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CLASS X - SCIENCE

# CARBON AND ITS COMPOUNDS - I


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# PK HITS🔥

- IUPAC Naming
- Electron Dot Structure (Ethanol, Amine)
- Homologous Series (MCQs)
- Important Reactions:
- Esterification
- Saponification
- Dehydration of Ethanol
- Working of Soap (diagram)

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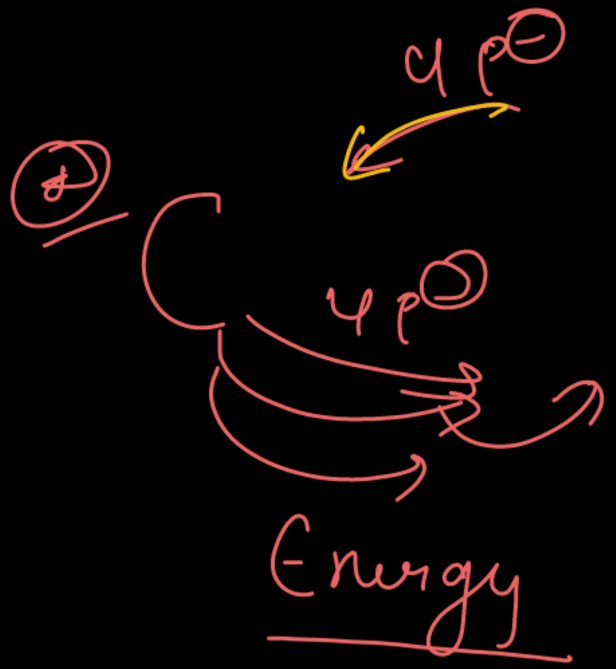
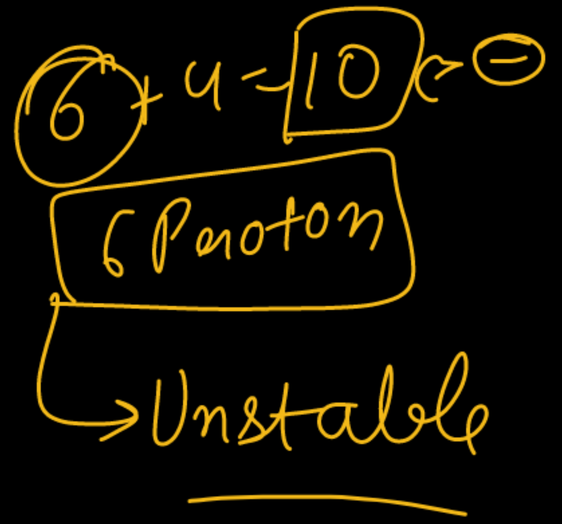
# CARBON

*Carbon is a non-metallic element* with the symbol **(C)**.


- Carbon is the 15th most abundant element in the Earth's crust.
- It is present in the atmosphere primarily as carbon dioxide.
- It is a fundamental component of organic substances such as carbohydrates, proteins, fats, alcohol, vinegar, and glucose.

- **Atomic number : 6** (6 protons and 6 electrons)
- It has **6 neutrons.**
- **Atomic mass: 12** (6 protons and 6 electron).
- **Electric configuration: 2, 4**
- **Valency: 4**


4 e⊖
4 e⊖
Energy


6 + 4 = 10 e⊖
6 Proton
Unstable

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# UNIQUENESS IN CARBON

- Carbon can form huge number of compounds.
- Number of carbon compounds are greater than all non-carbon compounds.
- Carbon based organic chemistry is studied as a separate branch of chemistry.

## BUT WHY CARBON IS UNIQUE?

Carbon is unique because of the following properties it shows:

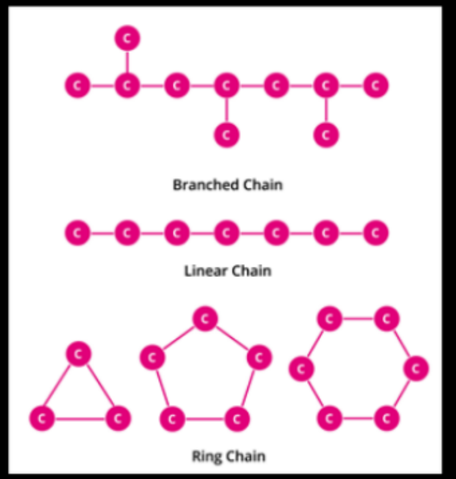
- Catenation
- Polymerisation
- Isomerism
- Tetravalency

# VERSATILITY OF CARBON

C-C-C-C अभय

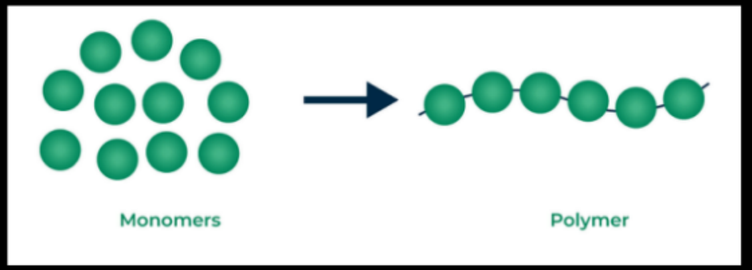
## CATENATION

It is a property which is present in Carbon which ***leads to direct bonding between atoms of same element to form long chains, branches or ring structures.***



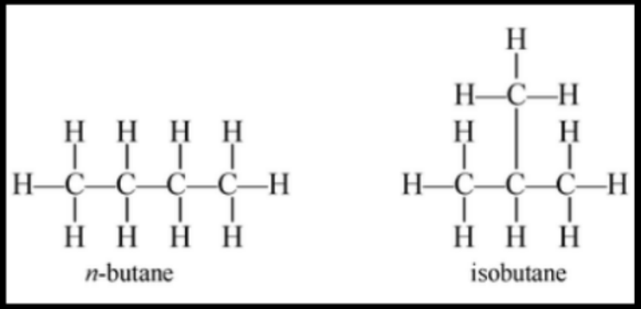

## POLYMERISATION

The chemical process that ***combines several monomers to form a polymer*** or polymeric compound.




## ISOMERISM

Compounds ***having same molecular formula, but different structures*** are called isomers and this property is called ***isomerism.***



# TETRAVALENCY

Why?

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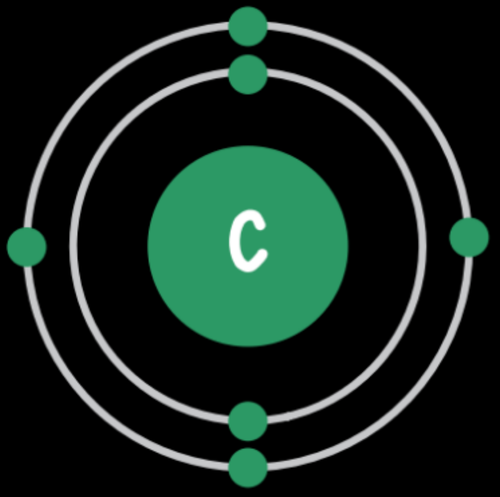
**Carbon neither gains nor loses 4 electrons to attain the noble gas electronic configuration.**

**Because:**

- It could gain four electrons forming **C4– anion**. But it *would be difficult for the nucleus with six protons to hold on to ten electrons, that is, four extra electrons.*
- It could lose four electrons forming **C4+ cation.** But 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.*

Since carbon has a **valency of four**, it is capable of ***bonding with four other atoms of carbon or atoms of some other mono-valent element*** by sharing electrons.




**The shared electrons 'belong' to the outermost shells of both the atoms and lead to both atoms attaining the noble gas configuration.**

# COVALENT COMPOUND

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A covalent bond is a chemical bond formed by the sharing of electrons between two atoms to achieve stability.

- Carbon requires, 4 electrons to achieve the inert gas electronic configuration.

## Properties of covalent compound (Ionic)

- **Physical state** - Solid, liquid and gas
- **Electrical conductivity** - Poor conductors of electricity *except HCl.*
- **Solubility** - Soluble in organic solvents and insoluble in water *except sugar in water.*
- **Melting and boiling point** - Low melting and boiling points → Inter Molecular forces are Weak

# TYPES OF COVALENT BOND

C–C C=C C≡C

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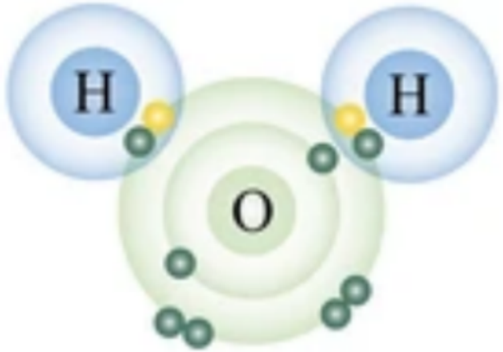
## Single Bonds

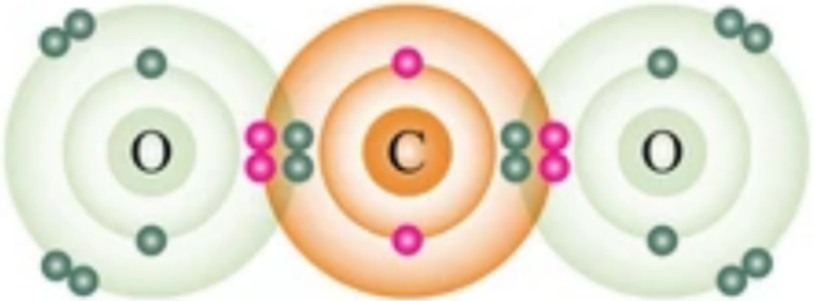



Water

$H_2O$ : H–O–H

Share 2 electrons

## Double Bonds

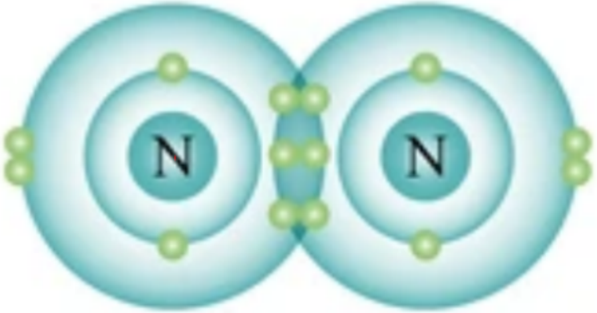



Carbon Dioxide

$CO_2$ : O=C=O

Share 4 electrons

## Triple Bonds




Nitrogen

$N_2$ : N≡N

Share 6 electrons

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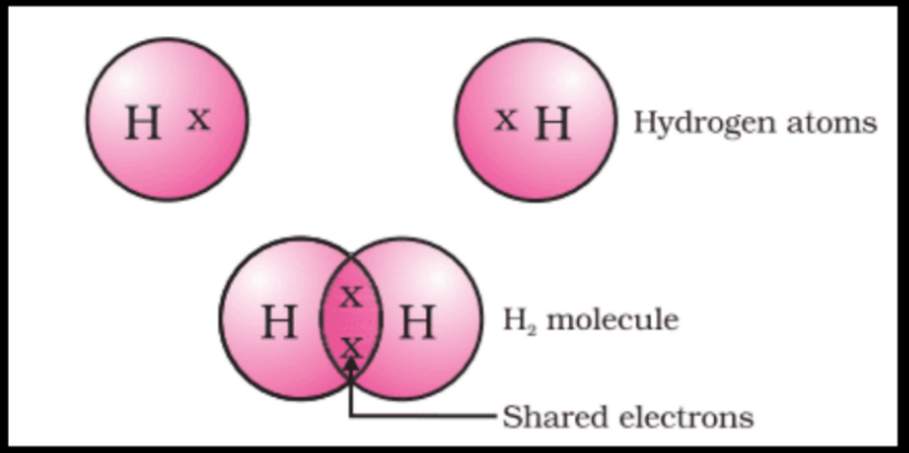
# LEWIS DOT STRUCTURES

