrogen carbonate
(iii) Sodium hydroxide.

- A. (i) $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2 \uparrow$
 (ii) $CH_3COOH + Na_2HCO_3 \rightarrow CH_3COONa + CO_2 \uparrow + H_2O$
 (iii) $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

11. (i) State an example of dehydrating agent. Give a chemical reaction to illustrate this property?

(ii) Give a chemical test to distinguish between alcohol and carboxylic acid?

- A. (i) Conc. sulphuric acid acts as dehydrating agent.



- (ii) Carboxylic acid reacts with sodium hydrogen carbonate and effervescence is observed due to the evolution of CO_2 gas.



Alcohols do not react with $NaHCO_3$.

12. How can a carboxylic acid and an alcohol be distinguished using their chemical property? Write any three differences?

A.

S.No.	Test	Ethanol	Ethanol Acid
1.	Litmus test	Does not affect litmus paper	It turns blue litmus red.
2.	Reaction with $NaHCO_3$	It does not react.	Effervescence are observed due to the evolution of CO_2 gas.
3.	Added C_2H_5OH in presence of few drops of conc. H_2SO_4 and heated.	No reaction	Fruity smell is observed due to the formation of ester.

13. State the appropriate reason for the formation of scum by soap in water?

- A.** 1. Soap are sodium or potassium salts of fatty acids. They form scum with Ca^{2+} or Mg^{2+} ions present in hard water.
2. State the part of soap molecule that attaches itself to dirt when soap is dissolved in water.

Two Marks Questions (30 words)

1. C_3H_6 , C_4H_8 and C_5H_{10} belong to the same homologous series?

(i) Define homologous series.

(ii) Why the melting and boiling points of C_5H_{10} is higher than C_4H_8 ?

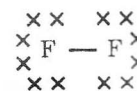
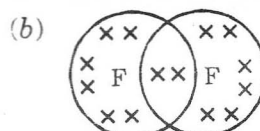
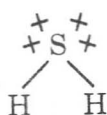
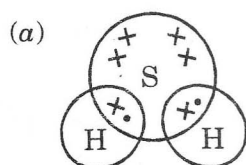
(iii) Arrange these hydrocarbons in order of increasing boiling points.

- A.** (i) The series of organic compounds in which same functional group substitutes for hydrogen in a carbon chain is called a homologous series. All consecutive members of the series differ by $-\text{CH}_2$ unit. Chemical properties remain the same and gradation in physical properties is seen.
(ii) Because molecular mass of C_5H_{10} molecule is more than C_4H_8 .
(iii) $\text{C}_3\text{H}_6 < \text{C}_4\text{H}_8 < \text{C}_5\text{H}_{10}$

Three Marks Questions (50 words)

1. Draw the electron dot structure for: (i) (a) H_2S , (b) F_2 .

(ii) What type of bond is present in F_2 ?



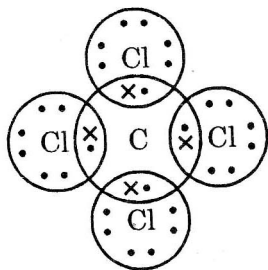
A. (i)

(ii) The bond in F_2 molecule is covalent in nature.

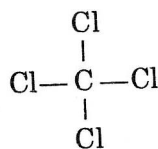
2. Explain how covalent bonds are formed. Mention two physical properties of covalt: - compounds. Draw electron dot structure of CCl_4 ?

A. When two atoms cannot achieve noble gas configuration by either gaining or losing electrons from the outermost shell, but they do so by sharing valence electron among both the atoms, covalent bond is formed.

- Two physical properties of covalent compounds are:
 - (i) They are generally poor conductors of electricity.
 - (ii) They have low boiling and melting points.
- Carbon has 4 valence electrons and chlorine has 7.



Or



3. Three organic compound A, B and C have the chemical formula HCHO, HCOOH and CH₃COCH₃. Write the names of functional group in A, B and C respectively?

A.

Organic Compound	Chemical Formula	Functional Group
A	HCHO	Aldehyde
B	HCOOH	Carboxylic acid
C	CH ₃ COCH ₃	Ketone

4. Give names of the following:

(a) An alcohol containing 4-carbon atoms.

(b) An acid with 5-carbon atoms

(c) Simplest ketone.

Define functional group in a carbon compound. Mention names of any four functional groups with their formulae.

A. (a) Butanol, (b) Pentanoic acid (c) Propan-2-one.

• An atom or group of atoms attached to the carbon chain by replacing one hydrogen atom or atoms and acts as a reactive site in the molecule, and decides the chemical properties of the compound, is called functional group.

