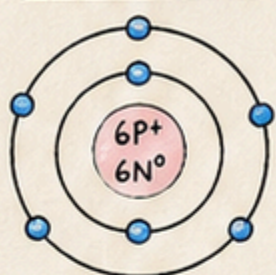




CHAPTER 4

Carbon is the basis of all organic compounds.

CARBON ATOM



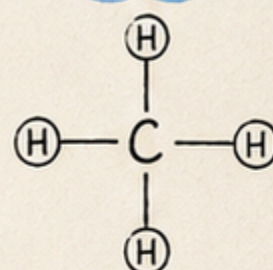
Atomic No. = 6
Electronic Config. = 2, 4

CARBON

— AND ITS —

COMPOUNDS

METHANE (CH₄)



Simplest Hydrocarbon

KEY CONCEPTS

* Catenation

Property of carbon to form long chains.

* Tetravalency

Carbon has valency 4. It forms four bonds.

* Covalent Bond

Carbon forms covalent bonds by sharing electrons.

* Hydrocarbons

Compounds of carbon and hydrogen only.

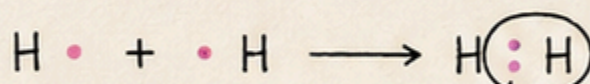
☆ Ethanol

An alcohol used as a fuel and in medicines.

* Ethanoic Acid

An organic acid found in vinegar.

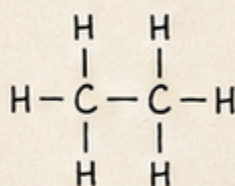
COVALENT BOND



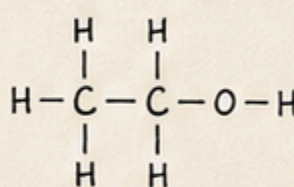
Shared pair of electrons

STRUCTURES TO REMEMBER

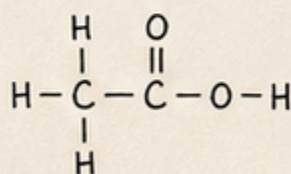
Ethane (C₂H₆)



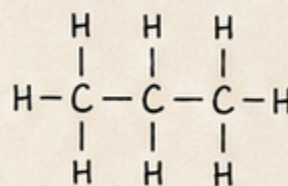
Ethanol (C₂H₅OH)



Ethanoic Acid (CH₃COOH)

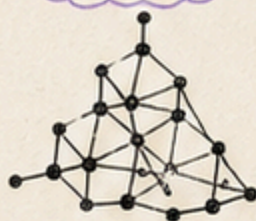


Propane (C₃H₈)



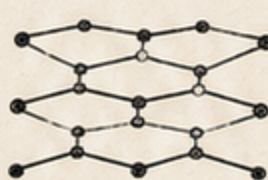
ALLOTROPES OF CARBON

DIAMOND



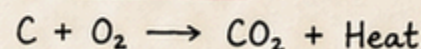
- Hardest natural substance
- Transparent
- Used in jewellery and cutting tools

GRAPHITE



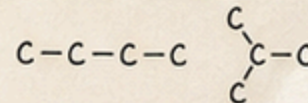
- Soft and slippery
- Good conductor of electricity
- Used in pencils, electrodes

COMBUSTION



Carbon burns in oxygen to form carbon dioxide with heat.

ORGANIC MOLECULES



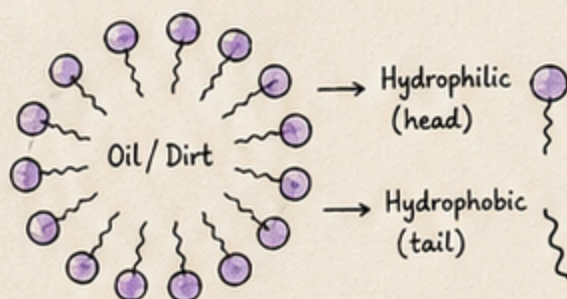
Carbon can form long chains, branches and rings.

☆ Most Important Chapter

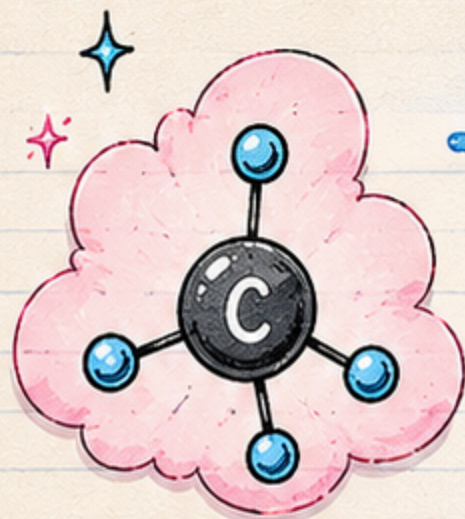
☆ Board Exam Revision

Quick Chemistry Notes

SOAP MOLECULE (MICELLE)

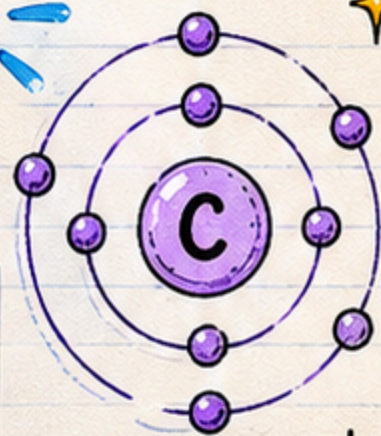


Soap molecules form micelles and entrap oil/dirt for cleaning.



Carbon.

INTRODUCTION TO CARBON



- Carbon is an **element** of immense significance.

- Food, clothes, medicines, books and living structures are carbon based.



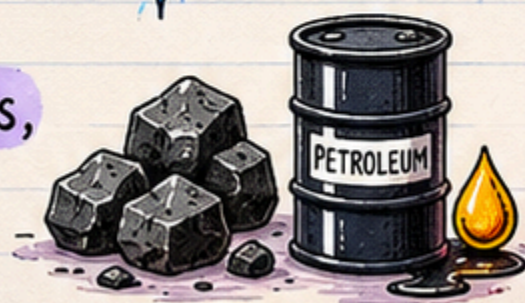
- Earth's crust contains only 0.02% carbon.



