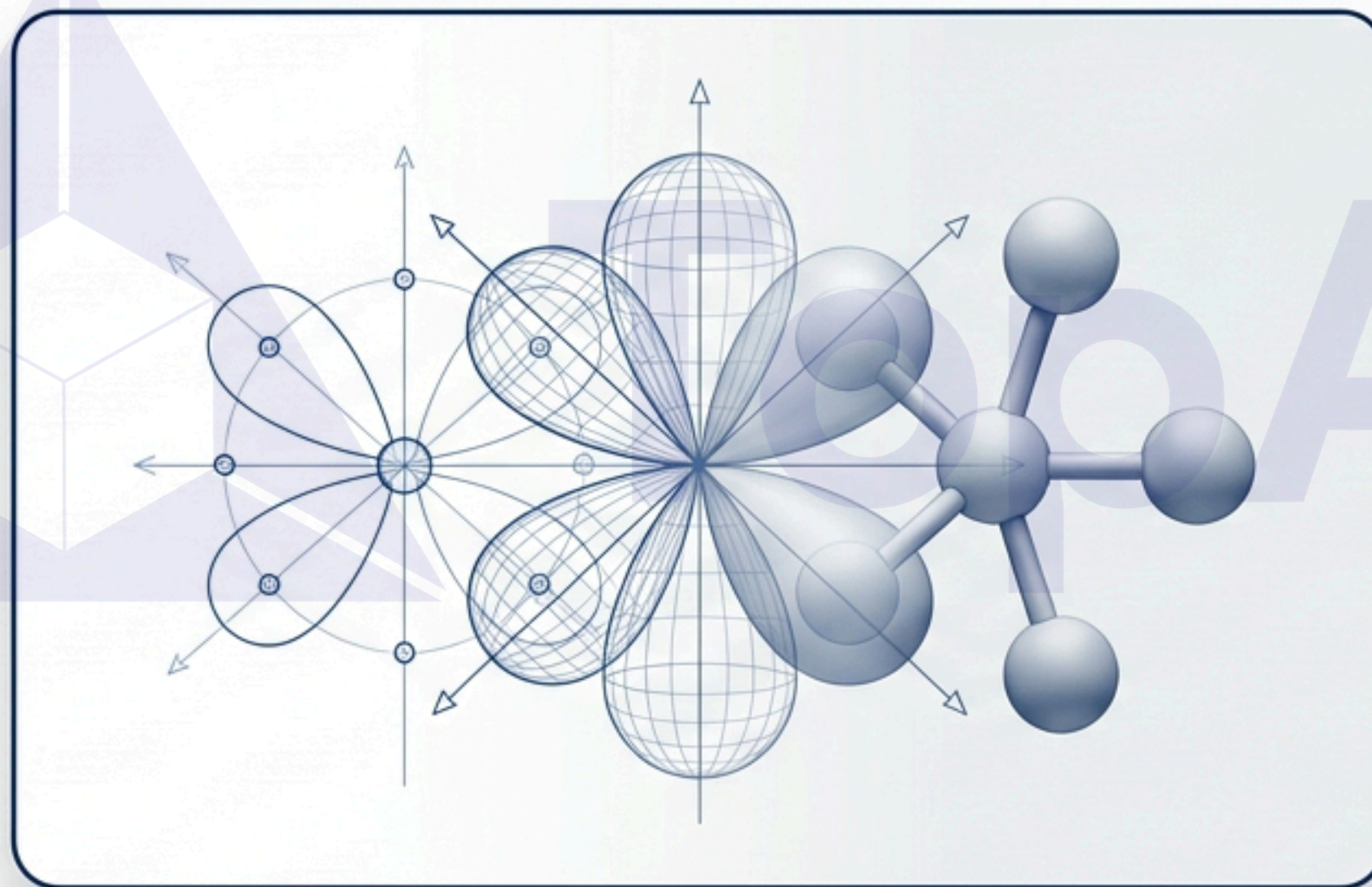