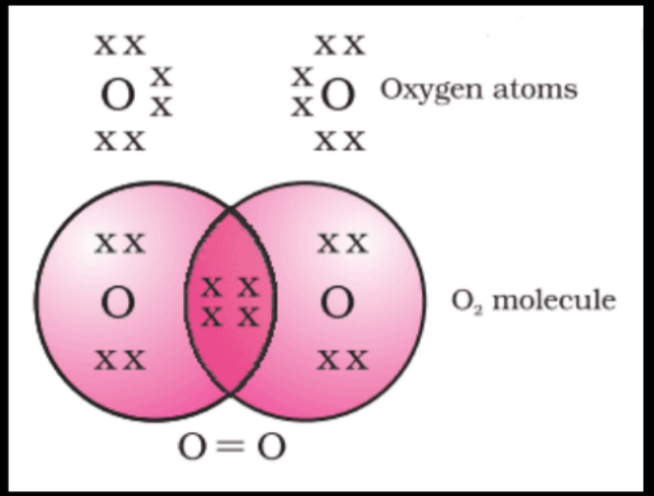
A Lewis dot structure *represents the valence electrons of an atom as dots* around its chemical symbol.

*It shows how atoms share or transfer electrons to form bonds.*

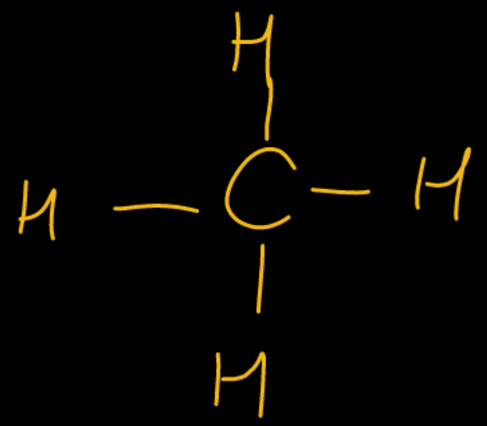
## Formation of Hydrogen molecule

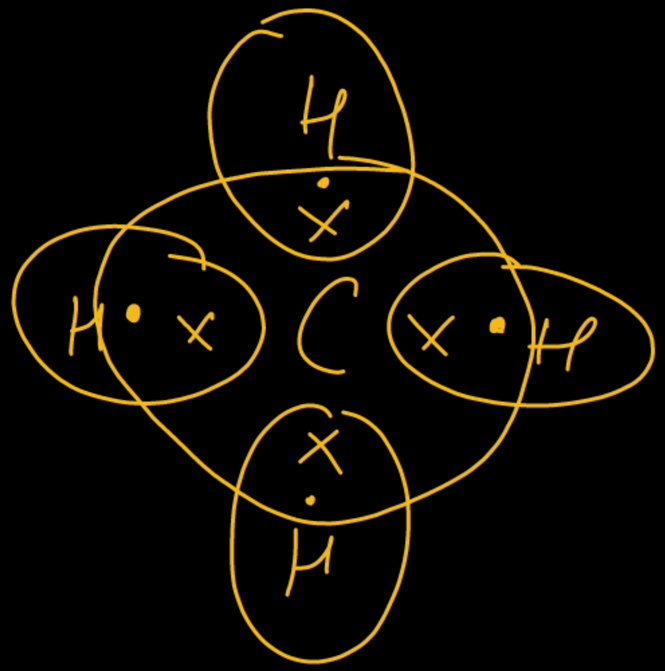


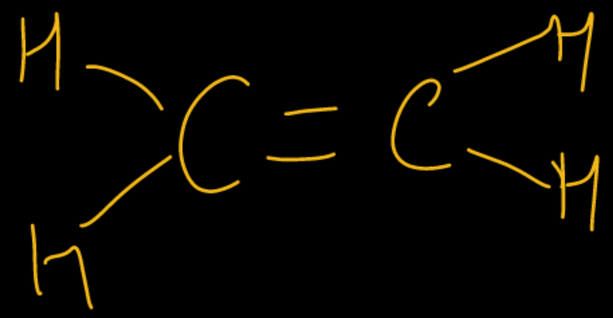

## Formation of Oxygen molecule

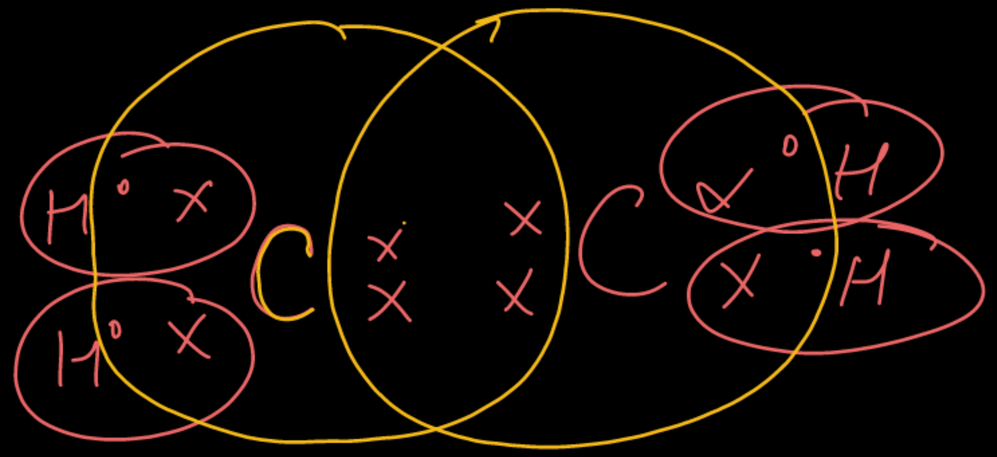


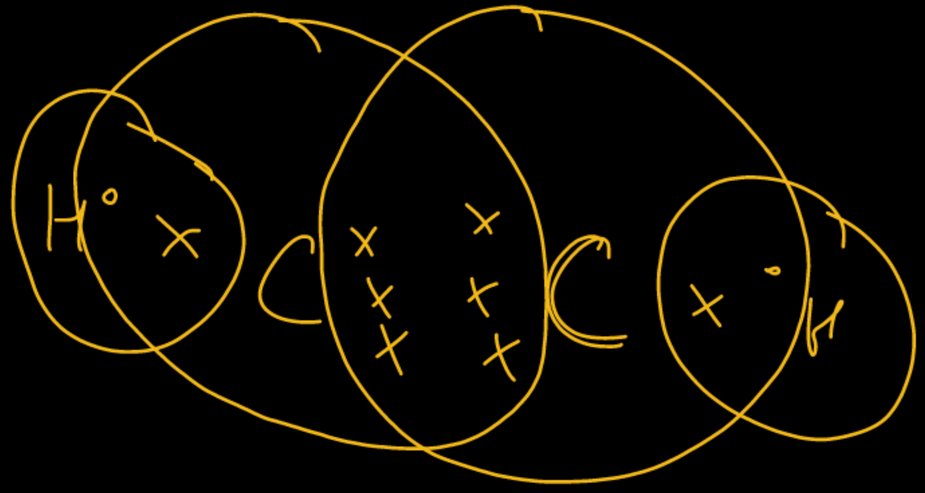
# $CH_4$











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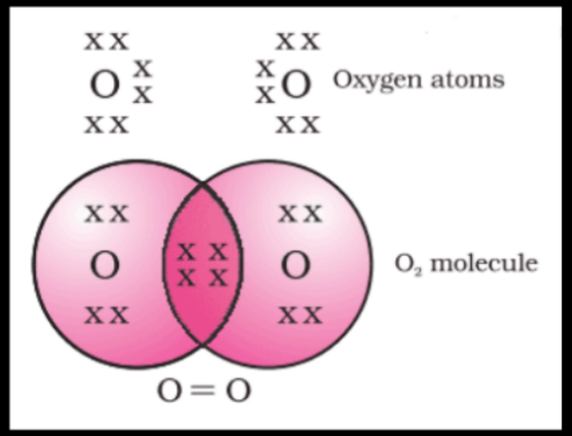
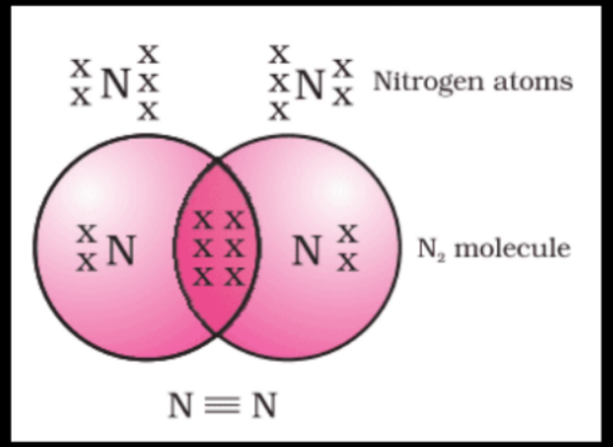
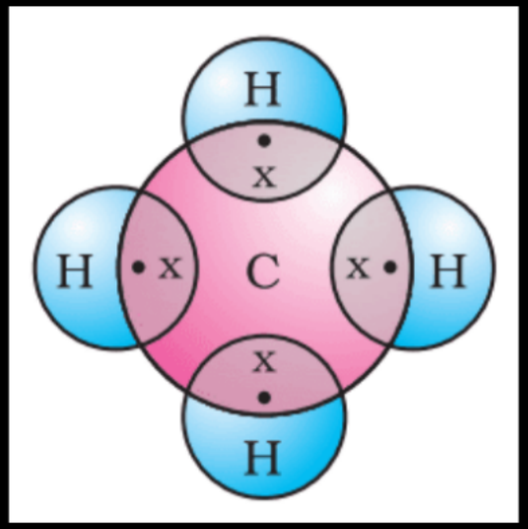
## Formation of Oxygen molecule