- Atmosphere contains 0.03% carbon dioxide.



- Carbon occurs in **minerals**, **carbonates**, **hydrogencarbonates**, **coal** and **petroleum**.



Why is **Carbon** Important?

★ Versatile Element

Forms a large number of compounds.

★ Basis of Life

Essential for all living organisms and life processes.

Forms in Nature

Elemental Form



Combined Form



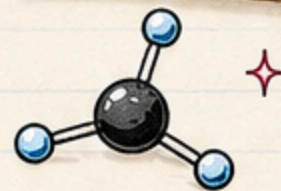
Quick Revision

Carbon exists in **elemental** and **combined** form.



BONDING IN CARBON - COVALENT BOND

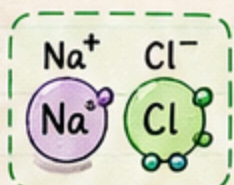
Sharing makes Carbon Special! ♥



SECTION 1

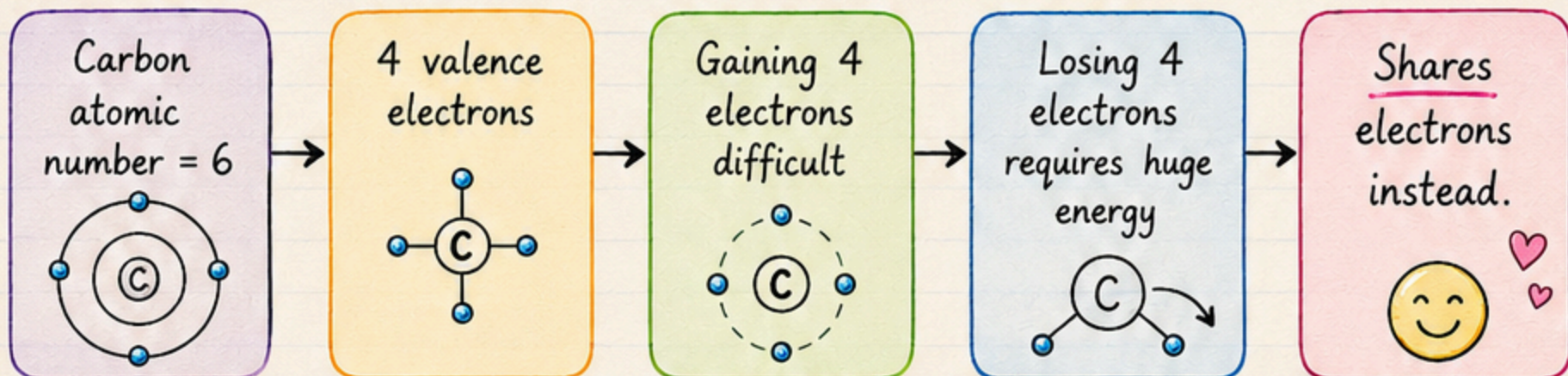
Ionic vs Carbon Compounds

Ionic Compounds	Carbon Compounds
✓ High melting & boiling points	✗ Poor conductors of electricity
✓ Conduct electricity in solution/molten state	✗ Low melting & boiling points
	✗ Weak intermolecular forces



SECTION 2

Why Carbon Does Not Form Ions?



★ Hence, carbon forms covalent bonds by sharing electrons.

SECTION 3

Definition

Bonds formed by sharing of electrons are called covalent bonds. ♥

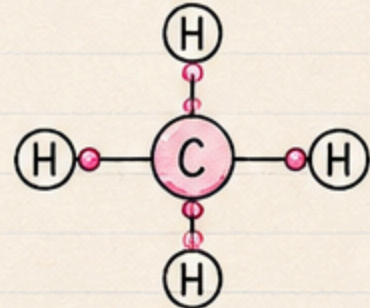
Example:

H₂ molecule



(Shared pair of electrons)

Carbon-Hydrogen bond (in methane)



Electrons are shared to achieve stability. ♥

Covalent bonds are the basis of all carbon compounds! ★

★ Carbon shares, connects and creates! ♥

REMEMBER

Carbon prefers sharing electrons, not gaining or losing them. 💡

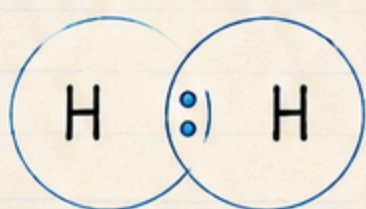
EXAMPLES OF COVALENT BONDING

1 Hydrogen (H_2)

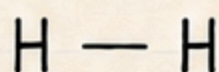
- Shares one pair of electrons.
- Single covalent bond.

Single Bond

Electron-dot structure:



Structural formula:



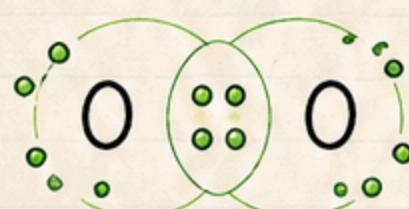
Each H needs 1 electron to be stable. ♥

2 Oxygen (O_2)

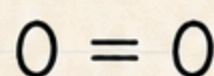
- Shares two pairs of electrons.
- Double bond.

Double Bond

Electron-dot structure:



Structural formula:



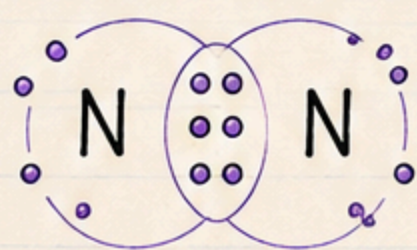
Each O needs 2 electrons to be stable. ♥

3 Nitrogen (N_2)

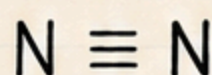
- Shares three pairs of electrons.
- Triple bond.