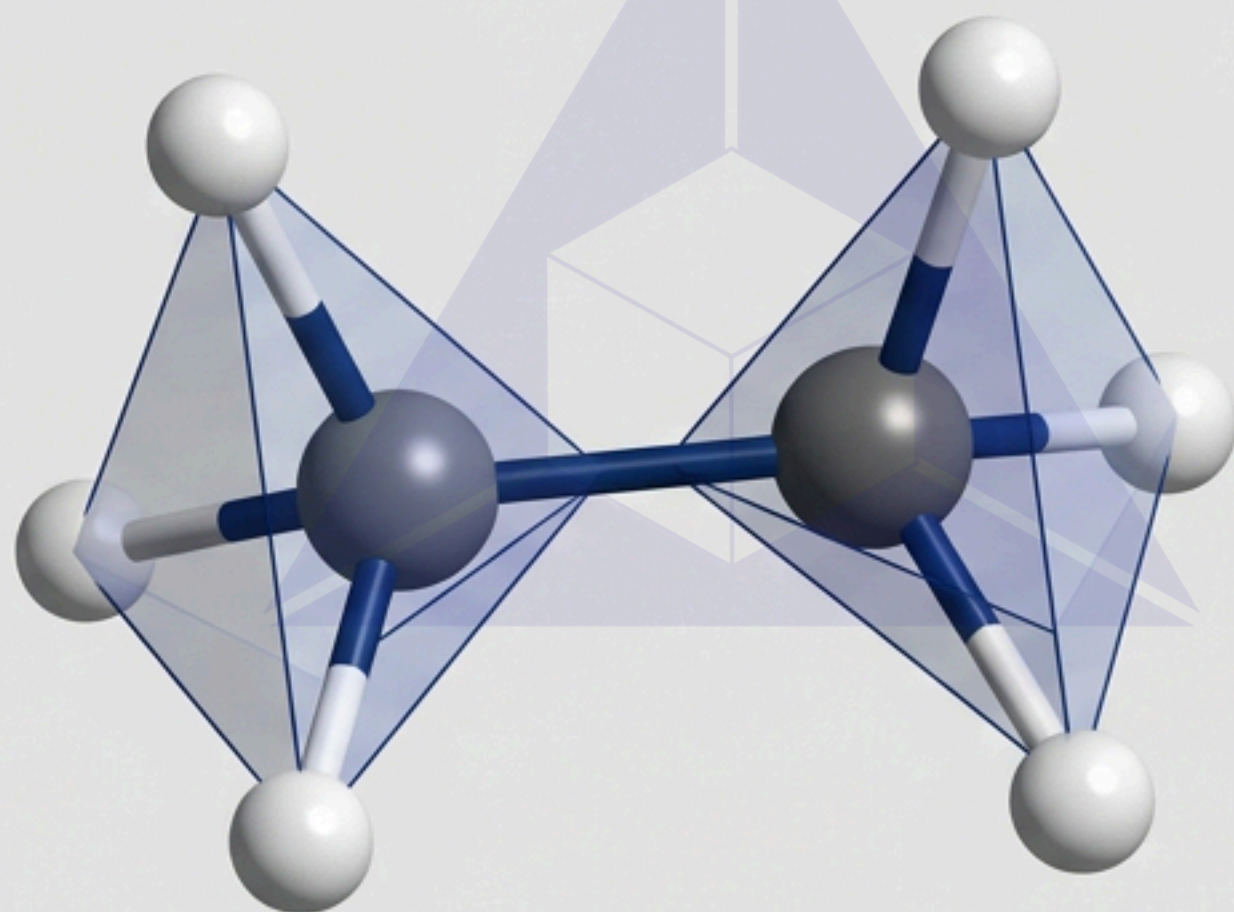