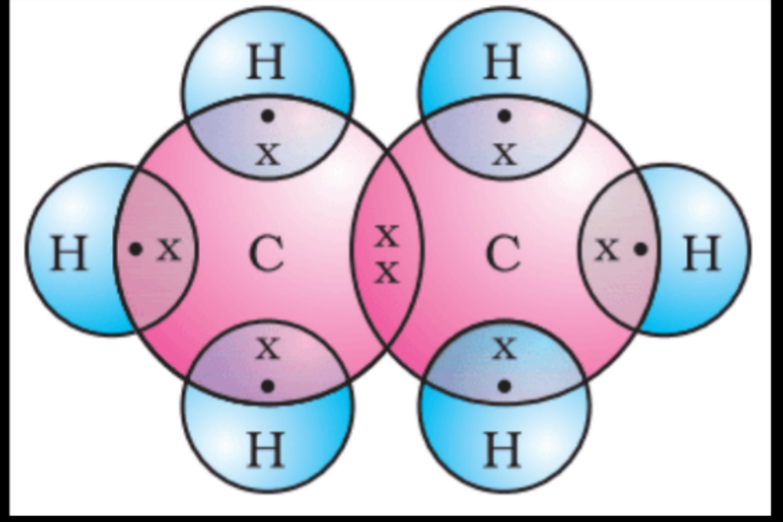

## Formation of Nitrogen molecule



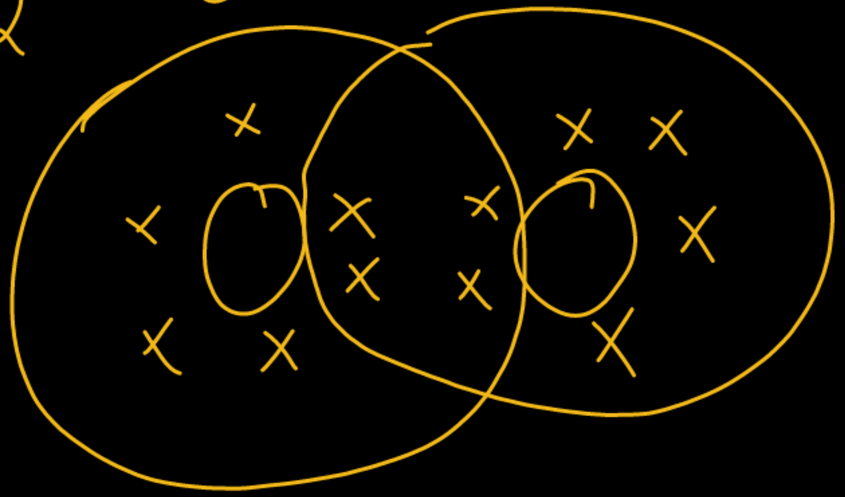

## Formation of Methane




## Formation of Ethane



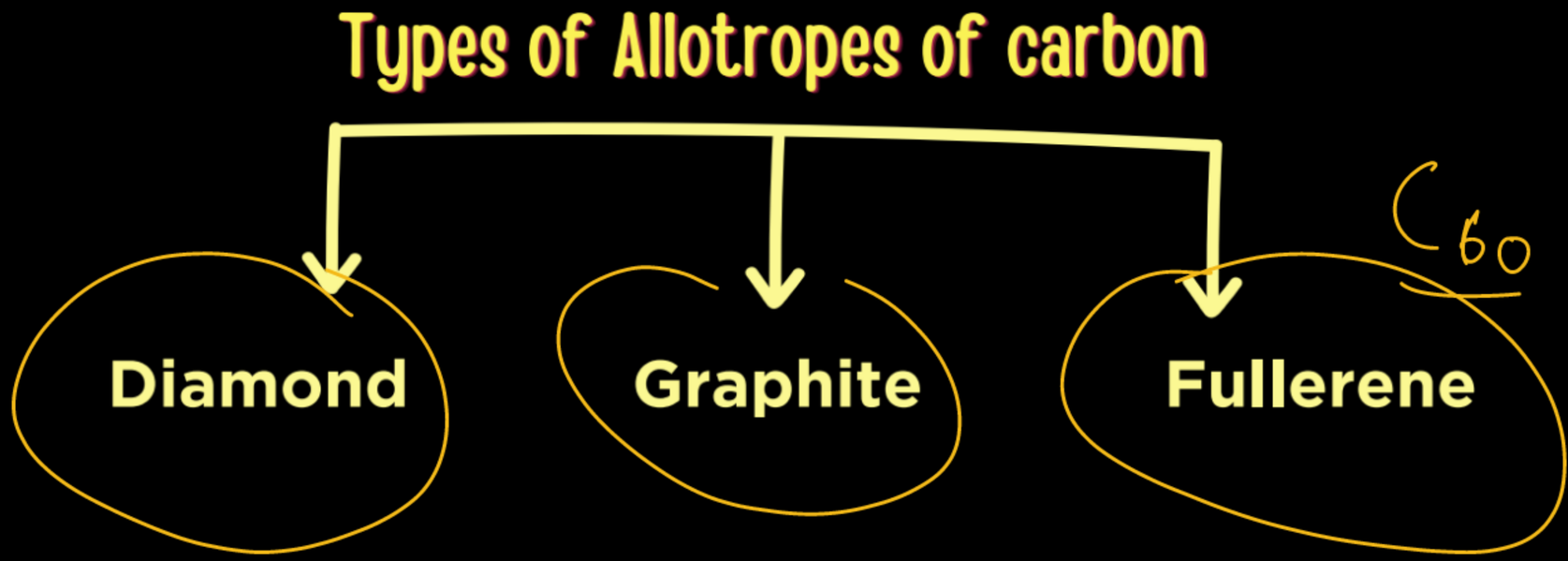
$O_2$ $O=O$

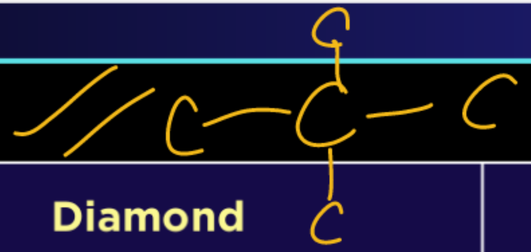


$N \equiv N$

# ALLOTROPES OF CARBON

Allotropes are *different physical forms of the same element*, with distinct structures and properties due to variations in atomic arrangement.





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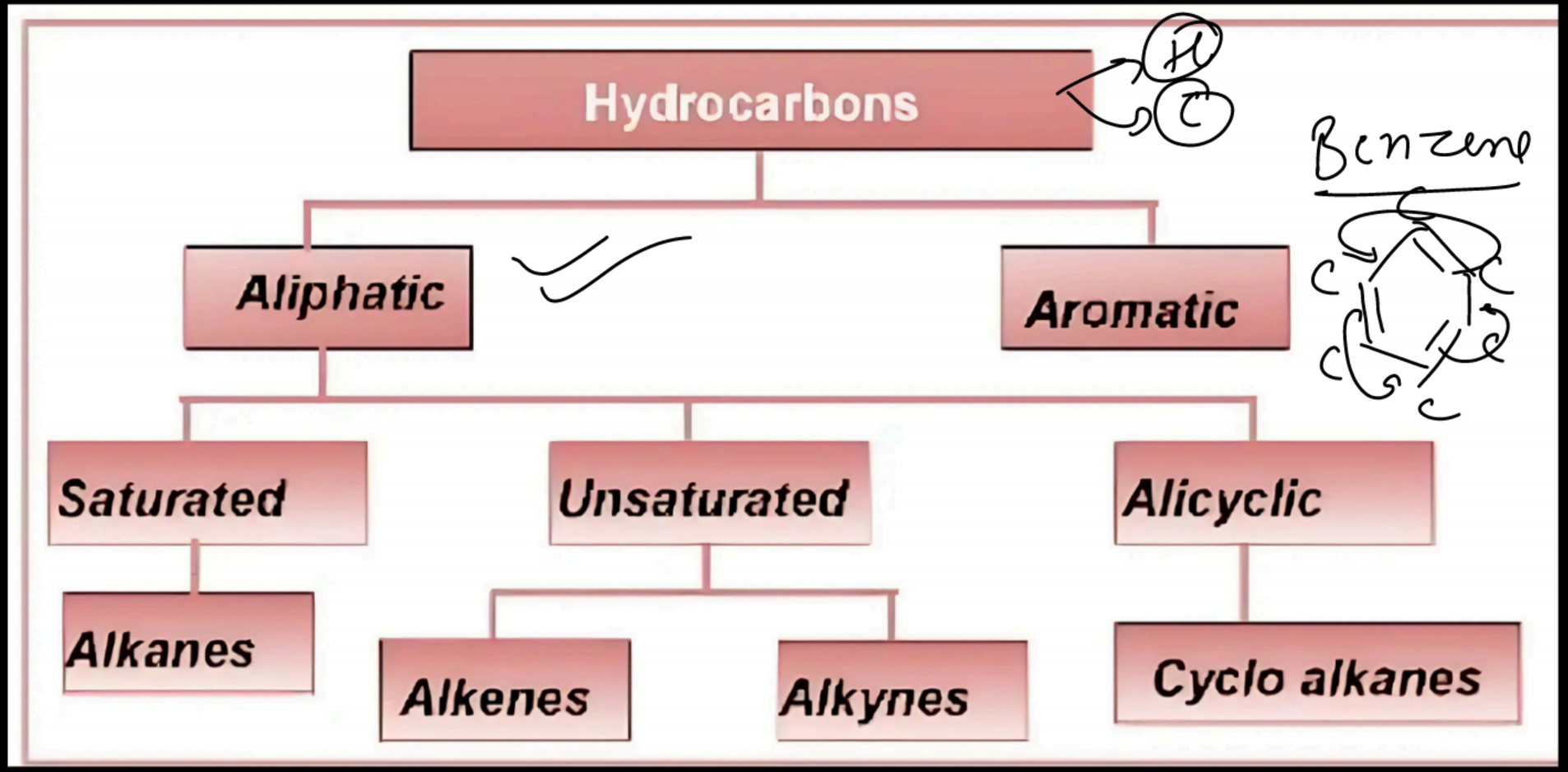
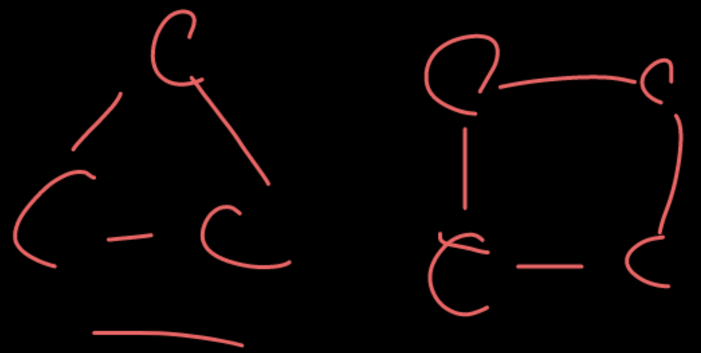
| Property | Diamond | Graphite | Fullerene |
|---|---|---|---|
| Structure | Three-dimensional network with strong carbon-carbon covalent bonds | Carbon atoms bonded with three others to form hexagonal rings | Atoms arranged in hollow spheres; most common is $C_{60}$ resembling a soccer ball |
| Hardness | Extremely hard | Soft | High strength |
| Conductivity | Poor conductor of electricity | Good conductor of heat and electricity | Exhibits high conductivity |
| Appearance | Shines when exposed to light | Opaque and shiny | Unique structure with single and double bonds |
| Melting Point | Very high | High | High |
| Uses | Jewelry, cutting, and drilling tools | Dry lubricant for machine parts, lead pencils | Research, nanotechnology, and medical applications |