Triple Bond

Electron-dot structure:



Structural formula:



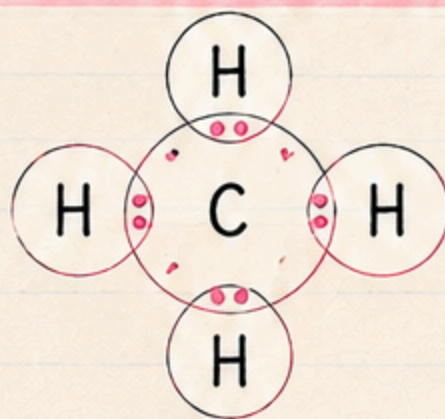
Each N needs 3 electrons to be stable. ♥

4 Methane (CH_4)

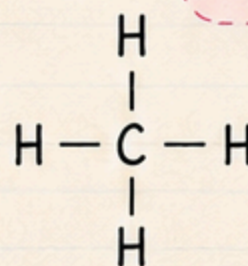
- Carbon is tetravalent.
- Shares four electrons with hydrogen atoms.

Tetra-valent Carbon

Electron-dot structure:



Structural formula:



C shares electron pairs with 4 H atoms to complete its octet. ♥

QUICK REVISION

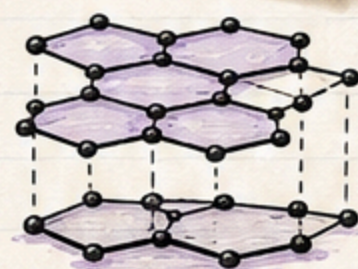
Covalent compounds are poor conductors of electricity. 💡





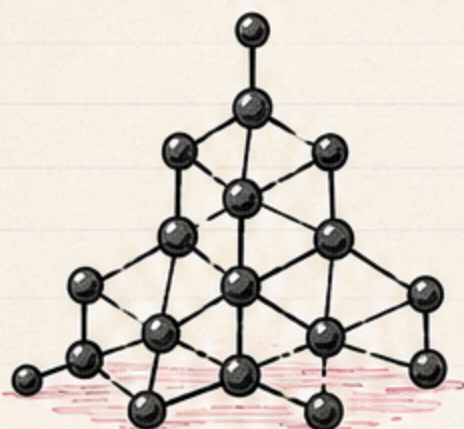
ALLOTROPE OF CARBON

Carbon
can exist
in different
forms. ♥



1

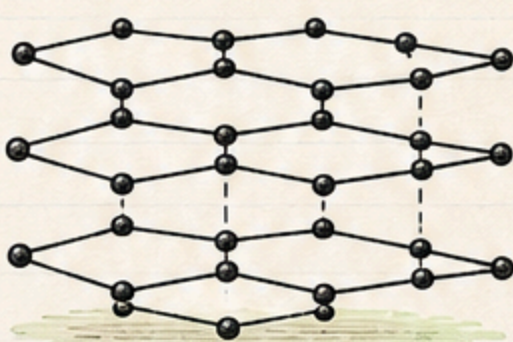
DIAMOND



- Each carbon bonded to four carbon atoms.
- Rigid three-dimensional structure.
- Hardest substance known.

2

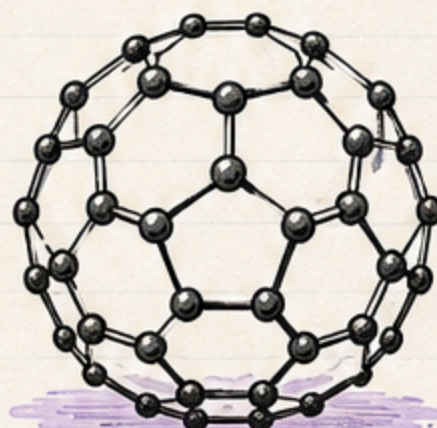
GRAPHITE



- Each carbon bonded to three carbon atoms.
- Hexagonal arrangement.
- Smooth and slippery.
- Good conductor of electricity.

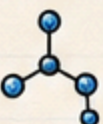
3

FULLERENES



- C-60 structure.
- Football-shaped arrangement.

DIAMOND vs GRAPHITE

Property	Diamond	Graphite
 Structure	3D tetrahedral structure	Layered hexagonal structure
 Hardness	Extremely hard	Soft and slippery
 Electrical Conductivity	Does not conduct electricity	Good conductor of electricity
 Melting Point	Very high	Very high (sublimes at high temperature)
 Appearance	Transparent and brilliant	Black to Grey and opaque

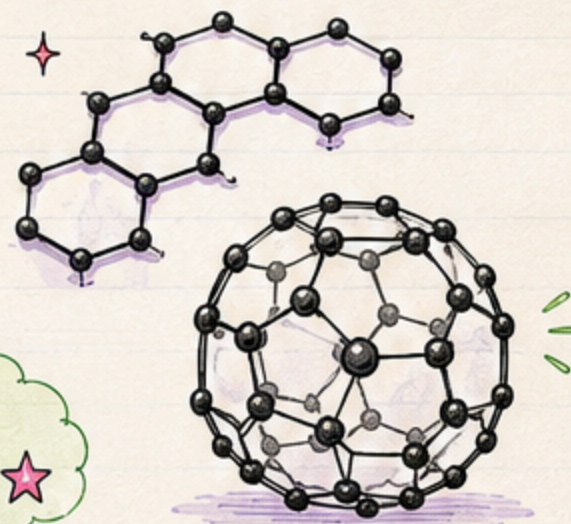
MEMORY TRICK

Diamond → Hard
Graphite → Conducts

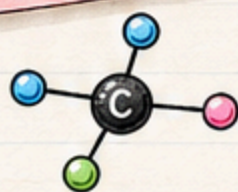
Allotropes have
same element but
different properties. ♥

★ Different arrangement of carbon atoms
leads to different properties. ♥

Examples:
Diamond, Graphite,
Fullerenes, Graphene,
Carbon nanotubes. ★



Carbon is the basis of millions of compounds!



VERSATILE NATURE OF CARBON

One element...
Countless
Compounds!



Why are carbon compounds so large in number?

1 CATENATION

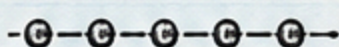
- Carbon forms bonds with other carbon atoms.
- Forms long chains, branched chains and rings.
- Strong carbon-carbon bond.