4.6.2 Other Examples of sp^3 , sp^2 and sp Hybridisation

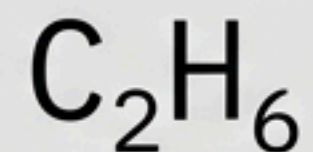
From simple carbon frameworks to hypervalent expanded-octet architectures.



Ethane: Tetrahedral Saturation



Formula



C-C Length

154 pm

C-H Length

109 pm

Bond Angle

109.5°

The Orbital Setup

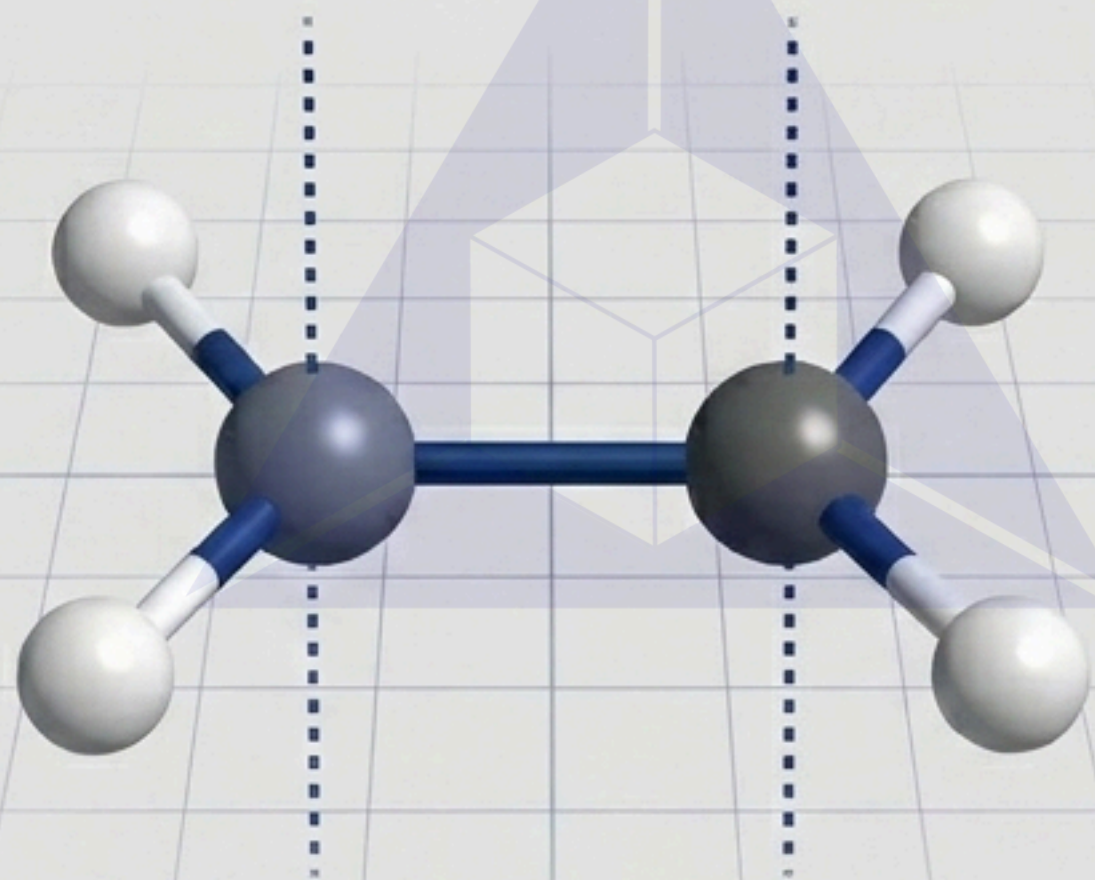
Both Carbon atoms assume the sp³ hybrid state.

The Overlap

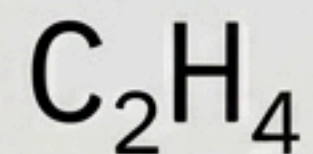
One sp³ orbital from each carbon overlaps axially to form a sturdy sp³-sp³ σ bond.
The remaining three form sp³-s σ bonds with Hydrogen.

PLANAR GEOMETRY

Ethene: The sp^2 Framework



Formula



C-C Length

134 pm
(shorter than Ethane)

