

Hyperconjugation: σ -Electron Delocalisation

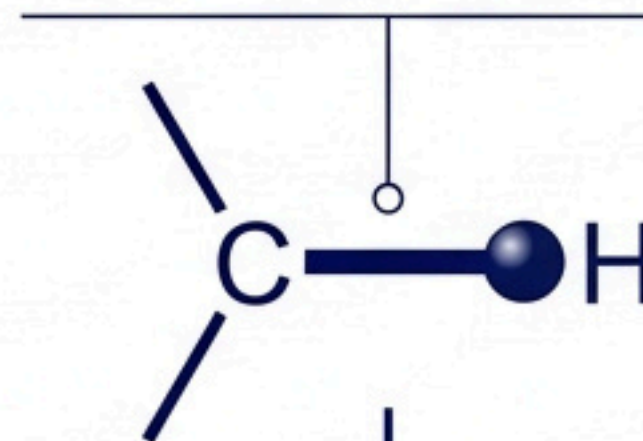
A permanent stabilizing effect where σ -electrons of a C–H bond delocalize into an adjacent empty or partially filled p-orbital (or π system).

[Permanent
Effect]

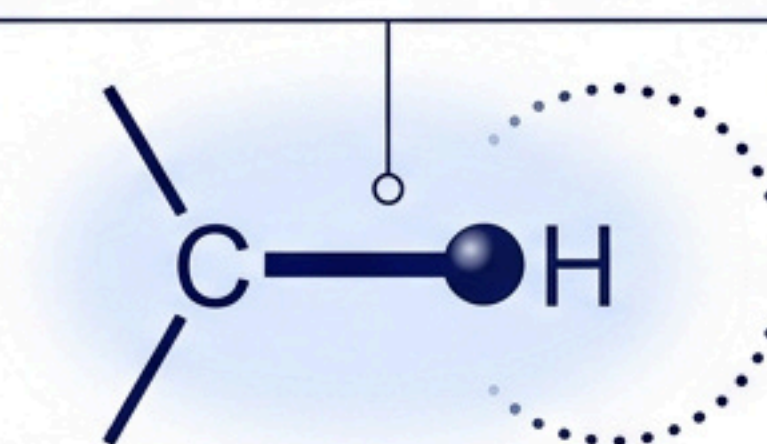
[$\sigma \rightarrow p$
Overlap]

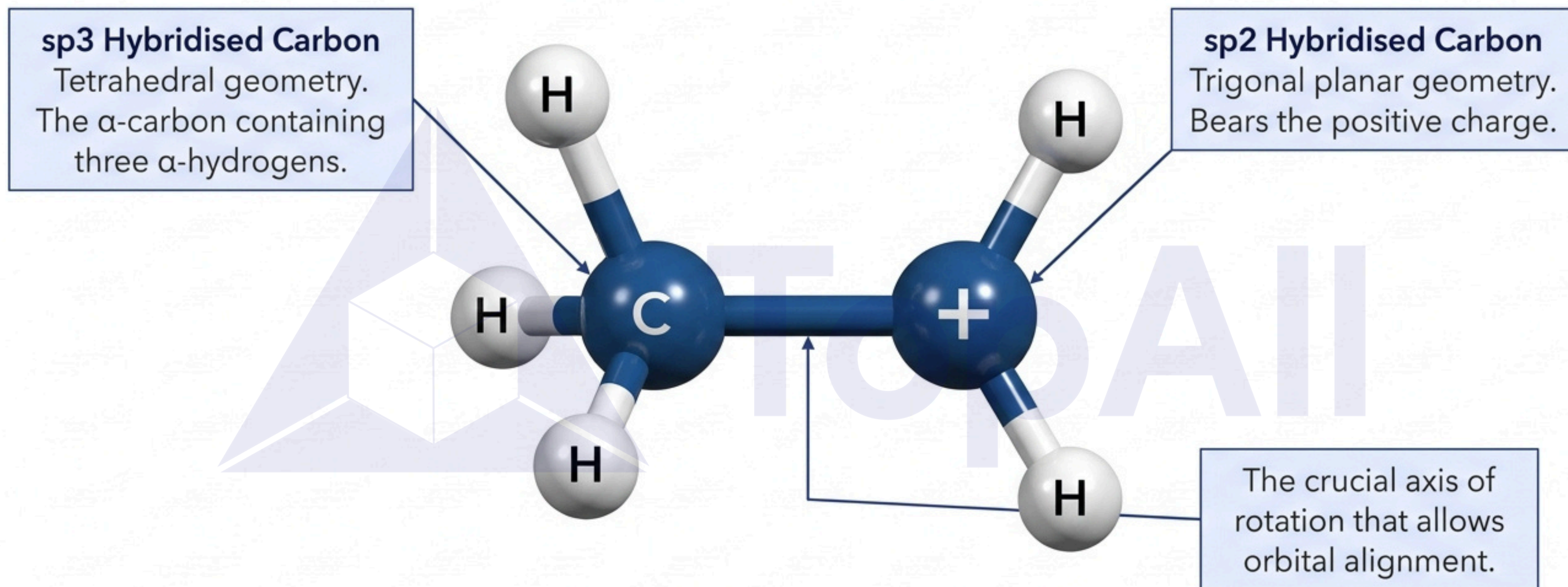
[No-Bond
Resonance]