# CLASSIFICATION OF HYDROCARBONS



Min →



# ALIPHATIC HYDROCARBONS

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Aliphatic hydrocarbons are hydrocarbons based on chains of C atoms. There are three types of aliphatic hydrocarbons.:

- **Alkanes** are ***saturated*** hydrocarbons with only ***single*** covalent bonds. → C–C → Single Bond
- **Alkenes** are ***unsaturated*** hydrocarbons that contain at least one C–C ***double*** bond. C=C
- **Alkynes** are ***unsaturated*** hydrocarbons that contain a C–C ***triple*** bond. C≡C

| Carbon Atom (#) | Root Name |
|---|---|
| 1 | Meth |
| 2 | Eth |
| 3 | Prop |
| 4 | But |
| 5 | Pent |
| 6 | Hex |
| 7 | Hept |
| 8 | Oct |
| 9 | Non |
| 10 | Dec |

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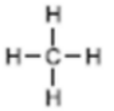
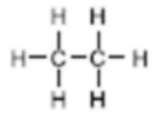
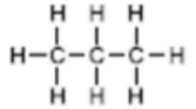
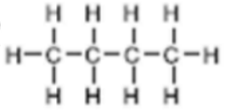
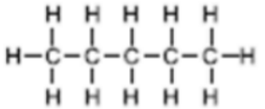
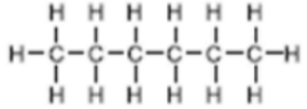
# SATURATED AND UNSATURATED HYDROCARBONS

$C_nH_{2n+2}$

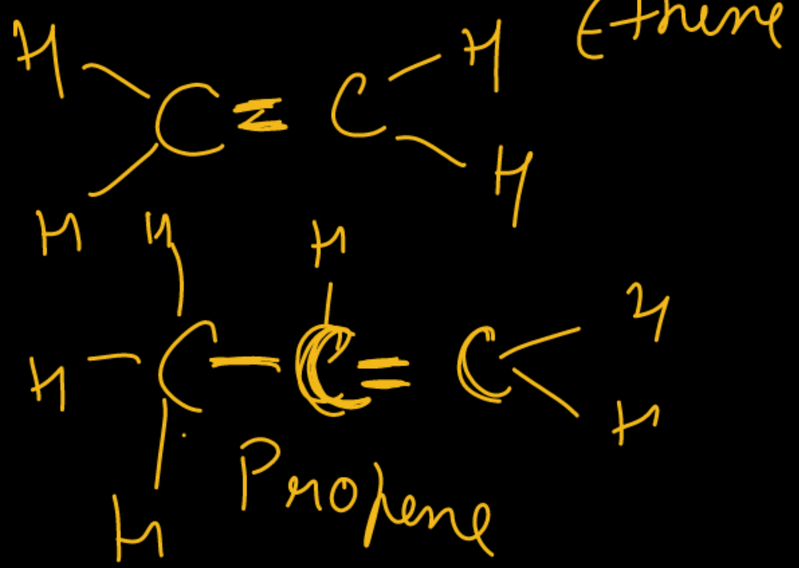
$C_nH_{2n}$

$C_nH_{2n-2}$

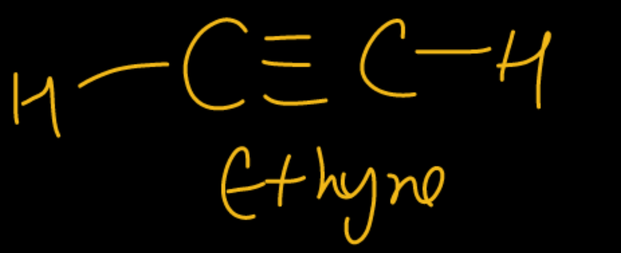
$C_2H_4$

| Name | Molecular Formula | Condensed Formula | Structural Formula |
|---|---|---|---|
| Methane | $CH_4$ | $CH_4$ |  |
| Ethane | $C_2H_6$ | $H_3CCH_3$ |  |
| Propane | $C_3H_8$ | $H_3CCH_2CH_3$ |  |
| Butane | $C_4H_{10}$ | $H_3C(CH_2)_2CH_3$ |  |
| Pentane | $C_5H_{12}$ | $H_3C(CH_2)_3CH_3$ |  |
| Hexane | $C_6H_{14}$ | $H_3C(CH_2)_4CH_3$ |  |

## Alkene




## Alkyne




② → Methane → Methene, Methyne

# CYCLIC RINGS

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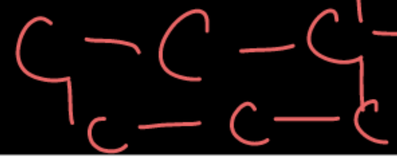
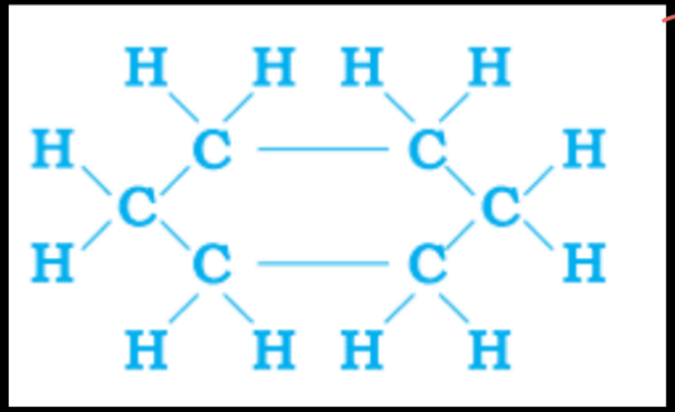
Cycloalkanes are *saturated hydrocarbons with carbon atoms arranged in a closed ring structure.*

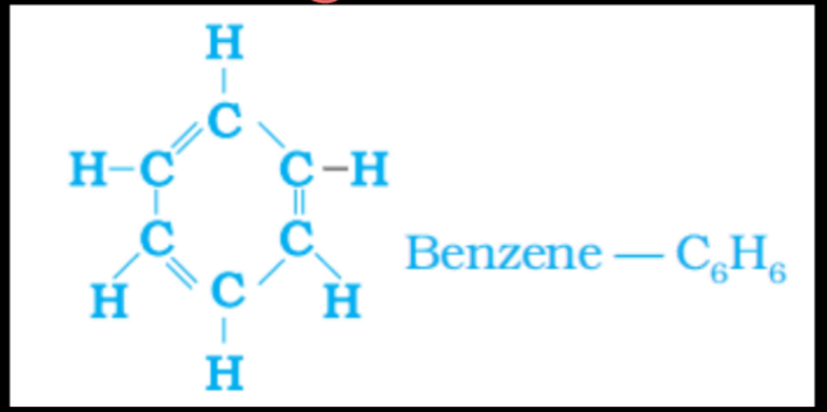
They only contain single bonds and follow the general formula **CnH2n.**

Cyclopropane





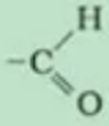
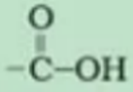
Cyclohexane (Saturated ring)

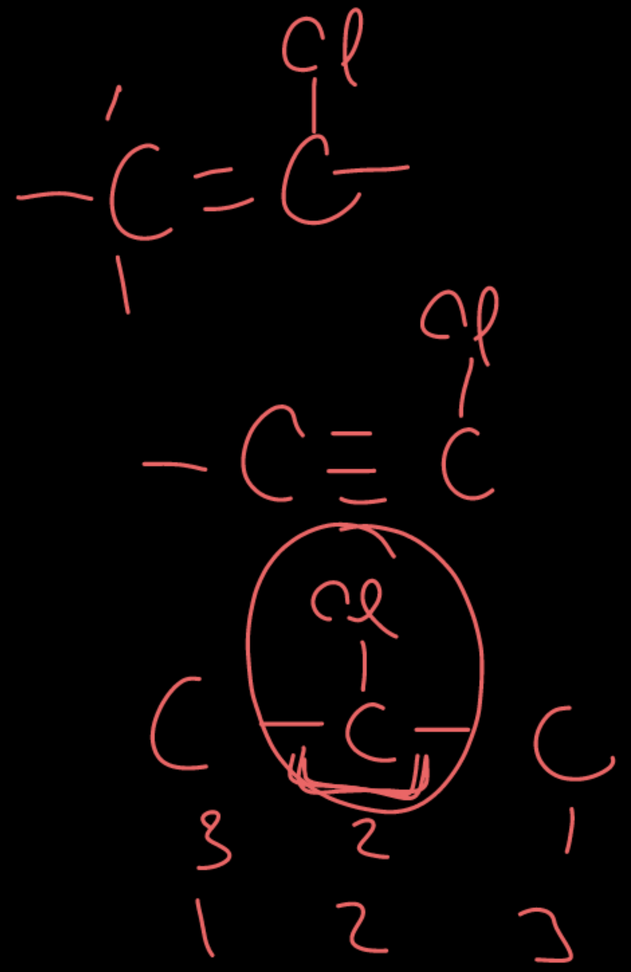



Benzene (Unsaturated ring)