C-H Length

108 pm

H-C-H Angle

117.6°

H-C-C Angle

121.0°

The Orbital Setup

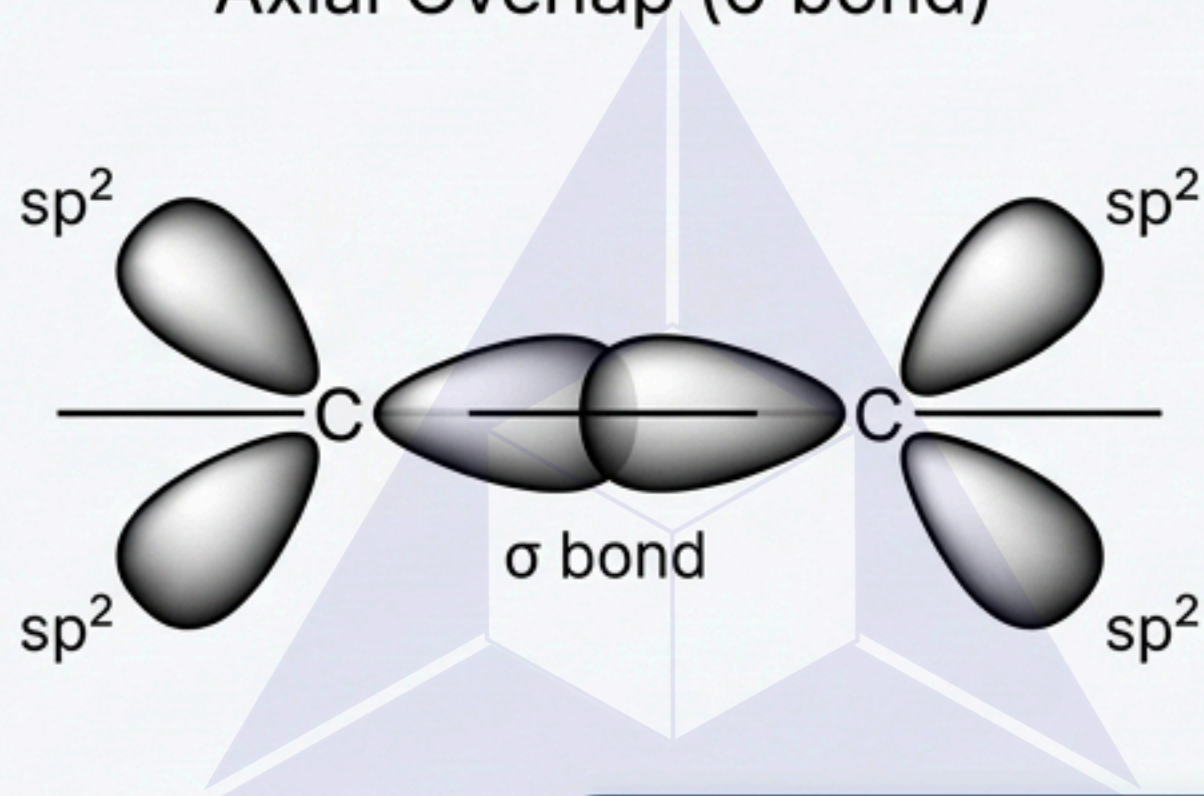
Each Carbon uses three sp^2 orbitals to build the flat trigonal σ skeleton.

The Leftover

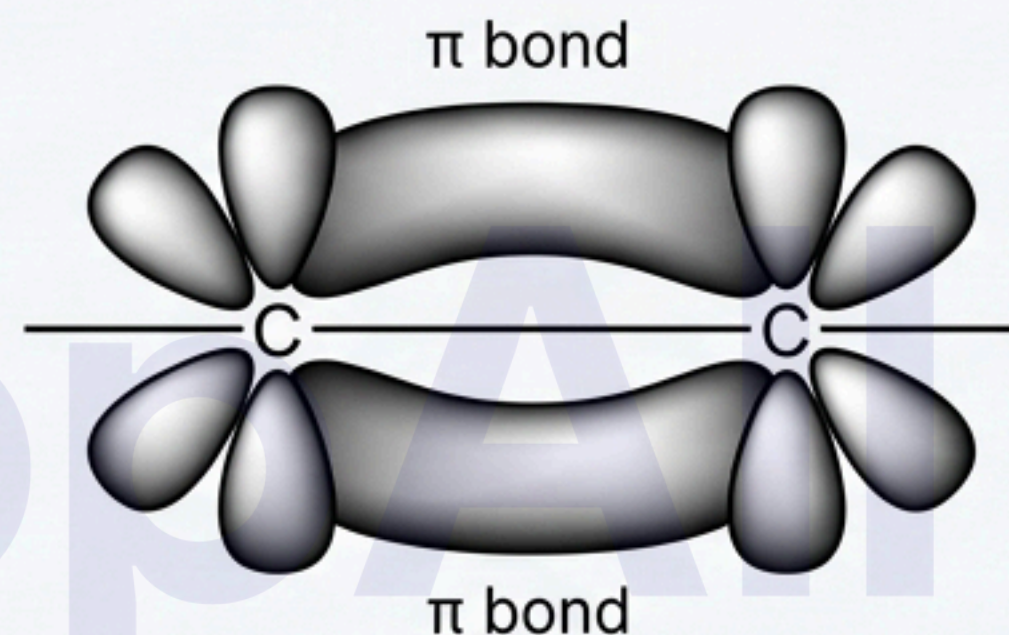
One unhybridized p orbital ($2p_x$ or $2p_y$) remains strictly perpendicular to the molecular plane on each carbon.