Catenation

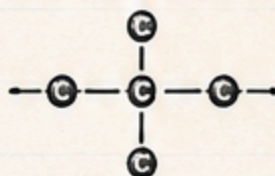
Ability of carbon to link with other carbon atoms.

★ Strong C-C bond
(~ 348 kJ mol⁻¹)

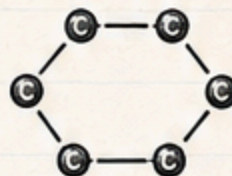
Long Chains



Branched Chains

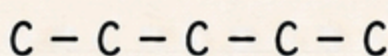


Rings



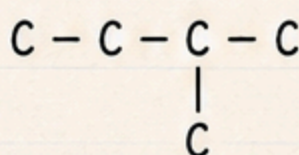
Types of Carbon Skeletons

Straight Chain



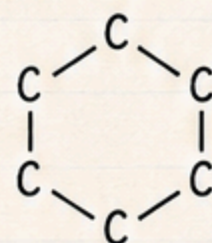
(Open chain)

Branched Chain



(Open chain)

Ring Structure

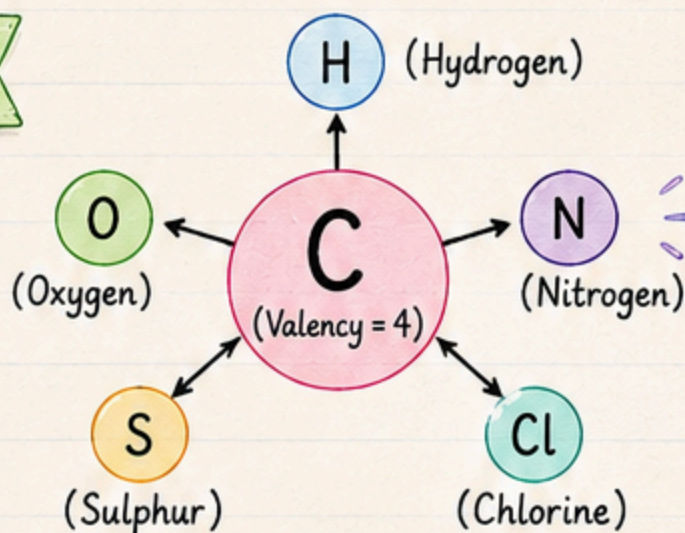


(Closed chain)

Catenation leads to
Large Molecules
and
Stable Compounds.

2 TETRAVALENCY

- Carbon valency = 4.
- Bonds with carbon, hydrogen, oxygen, nitrogen, sulphur and chlorine.



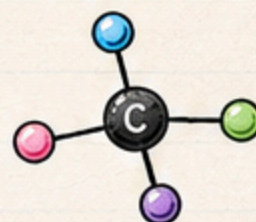
This ability makes carbon the basis of an enormous number of compounds!

KEY POINTS

★ Catenation → forms chains and rings.

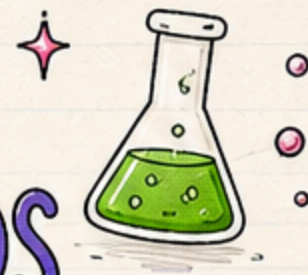
★ Tetravalency → forms bonds with many elements.

★ Result → Large Molecules + Stable Compounds!





SATURATED & UNSATURATED COMPOUNDS



Reactivity follows the bonding pattern! ❤️

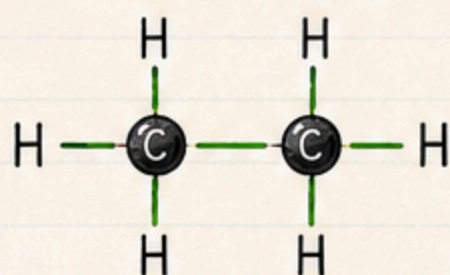
SATURATED COMPOUNDS	UNSATURATED COMPOUNDS
- Only <u>single bonds</u> between carbon atoms. - Example: Ethane (C_2H_6) - Less reactive.	- Have at least one <u>double</u> or <u>triple bond</u> between carbon atoms. - Examples: Ethene (C_2H_4) Ethyne (C_2H_2) - More reactive.



More multiple bonds, more reactivity! ❤️

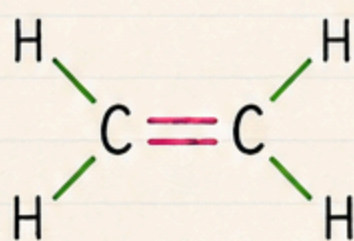
MOLECULAR STRUCTURES

ETHANE (C_2H_6)



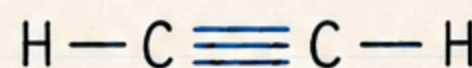
SINGLE BOND
(SATURATED)

ETHENE (C_2H_4)



DOUBLE BOND
(UNSATURATED)

ETHYNE (C_2H_2)



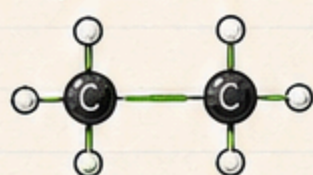
TRIPLE BOND
(UNSATURATED)

FAMILIES OF HYDROCARBONS

1. ALKANES

- Saturated hydrocarbons.
- Only single bonds.
- General formula: C_nH_{2n+2}

Example: Ethane (C_2H_6)

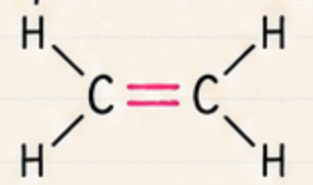


(All single bonds)

2. ALKENES

- Unsaturated hydrocarbons.
- At least one double bond.
- General formula: C_nH_{2n}

Example: Ethene (C_2H_4)



(One double bond)

3. ALKYNES

- Unsaturated hydrocarbons.
- At least one triple bond.
- General formula: C_nH_{2n-2}

Example: Ethyne (C_2H_2)



(One triple bond)

BOND DIFFERENCE

- $C - C \rightarrow$ Single bond (Saturated)
 $C = C \rightarrow$ Double bond (Unsaturated)
 $C \equiv C \rightarrow$ Triple bond (Unsaturated)

QUICK MEMORY

Single = Saturated
 Double/ Triple = Unsaturated

KEY POINT

Saturated compounds are more stable and less reactive, while unsaturated compounds are more reactive due to multiple bonds.