# FUNCTIONAL GROUPS

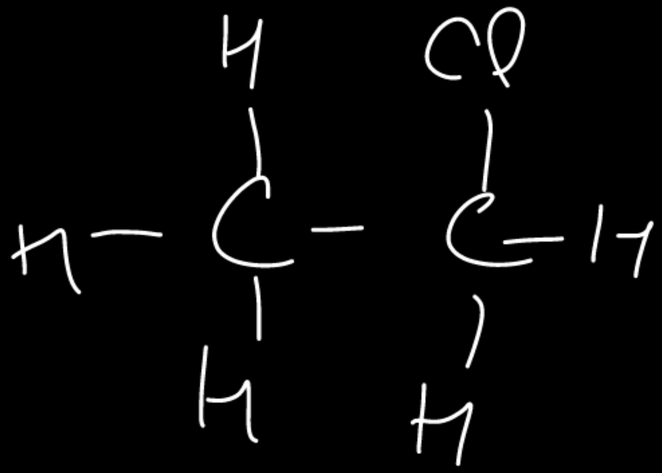
Functional groups are *specific groups of atoms within a molecule that determine its chemical properties and reactions.*

| Hetero atom | Functional group | Formula of functional group |
|---|---|---|
| Cl/Br | Halo- (Chloro/bromo) | —Cl, —Br (substitutes for hydrogen atom) |
| Oxygen | 1. Alcohol | —OH |
| | 2. Aldehyde |  |
| | 3. Ketone |  |
| | 4. Carboxylic acid |  |

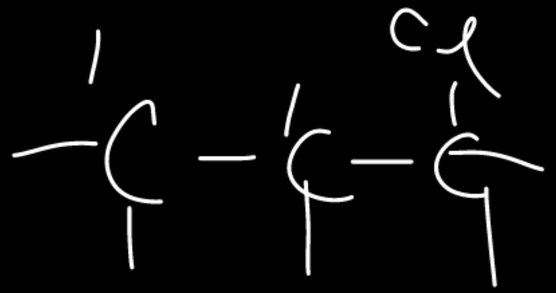


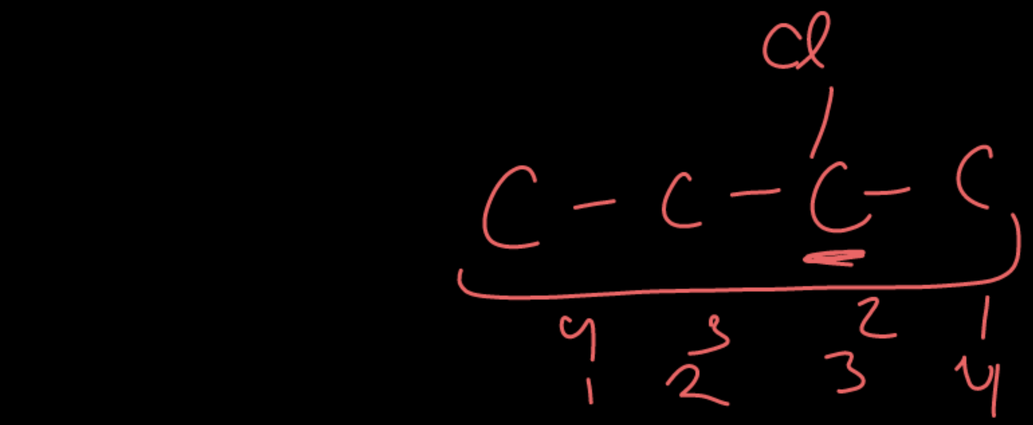
2 Chloro Propane
Chloro-2 propane

Iodo ethane



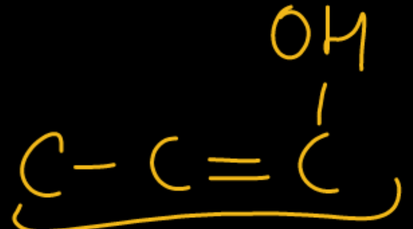
Chloro Ethane



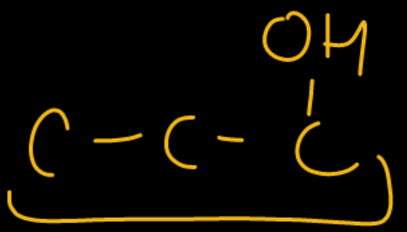



2 - Chloro Butane

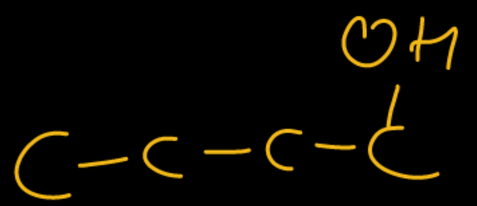
# Alcohol
– OH



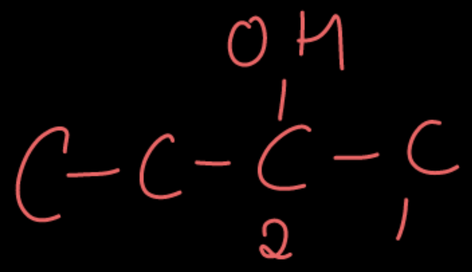
Propan(1)+ol
Propanol



Propan(2)+ol
Propanol

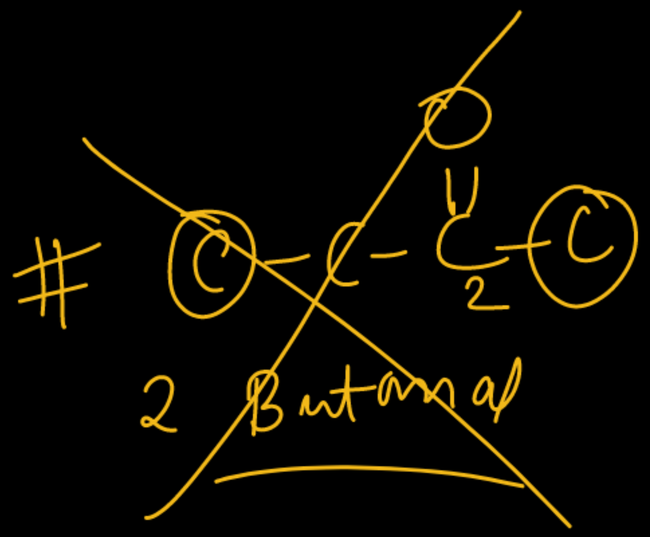


Butan(2)+ol
Butanol

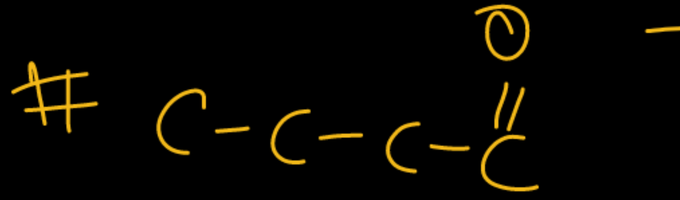


2 - Butanol

Butan - 2 - ol


#
2 Butanal


#
Propan-1-al
Propanal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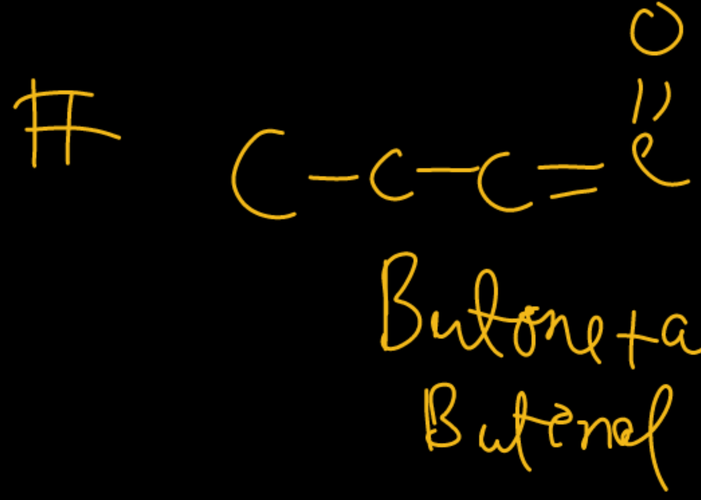
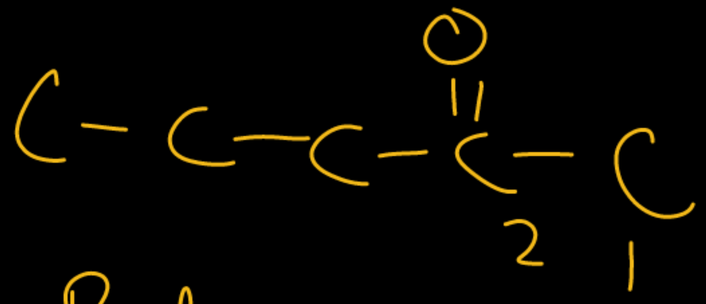