Sigma and Pi in Ethene

Axial Overlap (σ bond)



Lateral Overlap (π bond)



$\text{C}=\text{C}$ Double Bond = 1 σ (sp^2-sp^2) + 1 π (p-p)

The Pi-Bond Effect

The lateral overlap of the π bond restricts free rotation, locking Ethene into its rigid planar geometry and making the C-C bond significantly shorter (134 pm) than a single bond (154 pm).



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

$$E=mc^2$$



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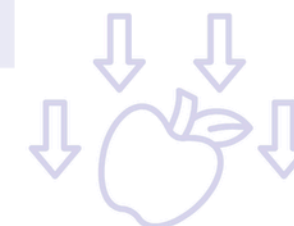
Practice Now



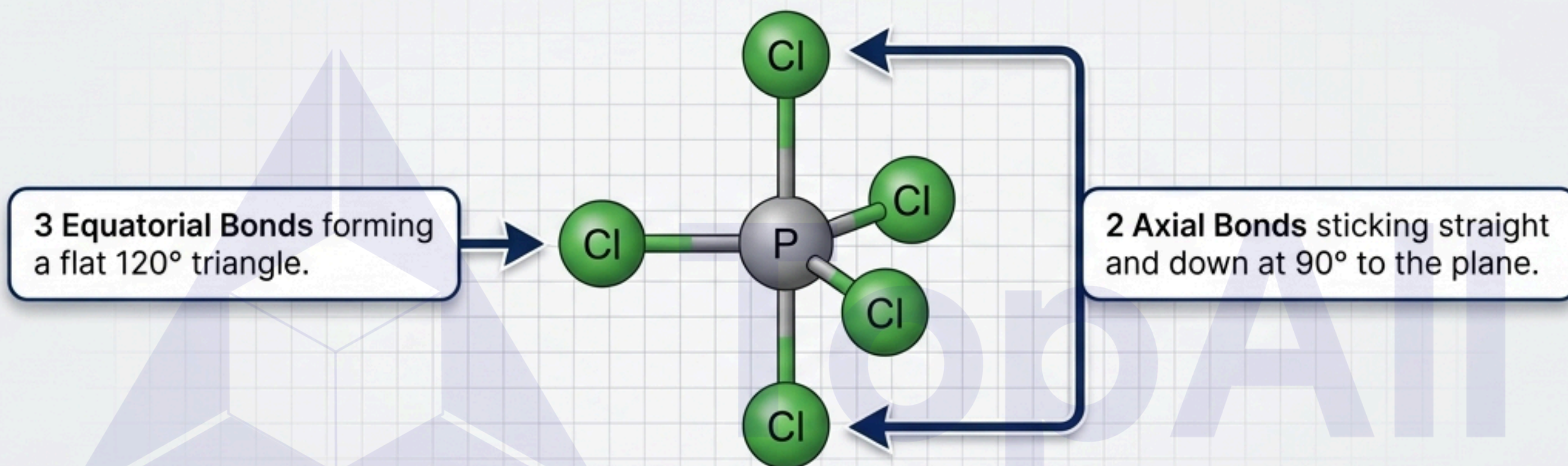
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Key Highlights

- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



Phosphorus Pentachloride: sp^3d



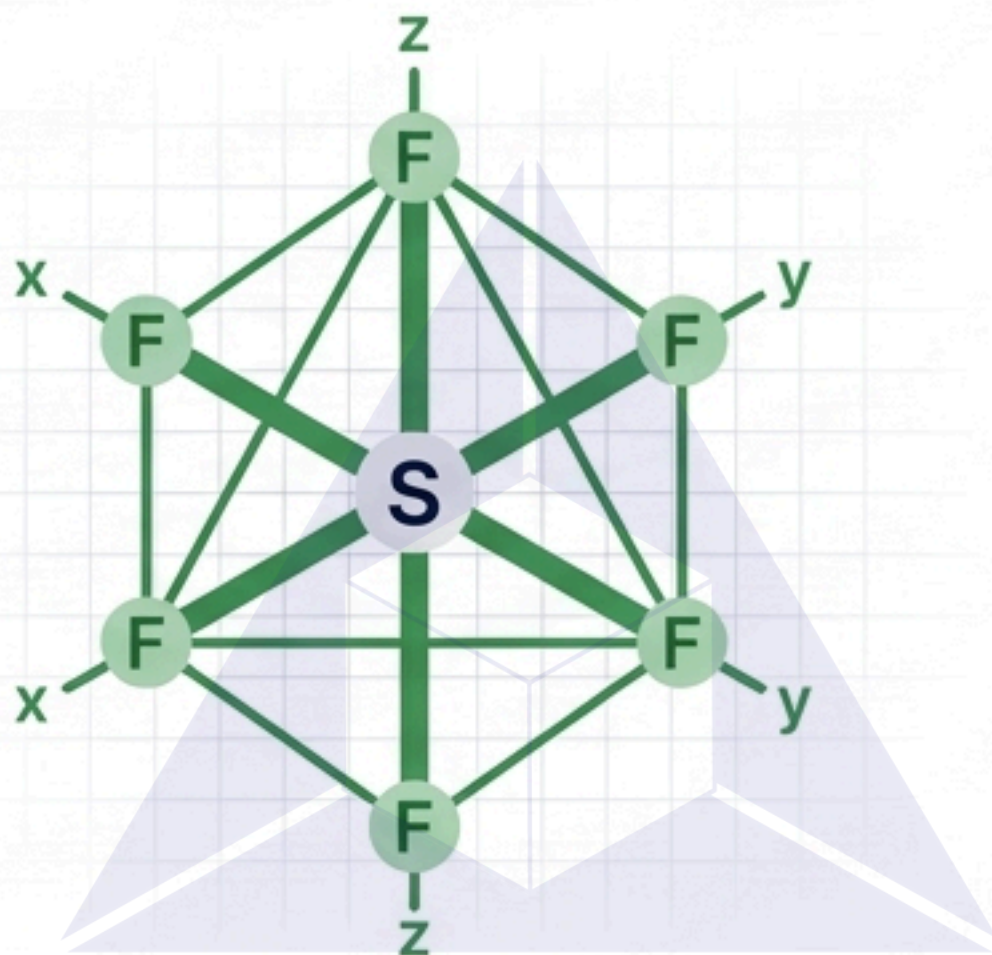
Formula Pill

Phosphorus ($Z=15$) mixes $1s + 3p + 1d \rightarrow 5 sp^3d$ orbitals

The Axial Tension

Axial bond pairs suffer greater repulsive interaction from the three equatorial pairs. Consequently, axial bonds are forced to be slightly longer and weaker, rendering the PCl_5 molecule highly reactive.

Sulphur Hexafluoride: sp^3d^2



1	Formula	SF_6
2	Geometry	Regular Octahedral
3	Uniform Angle	90°

Sulphur mixes $1s + 3p + 2d$
→ 6 identical sp^3d^2 orbitals

The Symmetry-Stability Link

All six sp^3d^2 orbitals overlap identically with the singly occupied orbitals of six Fluorine atoms. Unlike PCl_5 , there is no tension between differing bond lengths—every position is geometrically equivalent, creating exceptional chemical stability.

Geometry Comparison Grid

Molecule	Hybridisation	Geometry	Bond Angle(s)
Ethane (C_2H_6)	sp^3	Tetrahedral	109.5°
Ethene (C_2H_4)	sp^2	Trigonal Planar	120° (approx)
Ethyne (C_2H_2)	sp	Linear	180°
Phosphorous Pentachloride (PCl_5)	sp^3d	Trigonal Bipyramidal	120° & 90°
Sulphur Hexafluoride (SF_6)	sp^3d^2	Octahedral	90°

Hybridisation Explains Both Simple and Expanded-Octet Molecules

VSEPR Theory

Predicts geometry by minimizing electron pair repulsions.



The Hybridisation Concept



Valence Bond Theory

Provides the physical mechanism via atomic orbital mixing.

The Master Rule

Orbital mixing is nature's geometric blueprint. Whether satisfying the simple octet rule with pure s and p orbitals, or expanding to 10 or 12 valence electrons via d-orbital participation, atoms redistribute their energy to achieve the most stable, symmetrical arrangement possible.



You've Learned the Theory.

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