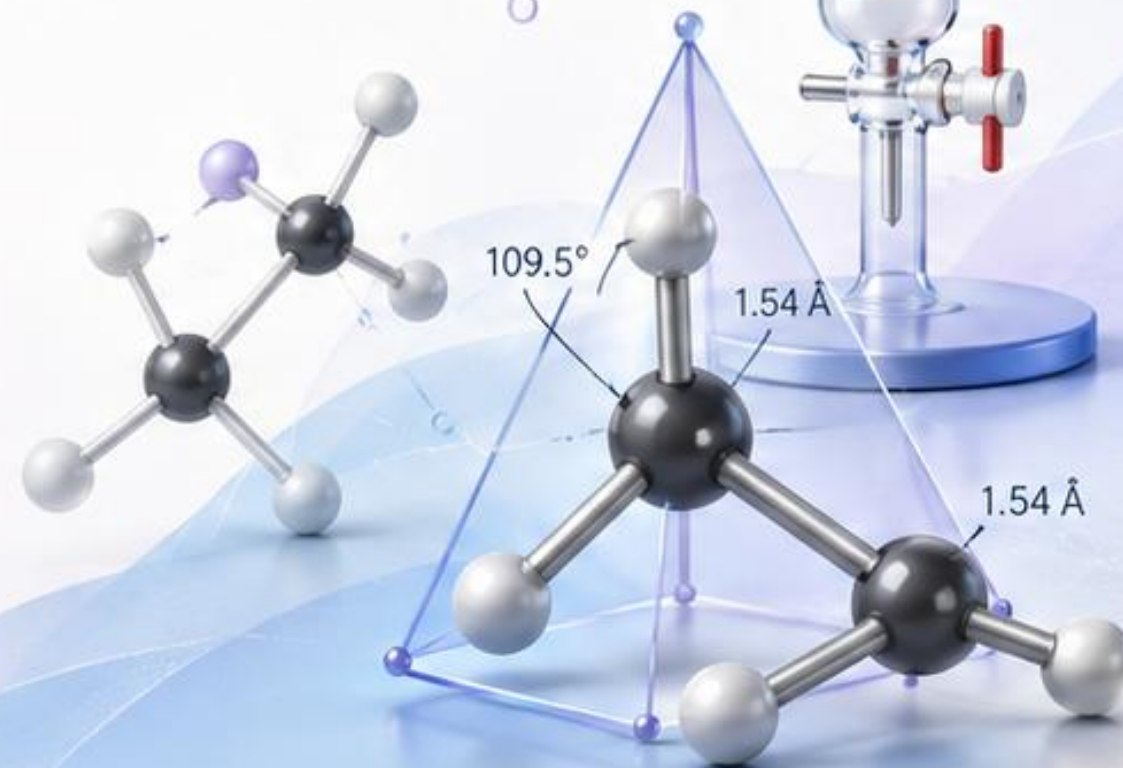
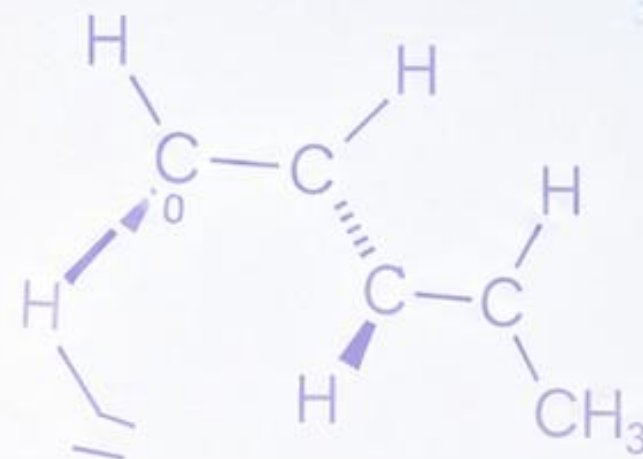




and Techniques



Chemistry Notes | Class 11

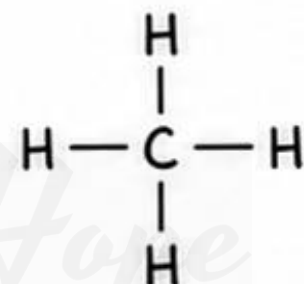
ORGANIC CHEMISTRY: SCOPE & HISTORY

1 WHAT IS ORGANIC CHEMISTRY?

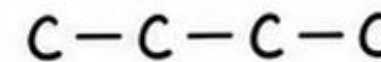
- Study of carbon compounds, especially compounds containing carbon-hydrogen bonds and their derivatives.
- Carbon forms an enormous variety of compounds because of tetravalence and catenation.
- Organic compounds are central to living systems and also occur in fuels, medicines, dyes, polymers, perfumes and many materials.