#
But-2-en-1-al
But-2-enal

Ketone

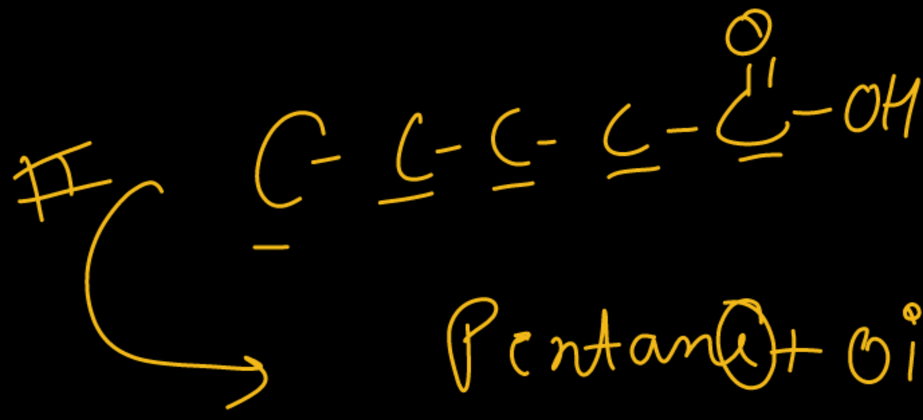
Propan(2)+ one

Propanone



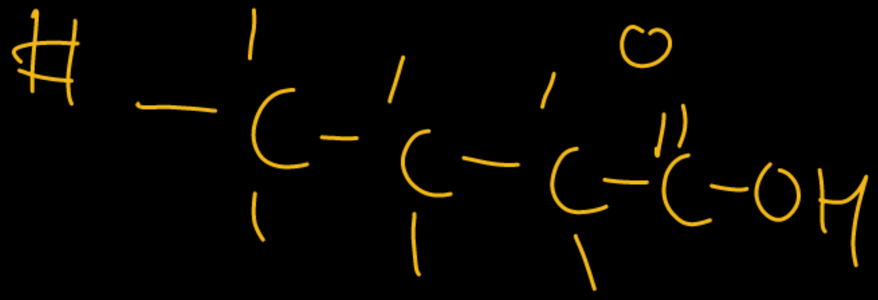
2 Pentane + one

2 Pentanone

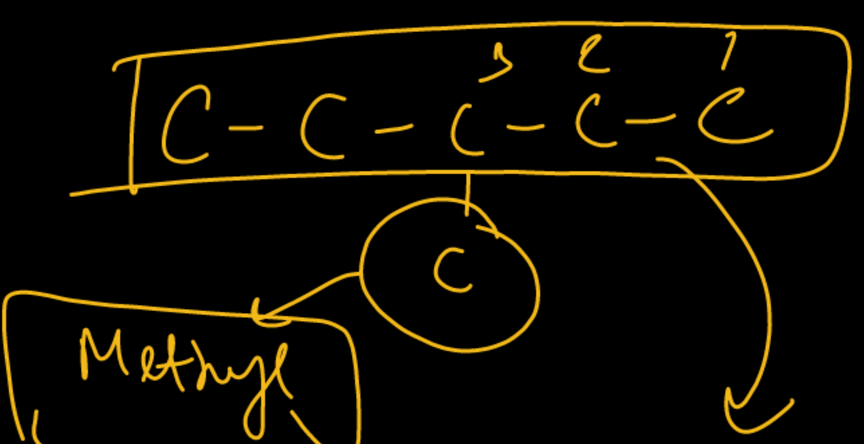


Pentan(1)oic Acid

Pentanoic Acid



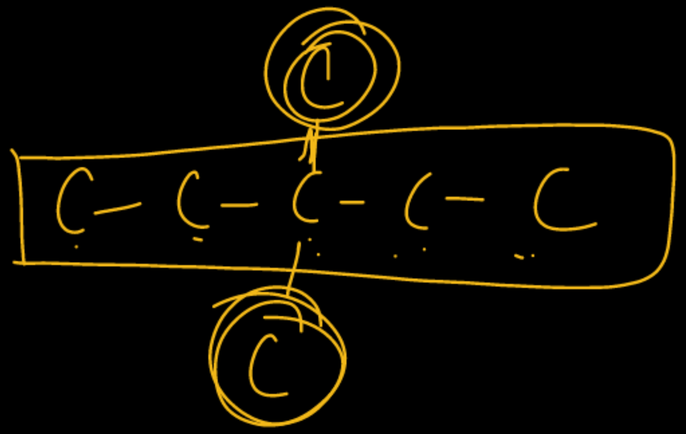
# Alkyl group



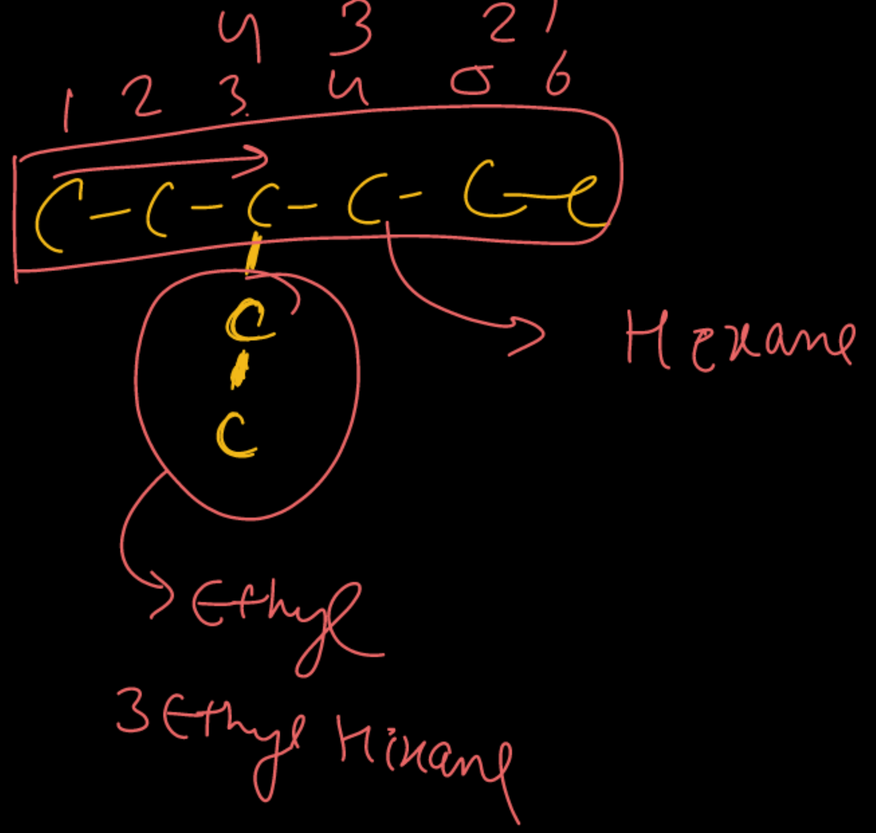

(Longest chain)