Localized σ Bond



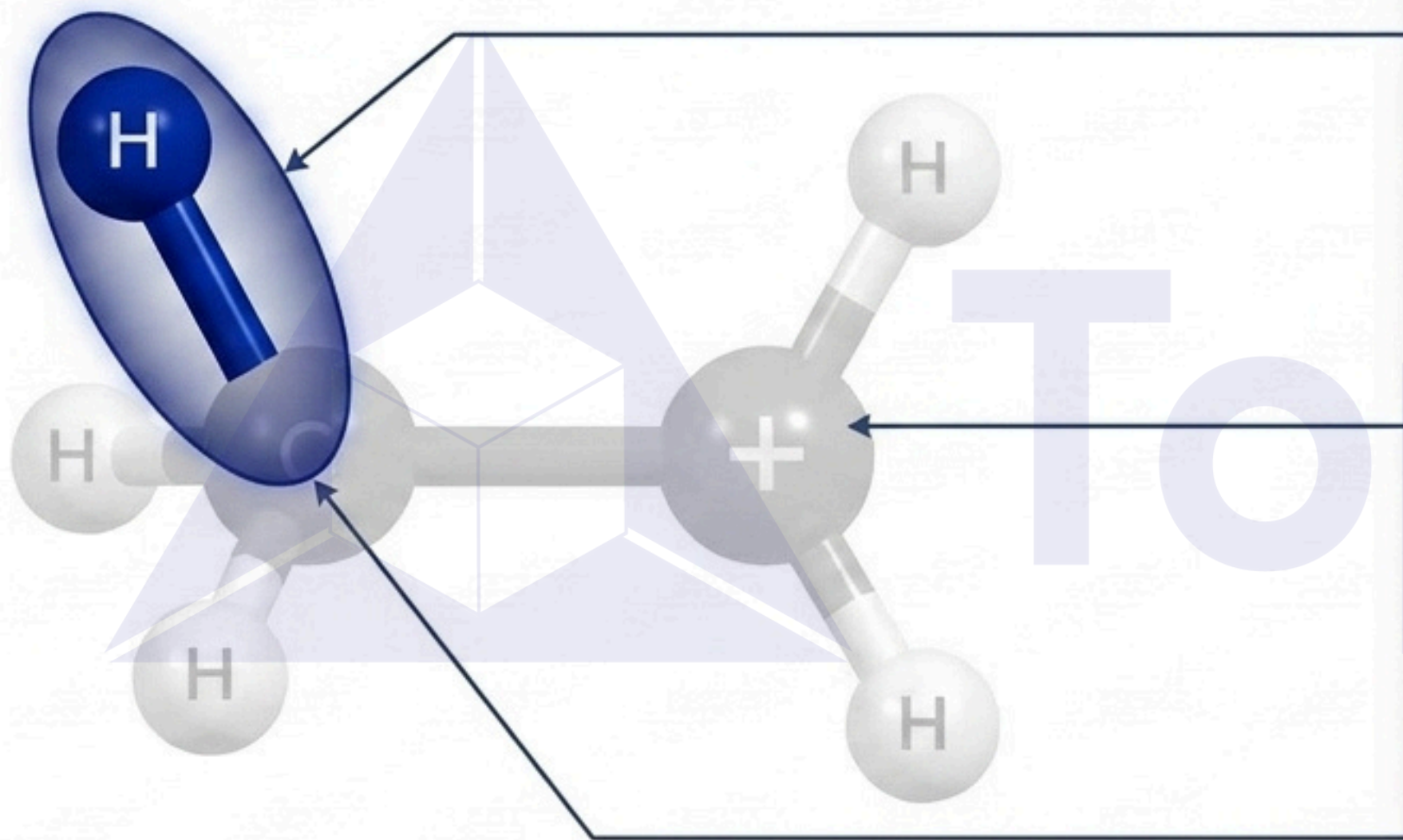
Delocalized σ Cloud





To understand hyperconjugation, we must look at the interactions between the α -hydrogens and the electron-deficient center.