2 WHY CARBON IS SPECIAL

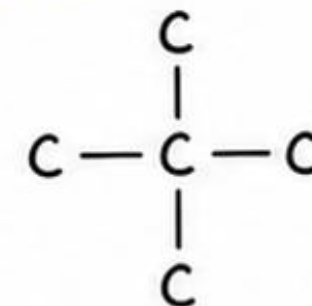
- Tetravalence: one carbon atom can form four covalent bonds.
- Catenation: carbon atoms link with one another to form long chains, branched chains and rings.
- Carbon makes stable single, double and triple bonds with carbon and many other elements.



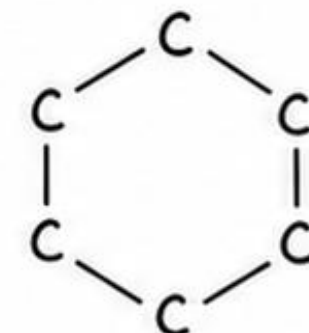
carbon bonded
four ways



straight chain



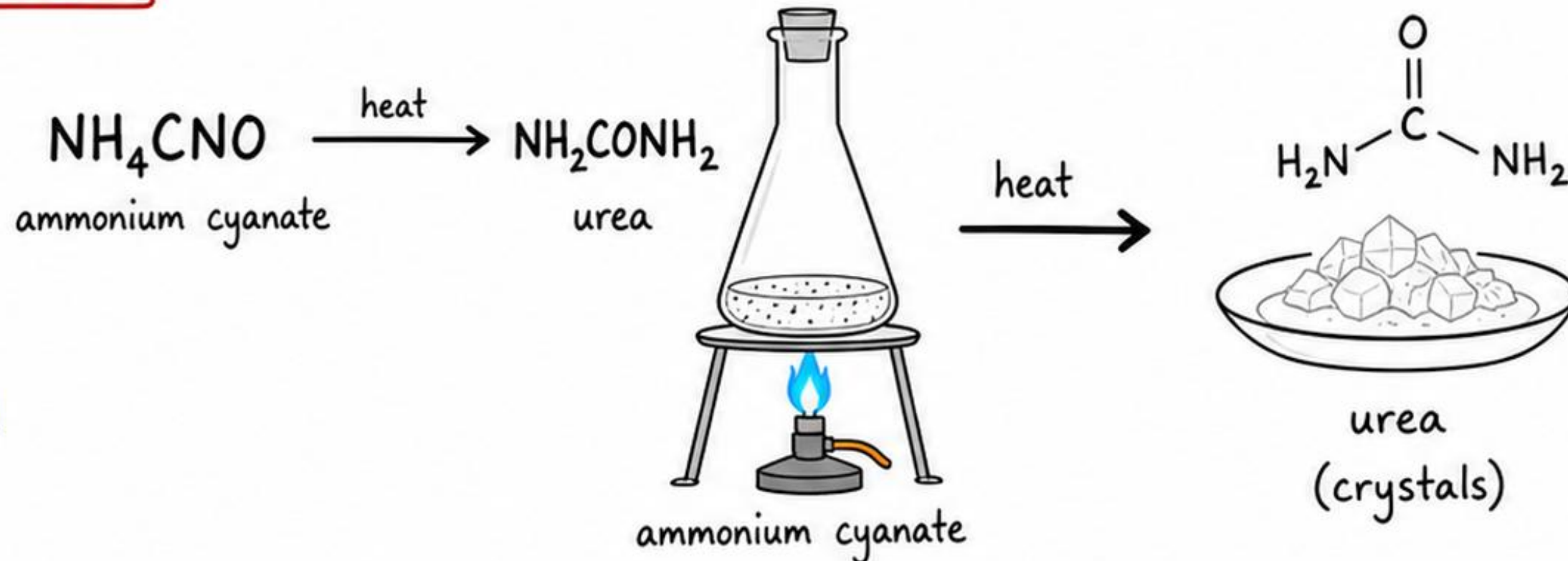
branched chain



ring (cyclohexane
skeleton)