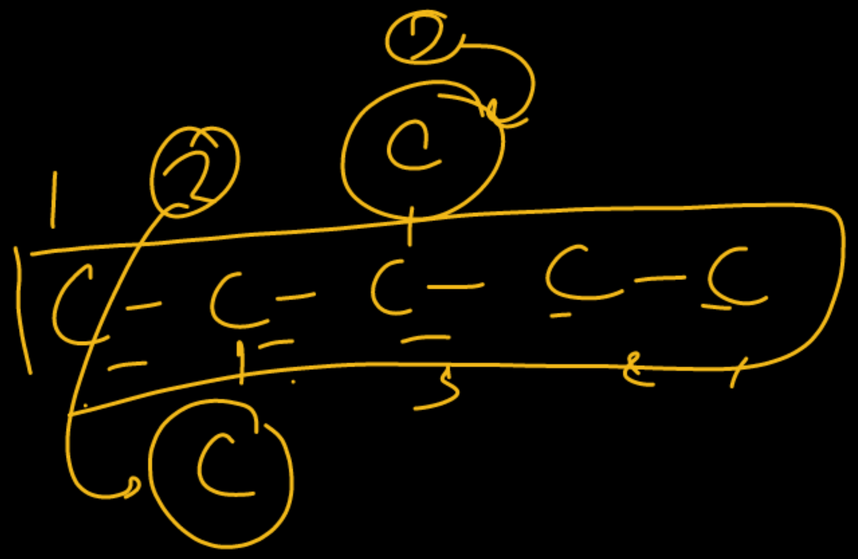
Pentane

3 Methyl Pentane



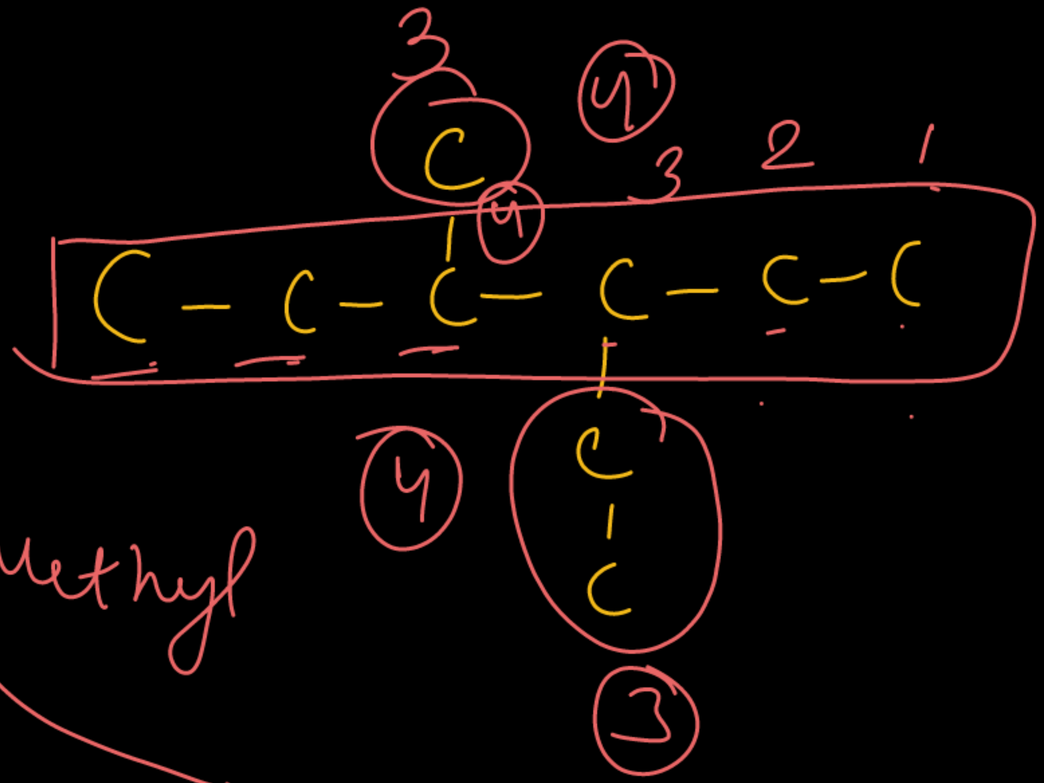
3,3 di-methyl Pentane





2,3 di-Methyl Pentane

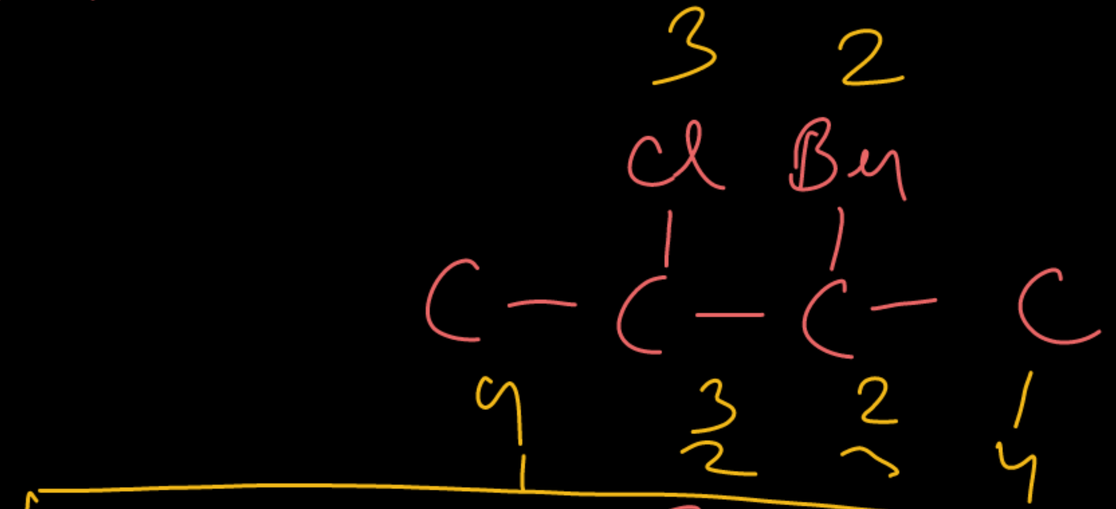
# Imp




3 Ethyl 4 Methyl

Hexane

#Imp

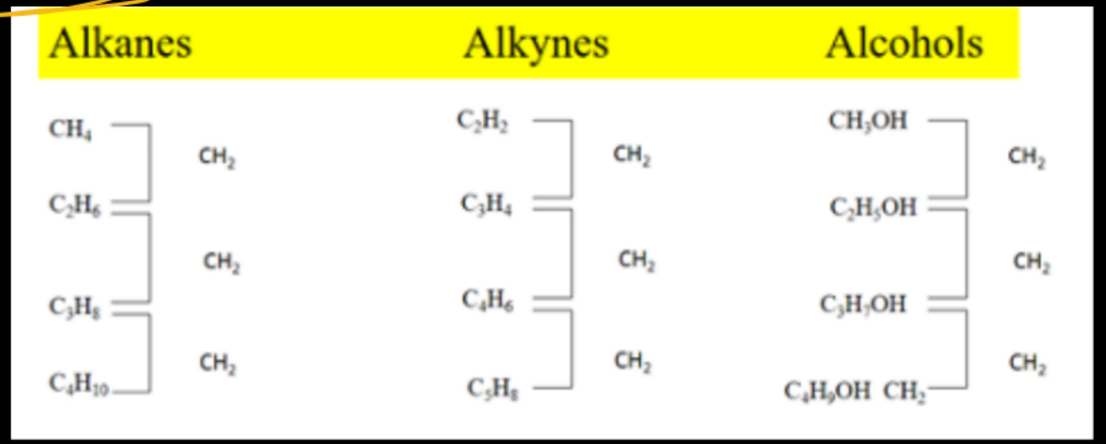


अभय

# HOMOLOGOUS SERIES

A homologous series is a group of organic compounds with a similar general formula, functional group, and chemical properties, **differing by a $CH_2$ unit** in their molecular structure.

- *Example: $CH_3OH$ (Methanol)*
- *$C_2H_5OH$ (Ethanol)*
- *$C_3H_7OH$ (Propanol)*
- *$C_4H_9OH$ (Butanol)*




## CHARACTERISITICS OF HOMOLOGOUS SERIES:

1. It has a *general formula* in terms of the number of carbon atoms.
2. It has the *same functional group.*
3. The members of a homologous series *have similar chemical properties.*
4. The members of a homologous series *show a gradation in physical properties with an increase in molecular mass.*
5. The *difference in molecular mass between two successive homologues is* ***14 u.***

$C_n H_{2n+2}$

$CH_4$ $C_2H_6$

$CH_2$

12 2

$12+2=14$

1st Member

$= C_2H_6 + CH_2 + CH_2$

3rd

$C_4H_{10}$

$C_{10}H_{20}$ = 3rd Member

$- \; CH_2$

$- \; CH_2 \; |^{84}$

$C_8H_{16}$

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# Abhay Premier League

(2024)

Q. Carbon compounds:

(i) are good conductors of electricity.

(ii) are bad conductors of electricity.

(iii) have strong forces of attraction between their molecules.

(iv) have weak forces of attraction between their molecules.

The correct statements are:

(a) (i) and (ii)

(b) (ii) and (iii)

(c) (ii) and (iv)

(d) (i) and (iii)

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# Abhay Premier League

(2024)

Q. Consider the following statements about the homologous series of carbon compounds:

(a) All succeeding members differ by a $-CH_2$ unit.

(b) The melting point and boiling point increase with increasing molecular mass.

(c) The difference in molecular masses between two successive members is 14 u.

(d) $C_2H_2$ and $C_3H_3$ are NOT successive members of the alkyne series.

The correct statements are –

(A) (a) and (b)

(B) (b) and (c)

(C) (a) and (c)

(D) (a) and (d)

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# Abhay Premier League

## (2021)

The IUPAC name of $CH_3 - \underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}} - CH_2 - CH_3$ is

(a) 2-ethyl-2-methyl propane

(b) 2, 2-dimethyl butane

(c) 1,1,1-trimethyl propane

(d) 2, 2-methyl butane

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# Abhay Premier League

(2021)

Q.In diamond, each carbon atom is bonded to four other carbon atoms to form

(a) a hexagonal array

(b) a rigid three-dimensional structure

(c) a structure in the shape of a football

(d) a structure of a ring

अभय

# Abhay Premier League

(2020)

Q. Which of the following compounds belong to the homologous series of alkynes?

$C_6H_6$, $C_2H_6$, $C_2H_4$, $C_3H_4$

Options:

(a) $C_6H_6$

(b) $C_2H_4$

(c) $C_2H_6$

(d) $C_3H_4$

$C_nH_{2n-2}$

$C_2H_2$ → $C_3H_4$

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# Abhay Premier League

Q.A hydrocarbon has four carbon atoms. Give its molecular formula if it is an alkene.

(a) $C_4H_{10}$

(b) $C_4H_8$

(c) $C_4H_6$

(d) $C_4H_4$

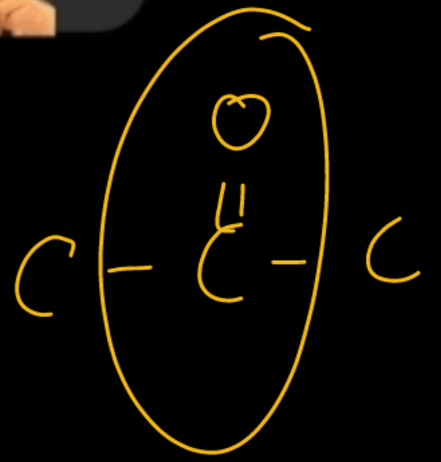
$C_nH_{2n}$

$C_4H_8$

अभय

# Abhay Premier League

Q.Name the functional group present in $CH_3COCH_3$.



(a) Alcohol

(b) Carboxylic acid

(c) Ketone

(d) Aldehyde

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# Abhay Premier League

(2024)

**Q.(i) Define a homologous series of carbon compounds.**

Answer: A homologous series is a group of organic compounds that have a similar general formula, possess similar chemical properties, and show a gradation in physical properties. Each member differs from the next by a CH2 unit.

**(ii) Why is the melting and boiling point of $C_2H_6$ higher than that of $C_2H_4$ or $C_2H_2$?**

Answer:The melting and boiling points of $C_2H_6$ (ethane) are higher than those of $C_2H_4$ (ethylene) and $C_2H_2$ (acetylene) because $C_2H_6$ is an alkane with single bonds. This structure allows for stronger van der Waals forces between molecules, whereas the presence of double and triple bonds in $C_2H_4$ and $C_2H_2$, respectively, leads to weaker intermolecular attractions.

**(iii) Why do we NOT see any gradation in chemical properties of a homologous series compounds?**

Answer: We do not see any gradation in chemical properties of a homologous series compounds because they contain the same functional group, which dictates their chemical reactivity.

Abhay Premier League

(iv) Write the name and structures of (i) aldehyde and (ii) ketone with the molecular formula $C_3H_6O$

(i) Aldehyde: Propanal Structure: $CH_3CH_2CHO$

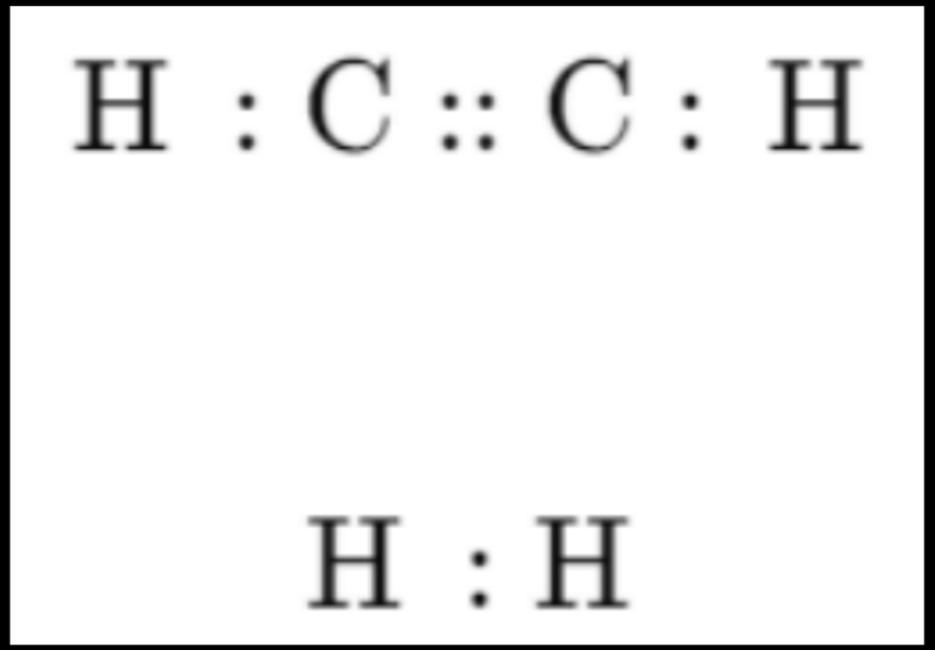
(ii) Ketone: Propanone Structure: $CH_3COCH_3$

# Abhay Premier League

(2024)

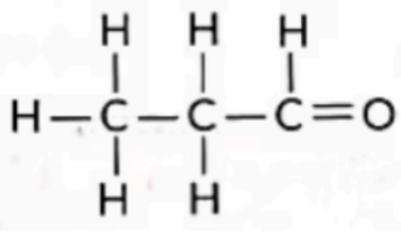
**Name and draw the electron dot structure of hydrocarbon .**