S.No.	Functional Group	Formula
1.	Alcohol	-OH
2.	Aldehyde	-CHO
3.	Ketone	$\begin{array}{c} \text{---C---} \\ \\ \text{O} \end{array}$
4.	Carboxylic acid	$\begin{array}{c} \text{---C=O} \\ \\ \text{OH} \end{array}$

5. List three physical properties of covalent compounds and give reason for each?

- A. (a) Covalent compounds have low melting and boiling points because intermolecular forces are small.
 (b) Generally these are poor conductors of electricity because the electrons are shared between atoms and no charged particles are formed.
 (c) Generally covalent compounds dissolve in organic solvents i.e., ether, benzene etc. and not in water. It is because these compounds are non-polar and dissolve in non-polar solvents as 'like-dissolves like'.

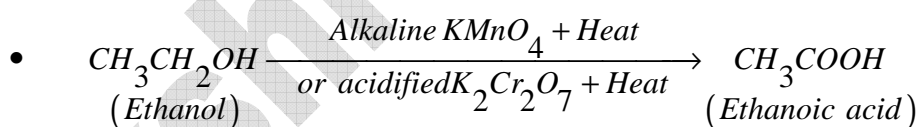
6. The general formula of three compounds A, B and C is C_nH_{2n} . B has highest boiling point and C has lowest boiling point.

- (i) Mention the type of compound A, B and C.**
(ii) Which of these has the minimum number of carbon atoms?
(iii) Name the homologous series to which A, B and C belong.

- A. (i) Unsaturated hydrocarbons with double bond.
 (ii) Compound 'C' has minimum number of carbon atoms.
 (iii) Alkene.

7. What are oxidizing agents? State two oxidizing agent. Write one chemical equation using oxidizing agent? (or) Define oxidizing agents. Explain its role in the oxidation of alcohols to acids. Write the oxidation reaction of ethanol?

- A. Substances which are capable of adding oxygen to others are known as oxidising agents.
- Alkaline potassium permanganate ($KMnO_4$) or acidified potassium dichromate ($K_2Cr_2O_7$) acts as an oxidising agent in oxidising alcohols into acids.



8. (a) What is saponification?
(b) Write chemical equation for a saponification reaction.
(c) In what way are detergents better than soaps?

- A. (a) Esters react in presence of an alkali to give back the alcohol and salt of carboxylic acid. This reaction is called saponification.
 (b) $CH_3COOC_2H_5 \xrightarrow{NaOH} CH_3COONa + C_2H_5OH$
 (c) Detergents do not form insoluble precipitates with the calcium and magnesium ions in hard water.

9. What are synthetic detergents? Mention their uses?

- A.
- Synthetic detergents are ammonium or sulphonate salts of long chain carboxylic acids.
 - These can be conveniently used even in hard water, as these do not form curd white precipitate (scum) with hard water. Detergents are used to make shampoos and products for cleaning clothes.

Five Marks Questions (70 words)

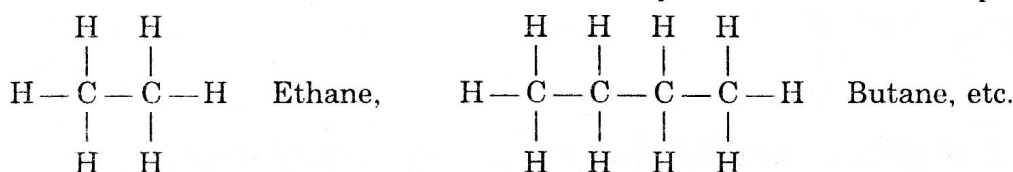
1. State the reason why carbon can neither form C⁴⁺ cations nor C⁴⁻ anions, but forms covalent compounds. Also state reasons to explain why covalent compounds:

- (i) Are bad conductors of electricity?
 (ii) Have low melting and boiling points? (Or)
Carbon does not form ionic compounds. Why?

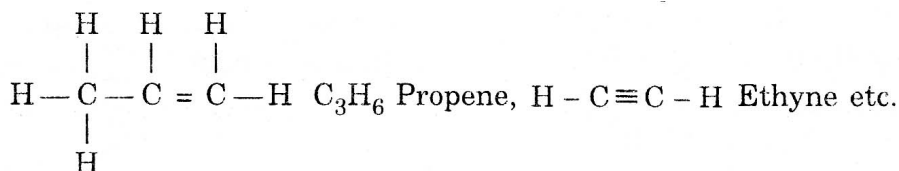
- A. Carbon can neither form C⁴⁺ cations nor C⁴⁻ anions, because:
- (a) To form C⁴⁻ anion, carbon must gain four electrons, but it would be difficult ' the nucleus having six protons to hold on to ten electrons i.e., four extra electrons.
- (b) To form C⁴⁺ cation, carbon must lose four electrons, but it would require a lar1 amount of energy to remove four electrons leaving behind a carbon cation with six protons in its nucleus holding on to just two electrons.
 So, it forms covalent compounds.
- (i) Covalent compounds are bad conductors of electricity, because the bonding in these compounds does not give rise to any ions.
- (ii) Covalently bonded molecules have strong bonds within the molecule, but intermolecular forces are small, so they have low melting and boiling points.