3 FROM VITAL FORCE TO LABORATORY SYNTHESIS

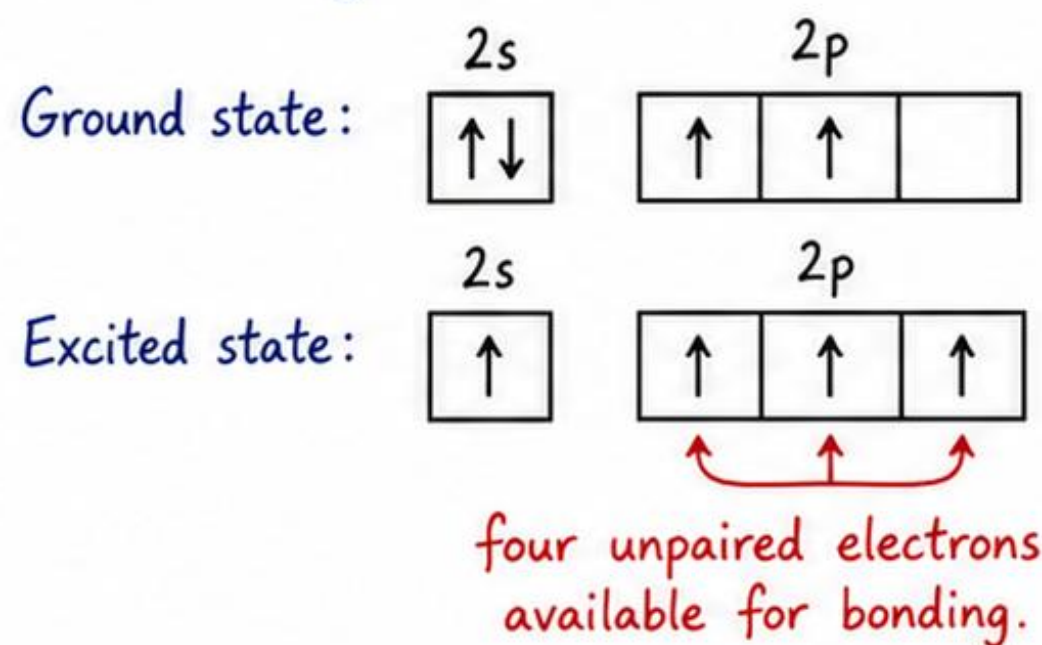
- Earlier belief: organic compounds could be formed only inside living organisms by a mysterious "vital force".
- In 1828, Friedrich Wöhler prepared urea from ammonium cyanate in the laboratory.
- This experiment rejected the vital-force idea and helped establish modern organic chemistry.



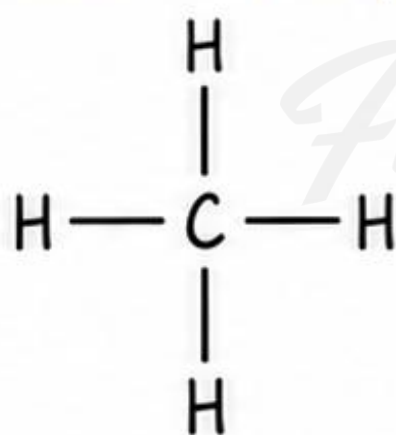
CARBON: TETRAVALENCE & HYBRIDISATION

TETRAVALENCE OF CARBON

- Carbon electronic configuration: $1s^2 2s^2 2p^2$.
- In the ground state it has only two unpaired electrons, yet carbon normally forms four covalent bonds.
- Promotion followed by hybridisation gives four bonding orbitals.



Methane, CH_4



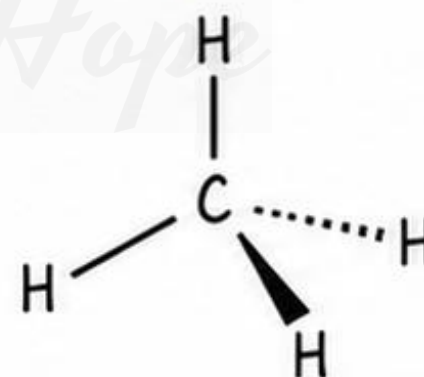
Four equivalent C-H σ bonds.