Step 1: The Donor (C–H σ Bond)



The Setup

The sp^3 carbon holds three C–H σ bonds.

The Requirement

Due to free rotation around the C–C single bond, one of these C–H bonds will naturally align parallel to the adjacent empty orbital.

The Role

This aligned σ bond acts as an electron-rich 'donor', ready to share its electron density.



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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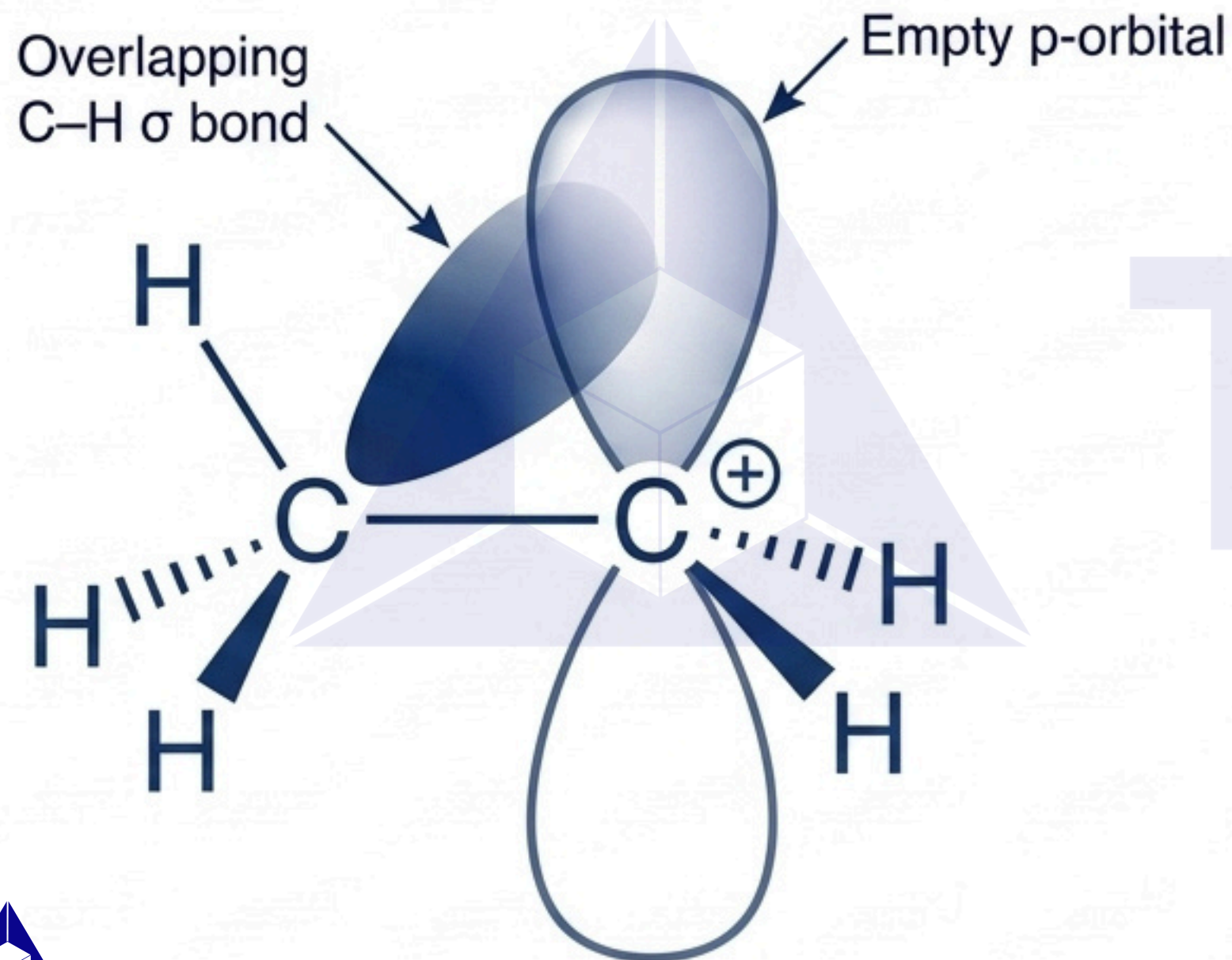
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Step 2: The Acceptor (Empty p Orbital) & Overlap



The Overlap:

The σ -electrons enter into partial conjugation with the unshared p-orbital.