- 2. (a) What are hydrocarbons ? Give example.
 (b) Give the structural difference between saturated and unsaturated hydrocarbons with two examples each.
 (c) What is functional group? Write the names of functional group present in:
 (i) CH₃CH₂OH (ii) CH₃COOH**

- A. (a) Organic compounds having only carbon and hydrogen atoms are called hydrocarbons. For examples, methane (CH₄).
- (b) Those organic compounds of carbon and hydrogen atoms only, which contain only single bounds between carbon atoms, are called saturated hydrocarbons. For example,



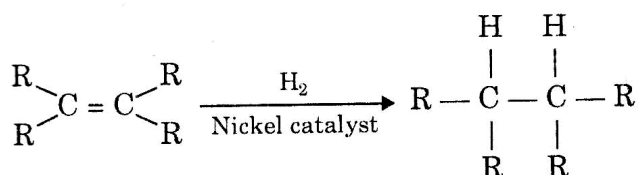
Those organic compounds which contain double or triple bond, between any two carbon atoms are known as unsaturated hydrocarbons. For example.



- (c) Functional group is defined as an atom or a group of atoms, present in a molecule which largely determines its chemical properties.
- In $\text{CH}_3\text{CH}_2\text{OH}$, functional group $-\text{OH}$ (Alcohol)
 - CH_3COOH , functional group is $-\text{COOH}$ (Carboxylic acid)

3. Describe the addition reaction of carbon compounds with its use. State the function of catalyst in this reaction?

- A. • Unsaturated hydrocarbons add hydrogen in the presence of catalysts such as palladium or nickel to give saturated hydrocarbons. Such reactions are called addition reactions.



- This reaction is commonly used in the hydrogenation of vegetable oils using a nickel catalyst. Vegetable oils generally have long unsaturated carbon chains while animal fats have saturated carbon chains.
- Animal fats generally contain saturated fatty acids -which are said to be harmful for health while some vegetable oils are healthy.
 - Catalysts are substances that cause a reaction to occur or proceed at a different rate without itself being affected.

4. (a) Why does carbon form compounds mainly by covalent bonding ?
 (b) List any two reasons for carbon forming a very large number of compounds.
 (c) An organic acid X is a liquid which often freezes during winter time in cold countries has formula $\text{C}_2\text{H}_4\text{O}_2$. On warming with ethanol in the presence of a few drops of concentrated sulphuric acid, a compound Y with a sweet smell is formed.
 (i) Identify X and Y.
 (ii) Write a chemical equation for the reaction involved.

- A. Carbon has atomic number 6 (2, 4) so it has four electrons in its outermost shell and needs to gain or lose four electrons to attain noble gas configuration. If it were to gain or lose electrons.

- (a) To form C^{4-} anion, it has to gain four electrons but it would be difficult for the nucleus with six protons to hold on to ten electrons that is four extra electrons.
- (b) To form C^{4+} cation, 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.

So, carbon completes its octet by sharing its valence electrons with other atoms of carbon or atoms of other elements to form covalent bonding.

- (b) Carbon forms a very large number of compounds due to
- (i) **Catenation:** Self-linkage of many carbon atoms in long chains of carbon, branched chains of carbon or even in rings with single, double or triple covalent bonds.
- (ii) **Tetravalency:** Carbon has a valency of four. It is capable of bonding with four other atoms of carbon, some other monovalent elements or oxygen, nitrogen, hydrogen, sulphur, chlorine etc. to form many compounds.
- (c) (i) 'X' is $CH_3 - COOH$ ethanoic acid.
'Y' is ethyl ethanoate, an ester $CH_3COOC_2H_5$.
- (ii) $CH_3COOH + CH_3CH_2OH \xrightarrow{Conc.H_2SO_4} CH_3COOC_2H_5 + H_2O$

5. Ethanol, ethanoic acid and soap solution are kept in three test tubes separately. Identify the compounds present in the different test tubes by chemical tests, using blue litmus, red litmus, and sodium metal?

A.

S.No	Test	Test Tube A	Test Tube B	Test Tube C
1.	Put blue litmus in all the three test tubes	No change	Turns red (Acidic in nature)	No change
2.	Put red litmus paper in test tubes	No change	No change	Turns blue (Basic in nature)
3.	Put sodium metal in all test tubes.	A gas is evolved which burn with pop sound. The gas is H_2 $2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2ONa + H_2 \uparrow$	Reacts to form a gas, H_2 , which burns with a pop sound.	No reaction

- Test tube A contains ethanol as it reacts with sodium metal but is neutral towards blue and red litmus paper.
- Test tube B contains ethanoic acid as it is acidic and reacts with sodium metal to evolve H_2 gas.
- Test tube C contains soap solution which is basic in nature.