FUNCTIONAL GROUPS & HOMOLOGOUS SERIES

Organic Chemistry made easy!



1. FUNCTIONAL GROUPS

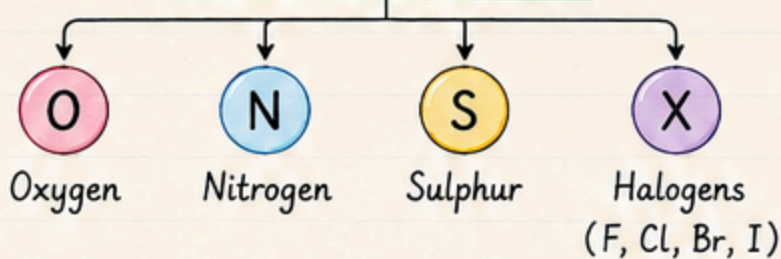
The chemical behaviour of organic compounds depends on their functional groups.

Functional Group	Symbol	General Formula	Example
Alcohol	-OH	R-OH	CH ₃ -CH ₂ -OH (Ethanol)
Aldehyde	-CHO	R-C(=O)-H	CH ₃ -C(=O)-H (Ethanal)
Ketone	-CO-	R-C(=O)-R'	CH ₃ -C(=O)-CH ₃ (Propanone)
Carboxylic acid	-COOH	R-C(=O)-OH	CH ₃ -C(=O)-OH (Ethanoic acid)
Halo compounds	-Cl / -Br	R-X (X = Cl, Br)	CH ₃ -CH ₂ -Cl (Chloroethane)

2. HETEROATOMS

Atoms other than carbon and hydrogen present in organic compounds are called heteroatoms.

Common Heteroatoms



★ Heteroatoms often replace hydrogen atoms in carbon compounds and change their properties.

3. HOMOLOGOUS SERIES

A homologous series is a family of organic compounds having the same functional group and similar chemical properties.

- All members have the same functional group.
- Successive members differ by -CH₂- unit.
- They have similar chemical properties.
- Physical properties change gradually.

Example:

Alkenes (one double bond)

General formula: C_nH_{2n}

Examples:

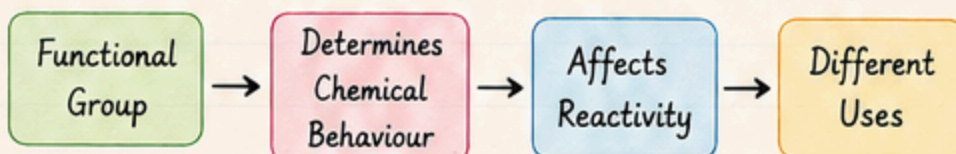
Ethene	C ₂ H ₄	n = 2
Propene	C ₃ H ₆	n = 3
Butene	C ₄ H ₈	n = 4

Each member differs by -CH₂- unit.

REVISION TIP

Identify the functional group → Predict the properties!

RELATION BETWEEN STRUCTURE & PROPERTIES



REMEMBER!

Same functional group → Similar properties
Different functional group → Different properties

★ QUICK CHECK

- Alcohols contain -OH group.
- Aldehydes contain -CHO group.
- Carboxylic acids contain -COOH group.



CHEMICAL PROPERTIES OF CARBON COMPOUNDS

Organic reactions in action!

Carbon compounds show a variety of chemical reactions!



1 COMBUSTION



Carbon compounds burn in oxygen to produce carbon dioxide, water, heat and light.

Equations:

- $C + O_2 \rightarrow CO_2 + \text{heat} + \text{light}$
- $CH_4 + O_2 \rightarrow CO_2 + H_2O + \text{heat} + \text{light}$

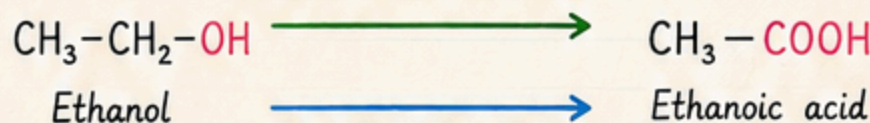
- Saturated hydrocarbons $\rightarrow$ clean flame
- Unsaturated compounds $\rightarrow$ yellow smoky flame



2 OXIDATION

Alcohols can be oxidised to carboxylic acids.

Using alkaline $KMnO_4$ (Warm)



Using acidified $K_2Cr_2O_7$ (Warm)

Alkaline $KMnO_4$

- Purple solution decolourises.
- Brown MnO_2 precipitate forms.



Acidified $K_2Cr_2O_7$

- Orange solution turns green.
- Indicates oxidation has occurred.



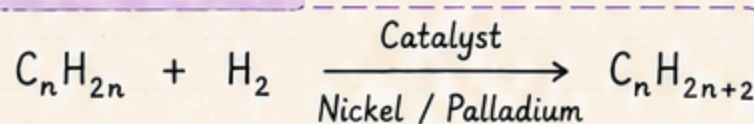
★ Oxidation adds oxygen or removes hydrogen.

3 ADDITION REACTION

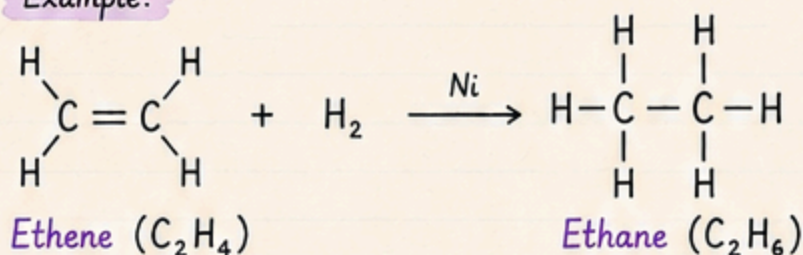


Unsaturated hydrocarbons add hydrogen to form saturated hydrocarbons.