THREE COMMON HYBRID STATES

① sp^3

= 1s + 3p orbitals mixed
 $\downarrow$
4 equivalent sp^3 orbitals

Geometry: tetrahedral
Bond angle: 109.5°

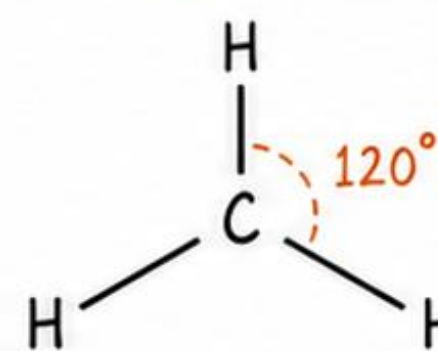


Example: methane, CH_4
(single-bonded carbon)

② sp^2

= 1s + 2p orbitals mixed
 $\downarrow$
3 equivalent sp^2 orbitals
+ 1 unhybridised p orbital

Geometry: trigonal planar
Bond angle: 120°

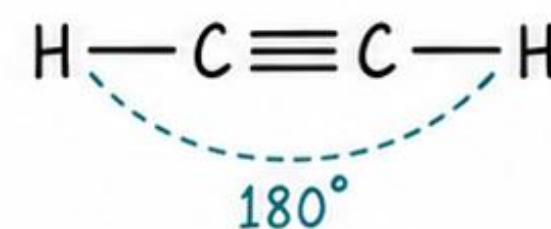


Example: ethene,
 $\text{H}_2\text{C}=\text{CH}_2$

③ sp

= 1s + 1p orbitals mixed
 $\downarrow$
2 equivalent sp orbitals
+ 2 unhybridised p orbitals

Geometry: linear
Bond angle: 180°



Example: ethyne,
 $\text{HC}\equiv\text{CH}$

s-character

$$\begin{aligned} sp^3 &= 25\% \\ sp^2 &= 33.3\% \\ sp &= 50\% \end{aligned}$$

As s-character increases:

- ✓ bond length decreases.
- ✓ bond strength increases.
- ✓ carbon electronegativity increases.

Order (increases)

$$sp > sp^2 > sp^3$$

(s-character, bond strength, electronegativity)

Order (increases)

$$sp < sp^2 < sp^3$$

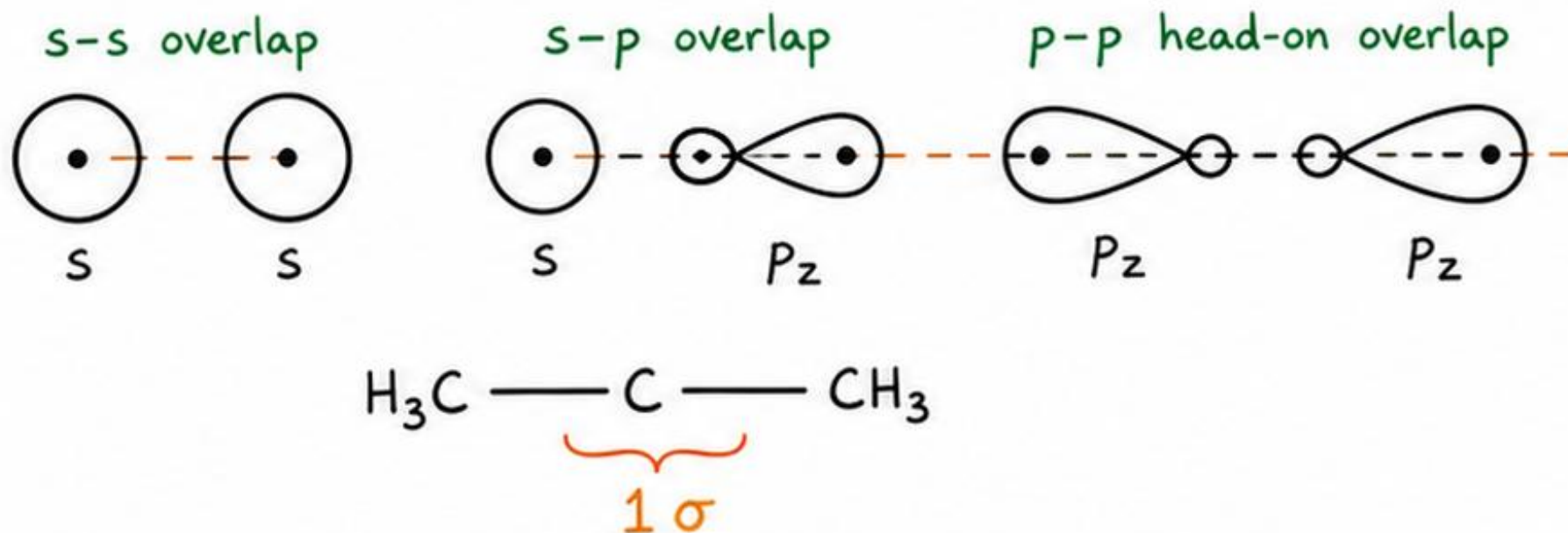
(bond length)