The Result:

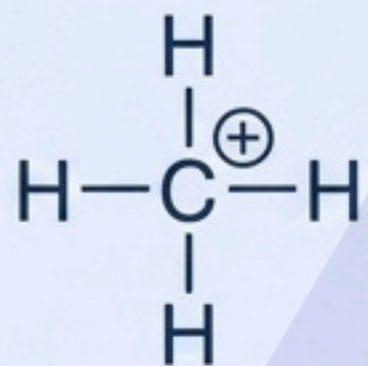
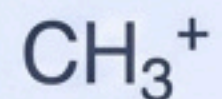
Dispersal of the positive charge. The adjacent C-H bond weakens, while the C-C single bond gains partial double-bond character.

Note:

Often termed “No-bond resonance” because the delocalization occurs without breaking the overall connectivity in the parent framework.

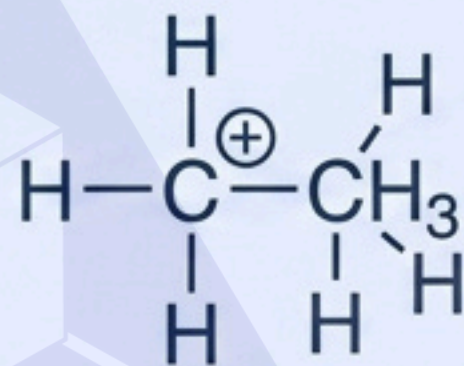
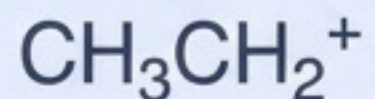
Macroscopic Consequence: Carbocation Stability

Methyl



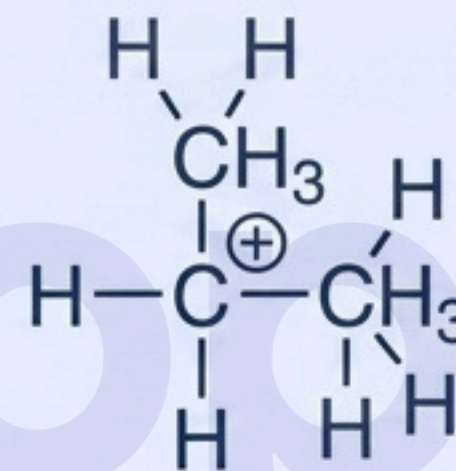
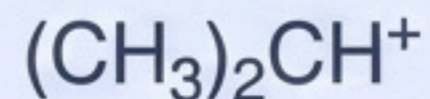
0 α -Hydrogens

Primary (1°)



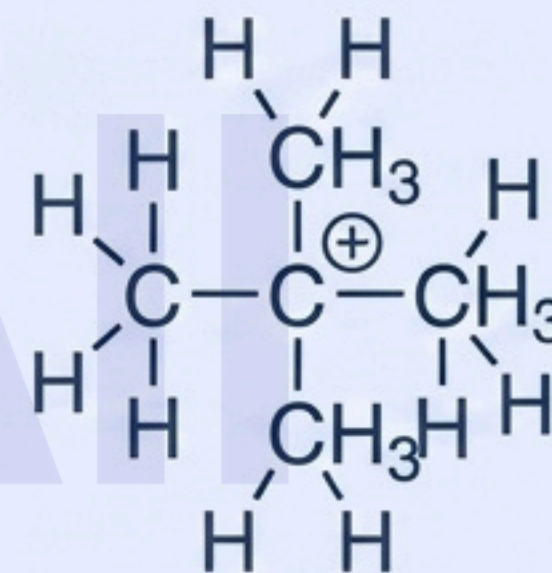
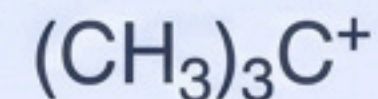
3 α -Hydrogens

Secondary (2°)



6 α -Hydrogens

Tertiary (3°)