General Reaction:



Example:



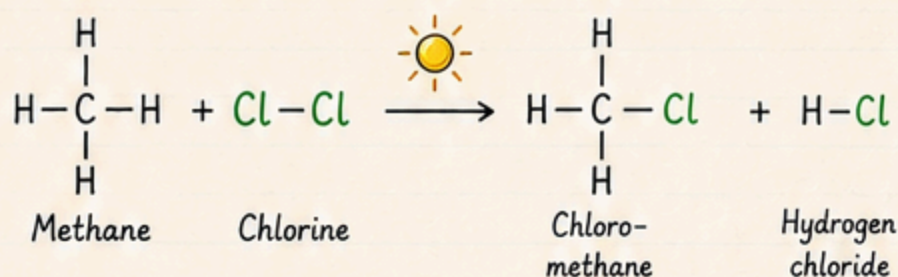
💡 Addition occurs at double or triple bonds.

4 SUBSTITUTION REACTION



In saturated hydrocarbons, one atom or group of atoms is replaced by another atom or group.

Example (Halogenation of Methane):



★ More chlorine can substitute further hydrogens to form CH_2Cl_2 , $CHCl_3$ and CCl_4

QUICK REVISION

1 COMBUSTION

- Burn in oxygen $\rightarrow$ CO_2 , H_2O , heat and light.



2 OXIDATION

- Alcohols oxidise to carboxylic acids.



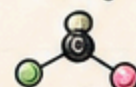
3 ADDITION

- Unsaturated + H_2 (Ni/Pd catalyst) $\rightarrow$ Saturated.



4 SUBSTITUTION

- H in saturated hydrocarbons replaced by other atoms/groups.



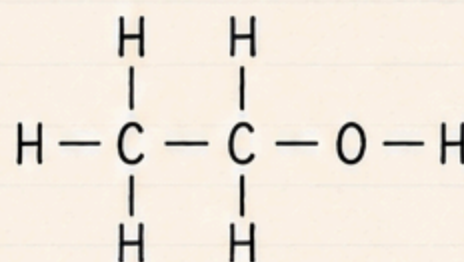


ETHANOL & ETHANOIC ACID

1. ETHANOL (C_2H_5OH)

PROPERTIES

- Liquid at room temperature.
- Active ingredient in alcoholic drinks.
- Good solvent.
- Soluble in water.



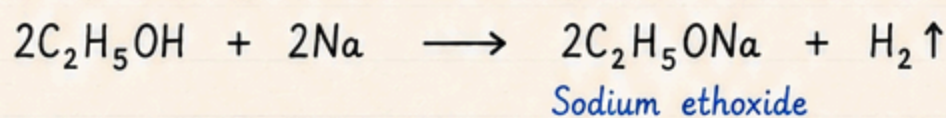
Ethanol

IMPORTANT
FOR BOARDS

FREQUENTLY
ASKED

REACTIONS -

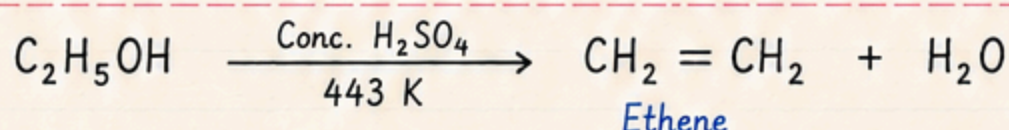
- ① Reaction with Sodium → Hydrogen gas evolved



Hydrogen
gas
evolved



- ② Dehydration → Conc. H_2SO_4 gives Ethene



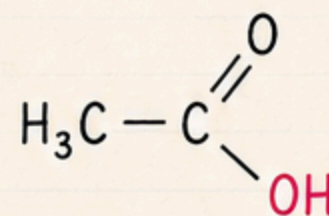
Elimination
of water



2. ETHANOIC ACID (CH_3COOH)

PROPERTIES

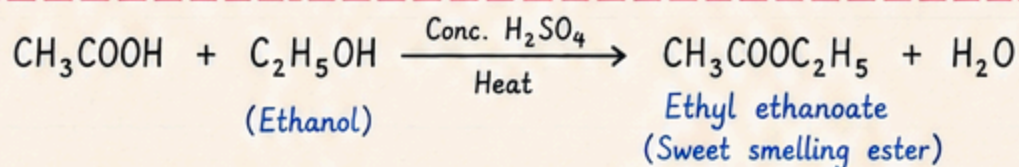
- Commonly called acetic acid.
- Vinegar contains 5–8% solution of acetic acid.
- Glacial acetic acid is pure acetic acid.
- Weak acid.



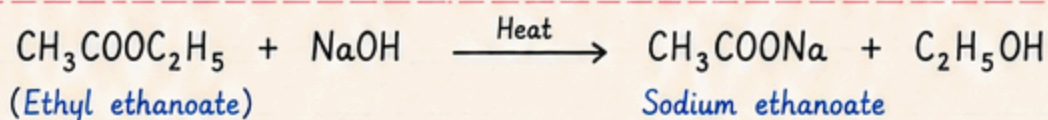
Ethanoic acid
(Acetic acid)

REACTIONS -

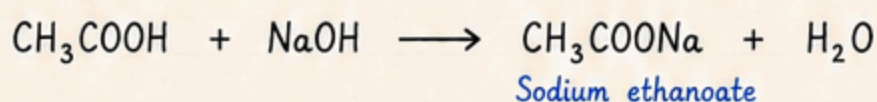
- ① Esterification



- ② Saponification

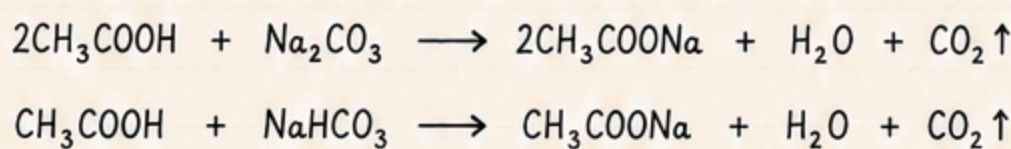


- ③ Reaction with NaOH



Acids react
with bases to
form salt + water.