SIGMA (σ) AND PI (π) BONDS

Covalent bonds form by overlap of atomic orbitals. The way the orbitals overlap gives σ and π bonds.

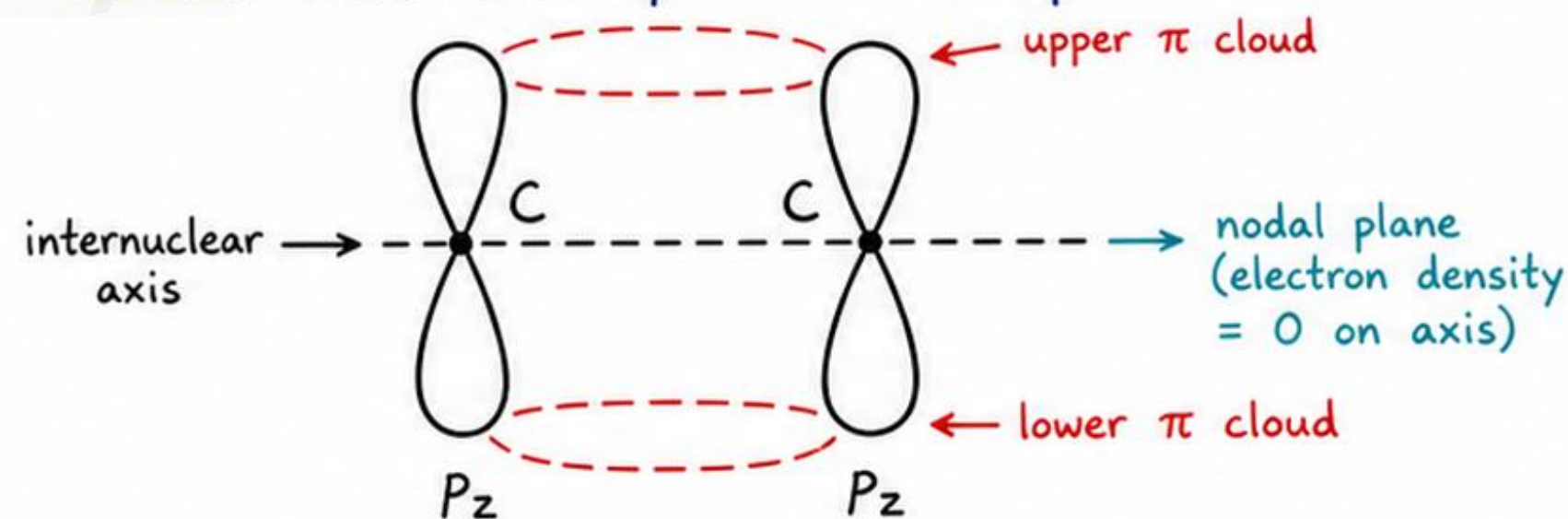
SIGMA BOND (σ)

- Formed by head-on (axial) overlap along the internuclear axis.
- Electron density is greatest between the two bonded nuclei and is cylindrically symmetrical around the axis.
- Stronger overlap, so a σ bond is generally stronger than a π bond.
- Free rotation is usually possible around an isolated single σ bond.

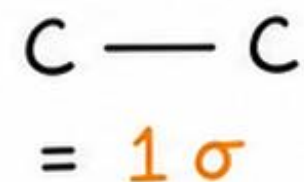


PI BOND (π)

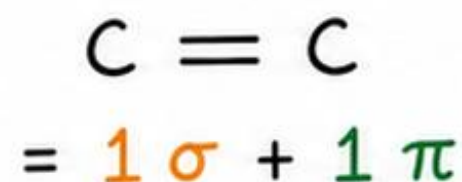
- Formed by sideways overlap of two parallel, unhybridised p orbitals.
- Electron cloud lies above and below the plane containing the nuclei.
- The internuclear axis is a nodal plane: electron density on the axis is zero.
- Sideways overlap is weaker; π electrons are more exposed and usually react more easily.
- Rotation about a double bond is restricted because rotation would break p-orbital overlap.