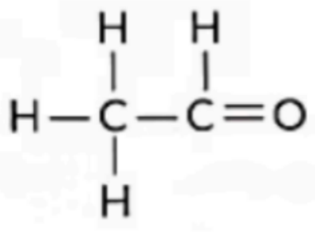
**Ethene (Ethylene) Electron dot structure:**



# Abhay Premier League

**[Q]** **Consider the following organic compounds:**

(i) 

(ii) 

**(a) Name the functional group present in these compounds.(b) Write the general formula for the compounds of this functional group.**

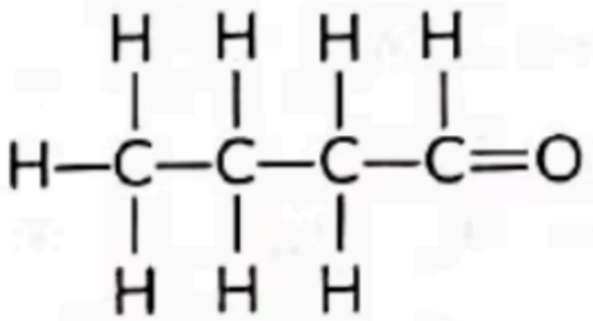
**(c) State the relationship between these compounds and draw the structure of any other compound having similar functional group (Term II, 2021-22)**

**Ans: (a)** Aldehyde (—CHO) group.

**(b)** $C_nH_{2n}O$

**(c)** Compound (i) is propanal, and compound (ii) is ethanal. They belong to the same homologous series where each successive compound differs from each other by a—$CH_2$ unit.

Other member of same homologous series:



Butanal

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# Abhay Premier League

Q.Give reasons for the following:

(i) Element carbon forms compounds mainly by covalent bonding.

(ii) Diamond has high melting point.

(iii) Graphite is a good conductor of electricity.

Answer:

(i) As carbon has four valence electrons and it can neither loose nor gain lour electrons thus, it attains noble gas configuration only by sharing of electrons. I bus, it forms covalent compounds.

(ii) In diamond, each carbon atom is bonded to four other carbon atoms forming a rigid three-dimensional structure. This makes diamond the hardest known substance. Thus, it has high melting point.

(iii) In graphite, each carbon atom is bonded to three other carbon atoms by covalent bonds in the same plane giving a hexagonal array. Thus, only three valence electrons are used for bond formation and hence, the fourth valence electron is free to move. As a result, graphite is a good conductor of electricity.

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Abhay Premier League

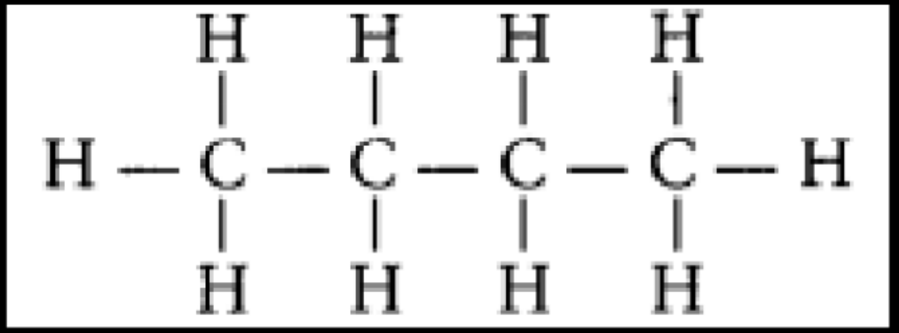
**Q.Name a cyclic unsaturated carbon compound. (2020)**

Benzene,  is a cyclic unsaturated carbon compound.

Abhay Premier League

## Q.Write the number of covalent bonds in the molecule of butane, C4H10.

Butane (C4H10) has the following structural formula as:

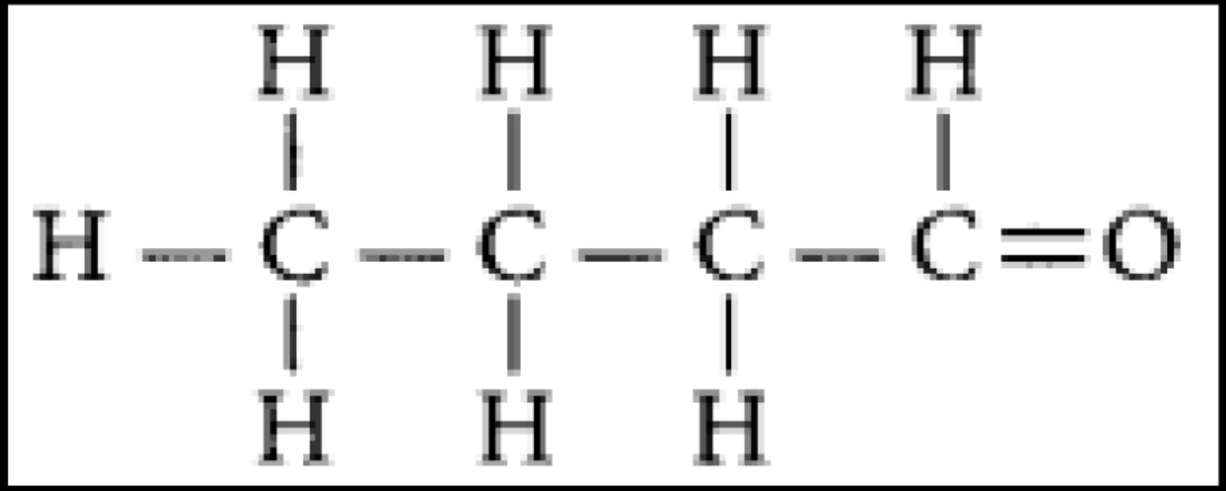


Total number of covalent bonds is 13 in which there are 10 C – H and 3 C – C covalent bonds.

**Q.Write the name and structure of an aldehyde with four carbon atoms in its molecule. (2019)**

**Answer:**

**An aldehyde with four carbon atoms is butanal and its structure is.**




**Q. Write the next homologue of each of the following:**

**(i) $C_2H_4$**

**(ii) $C_4H_6$ (Delhi 2016)**

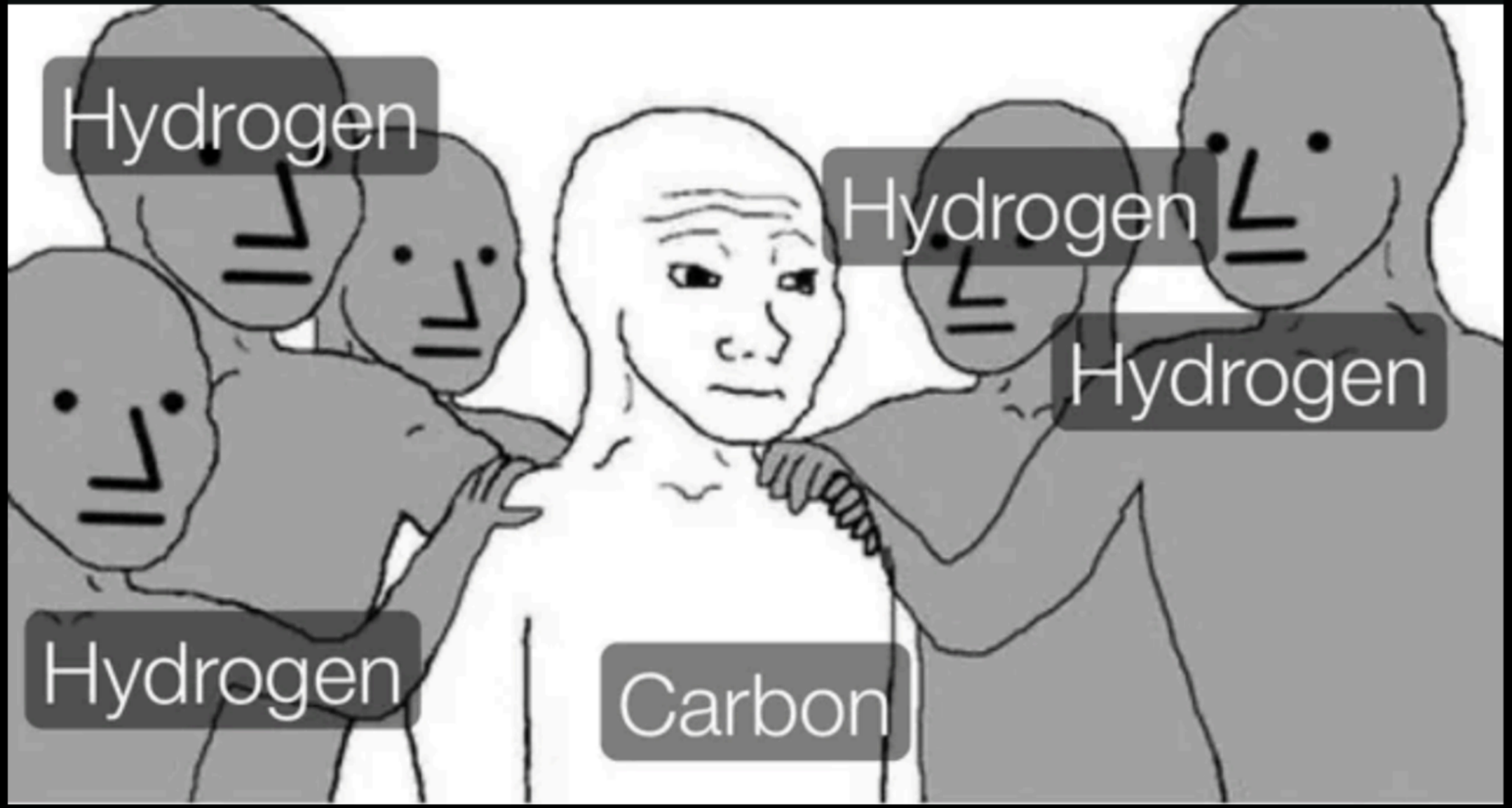
**Answer:**

**(i) $C_2H_4$**

- $C_2H_4$ belongs to the alkene series, which follows the general formula $C_nH_{2n}$.
- The next homologue will be $C_3H_6$ (propene).

**(ii) $C_4H_6$**

- $C_4H_6$ belongs to the alkyne series, which follows the general formula $C_nH_{2n-2}$.
- The next homologue will be $C_5H_8$ (pentyne).


Hydrogen
Hydrogen
Hydrogen
Hydrogen
Carbon