- ④ Reaction with
Carbonates /
Hydrogencarbonates

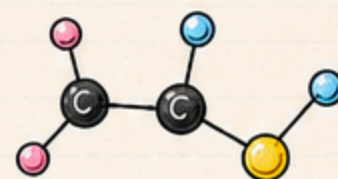


Effervescence
of CO_2 gas
observed.

★ Both ethanol and ethanoic acid are important in daily life and industries. ♥

QUICK REVISION

- Ethanol → Alcoholic drinks, solvent
- Ethanoic acid → Vinegar, weak acid, used in esters & salts



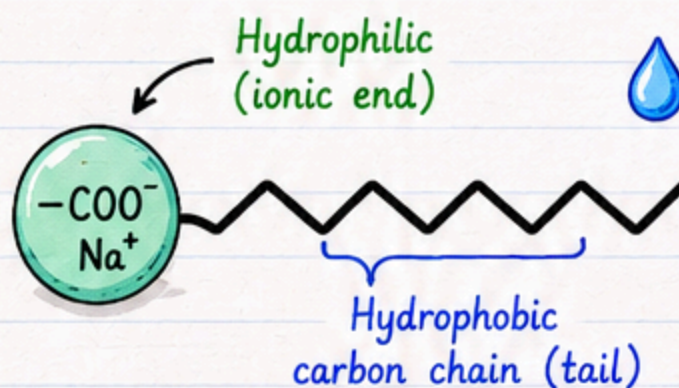
Used for
cleaning
and removing
oil & grease.

SOAPS & DETERGENTS



1. SOAP MOLECULES

- Soap molecules have two parts.
- **Hydrophilic (ionic) end**
- **Hydrophobic carbon chain (non-polar tail)**

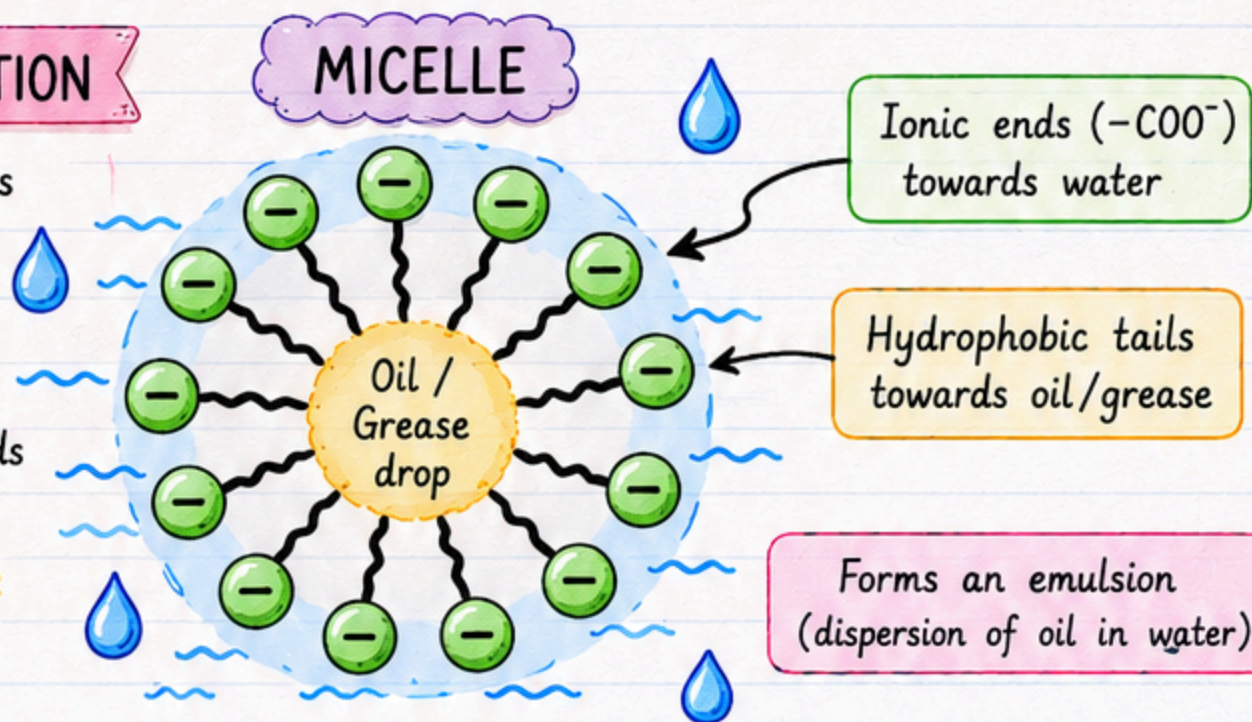


Example:

$R - COO^- Na^+$
(Sodium stearate)
A soap molecule

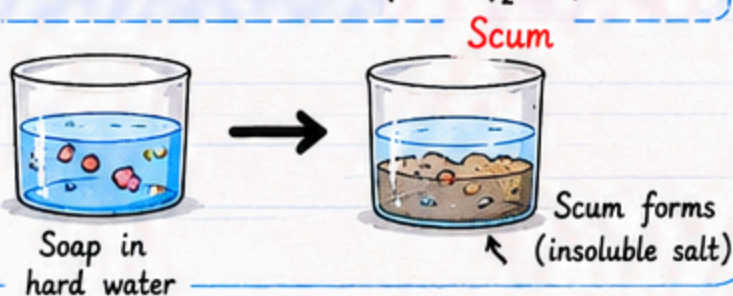
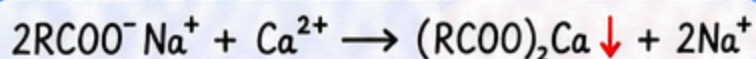
2. MICELLE FORMATION

- In water, soap molecules form micelles.
- The hydrophobic tail towards oil/grease.
- The hydrophilic ionic ends towards water.
- This forms an emulsion, so that dirt can be washed away.



3. HARD WATER

- Hard water contains calcium (Ca^{2+}) and magnesium (Mg^{2+}) salts.
- Soap reacts with these ions and forms insoluble scum.