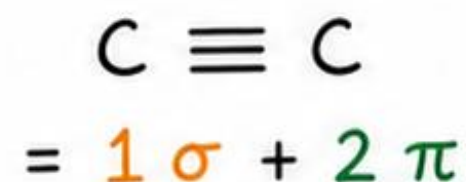
Single bond:



Double bond:



Triple bond:



Bond strength (typical):



Bond formation order:

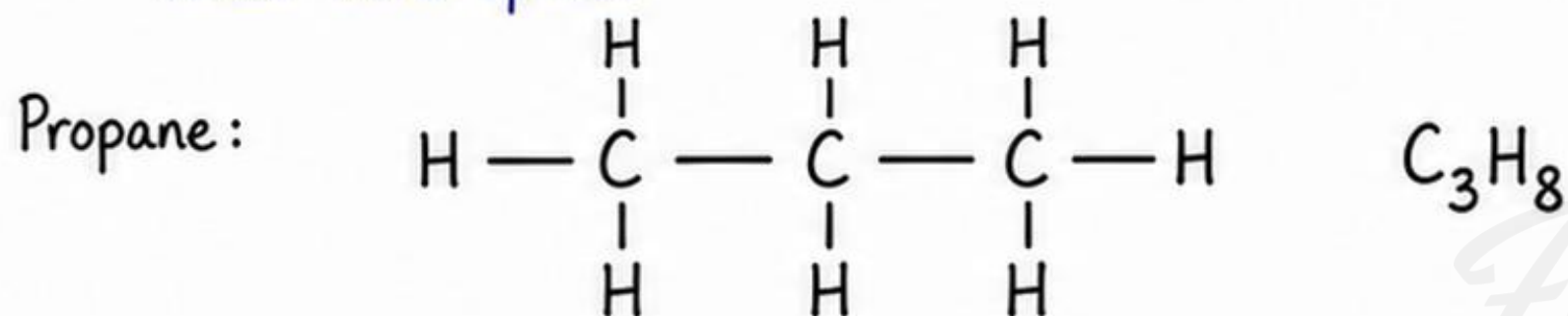
the σ bond forms first;
additional bond(s) are π bonds.

REPRESENTING ORGANIC STRUCTURES

The same molecule can be written in different ways. Each representation shows a different amount of structural detail.

① COMPLETE STRUCTURAL FORMULA

- Shows every atom and every covalent bond.
- Useful for seeing exact connectivity, but takes more space.



② CONDENSED FORMULA

- Bonds and atoms are grouped without drawing every C-H bond.



Explain: brackets show a branch attached to the preceding atom.

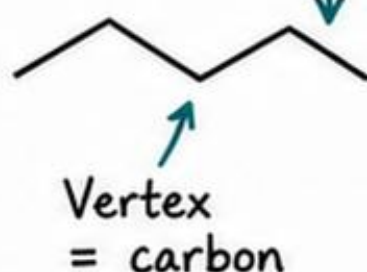
③ BOND-LINE / SKELETAL FORMULA

- Carbon atoms are understood at line ends and vertices.
- Most hydrogen atoms attached to carbon are omitted.
- Heteroatoms such as O, N, Cl and H attached to them are written.



Labels:

Line end
= carbon



④ HOW TO READ A SKELETAL FORMULA

- Count every line end and vertex as a carbon.
- Complete carbon valency to four with hidden H atoms.
- Keep all multiple bonds exactly as drawn.
- Write all heteroatoms and their attached H atoms.

Example: Given skeletal formula:



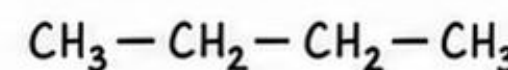
Step 1: Count line ends and vertices.

4 carbons

Step 2: Add H atoms to satisfy valency.

Step 3: No multiple bonds here.

Step 4: No heteroatoms here.



Therefore:
butane,
 C_4H_{10}

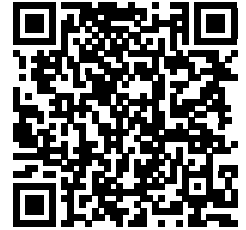


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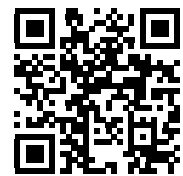


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