9 α -Hydrogens

3°

>

2°

>

1°

>

CH₃⁺

Increasing Hyperconjugative Stabilization

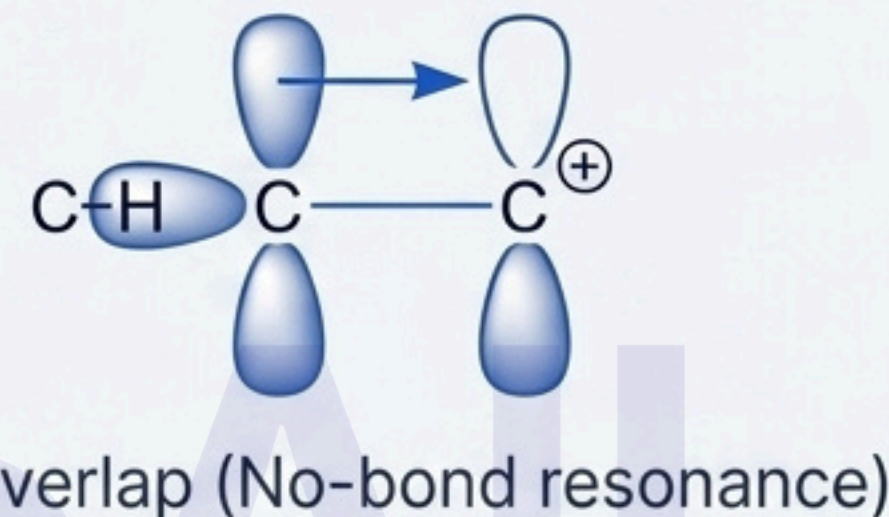


Revision Frame: Hyperconjugation

Definition

- Permanent electronic effect.
- Involves delocalisation of σ -electrons (usually C-H or C-C) into an adjacent empty p-orbital or π -bond.

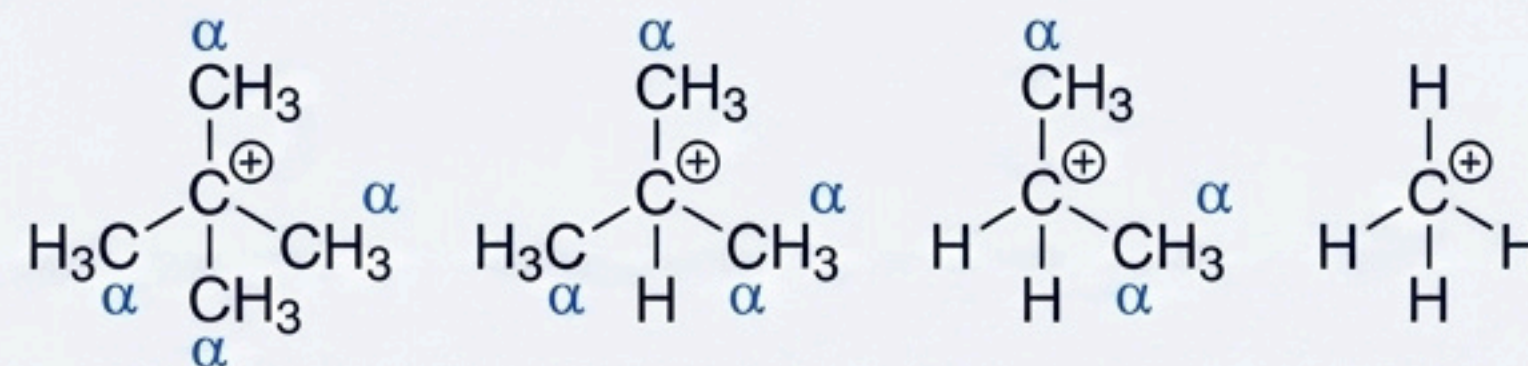
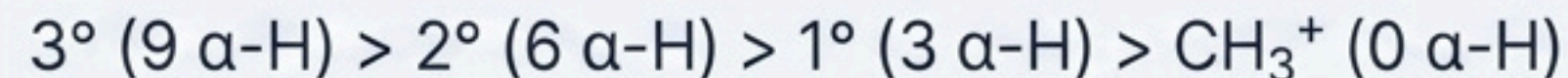
Mechanism



The Rule

More α -hydrogens = More hyperconjugative structures = Greater stability.

Stability Trend





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Practice the moment you finish studying
Jump in while the concept is still fresh in your head

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