4. DETERGENTS

- Detergents are effective in hard water.
- They do not form insoluble precipitates with Ca^{2+} and Mg^{2+} .
- Hence, they clean well even in hard water.



Key Points

- ✓ Soap → not effective in hard water.
- ✓ Detergents → work in hard water.



QUICK REVISION

"Soap cleans by emulsifying oily dirt."

Common Uses

- ✓ Soaps → bathing, washing clothes, utensils.
- ✓ Detergents → clothes washing (laundry), dishwashing.



MCQs • PYQs • ONE-LINER REVISION • MIND MAP

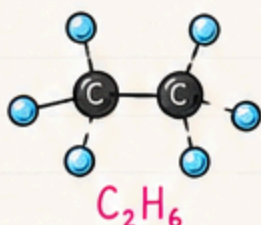


1 MCQs

Practice
Makes
Perfect!

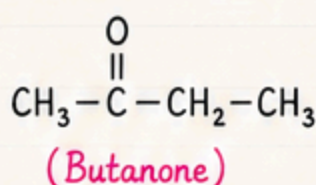
1. Ethane (C_2H_6) has:

- ☐ 6 covalent bonds
- ☐ 7 covalent bonds
- ☐ 8 covalent bonds
- ☐ 9 covalent bonds



2. Butanone contains:

- ☐ alcohol
- ☐ aldehyde
- ☐ ketone
- ☐ carboxylic acid



3. Blackened vessel bottom means:

- ☐ fuel not burning completely
- ☐ food not cooked completely
- ☐ fuel wet
- ☐ complete combustion



ANSWER KEY: 1. (C) 2. (C) 3. (A)

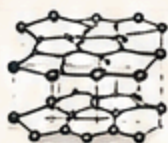
2 PYQ IMPORTANT QUESTIONS

- 1 Explain covalent bond formation in CH_3Cl .
- 2 Define homologous series.
- 3 Differentiate ethanol and ethanoic acid.
- 4 Explain cleaning action of soaps.
- 5 What is hydrogenation?

Focus
Revise
Score
100/100 😊

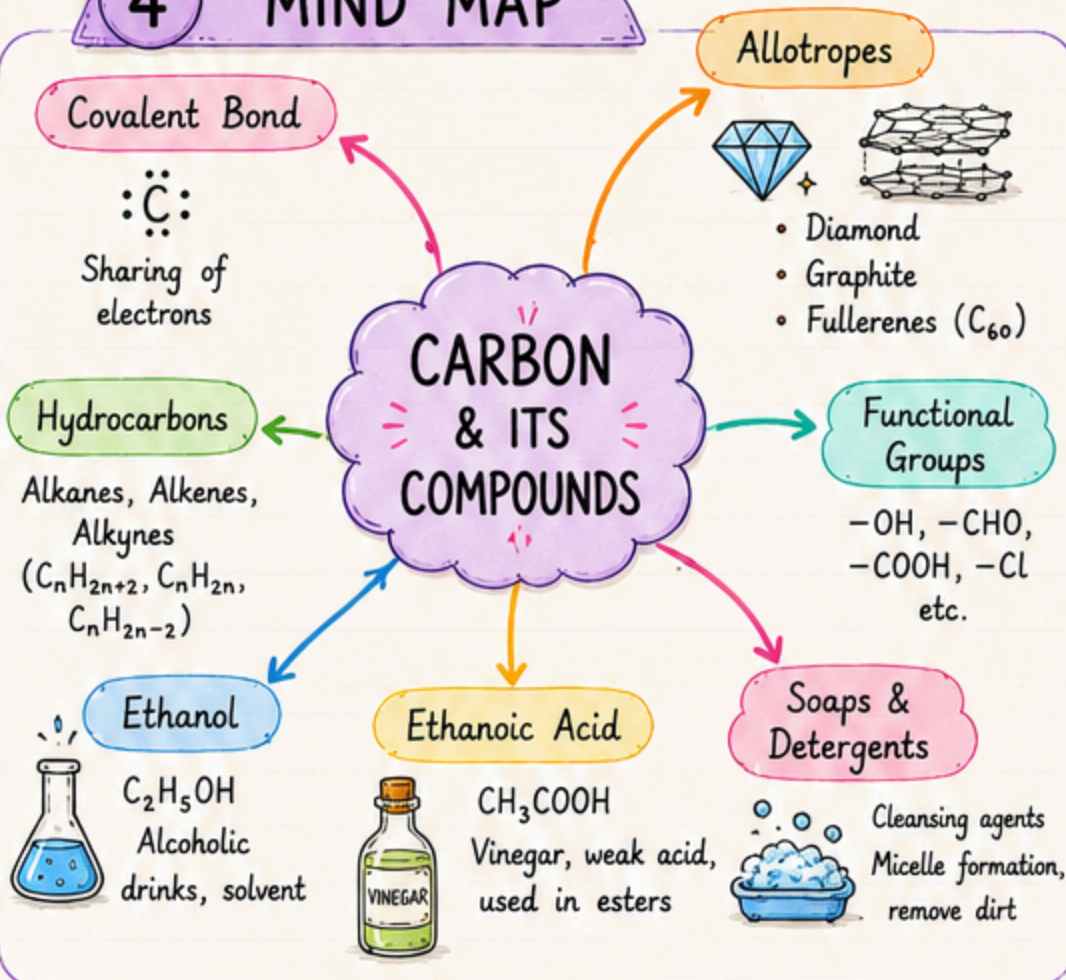
3 ONE-LINER REVISION

- Carbon is tetravalent.
- Catenation gives long chains.
- Covalent compounds are poor conductors.
- Diamond is hardest allotrope.
- Graphite conducts electricity.
- Soap forms micelles.



Memory Trick
Hard Diamond,
Slippery Graphite!

4 MIND MAP



SUCCESS FORMULA

- ✓ Understand Concepts
- ✓ Practice Questions
- ✓ Revise Regularly
- ✓ Stay Consistent
- ✓ Score Excellent!

Don't Just Study,
Understand &
Excel!

KEY TO SUCCESS

- ★ Plan Your Study
- ★ Focus on Weak Areas
- ★ Solve PYQs
- ★ Revise with Mind Maps

@ DiagramDidi