

UNIT 7 • ALCOHOLS, PHENOLS AND ETHERS

Structures of Functional Groups

An architectural analysis of bond angles, lengths, and the electrostatic forces that shape them.

Key Vocabulary

sigma (σ) bond

Formed by the direct head-on overlap of a carbon sp^3/sp^2 hybridized orbital with an oxygen sp^3 hybridized orbital.

sp^3 / sp^2 hybridisation

Determines the baseline geometry of the carbon atom. The sp^2 carbon (as seen in phenol) is more electronegative than the sp^3 carbon (in alcohols/ethers).

partial double bond character

A state arising from the conjugation (sharing) of unshared electron pairs on the oxygen atom with an adjacent aromatic ring.



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$$E=mc^2$$



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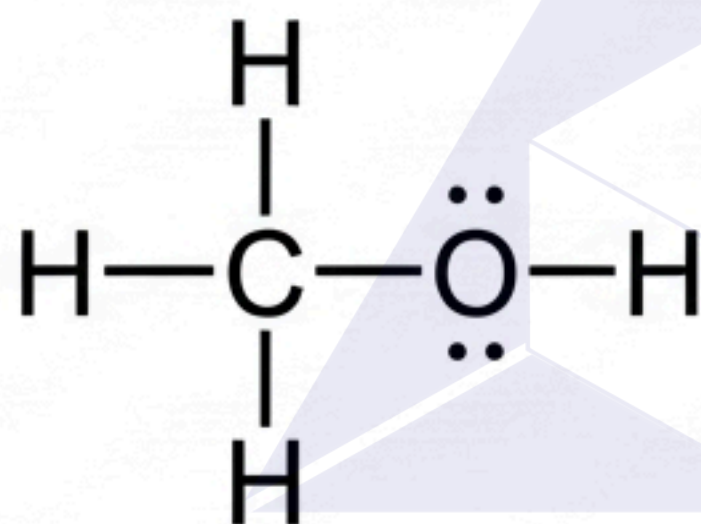
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The Visual Anchor

Methanol



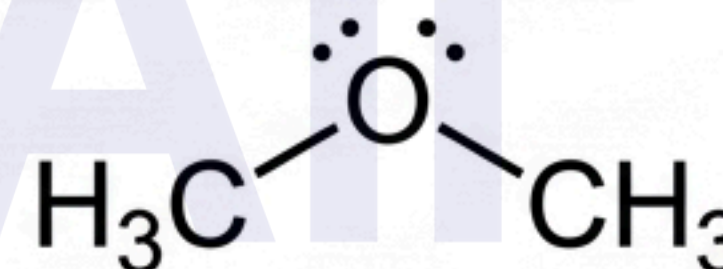
C-O: 142pm | $\angle$ C-O-H: 108.9°

Phenol



C-O: 136pm | $\angle$ C-O-H: 109°

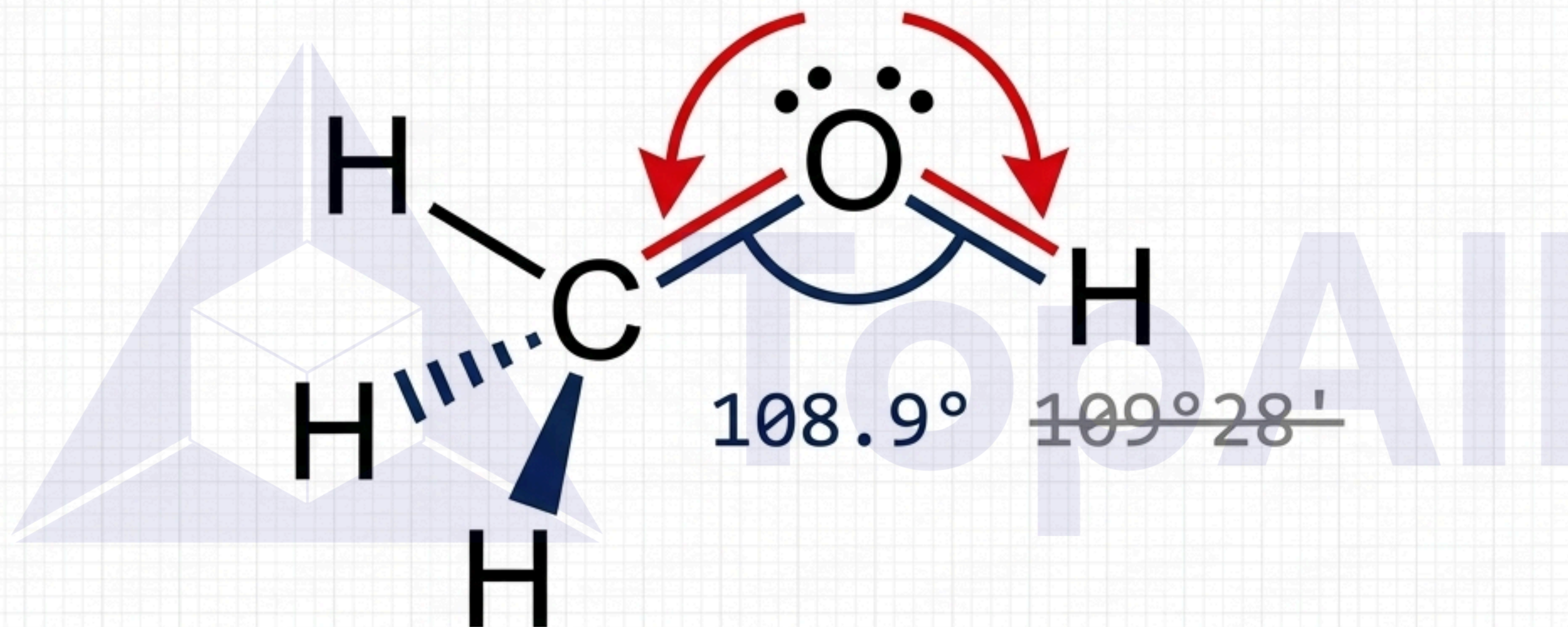
Methoxymethane



C-O: 141pm | $\angle$ C-O-C: 111.7°

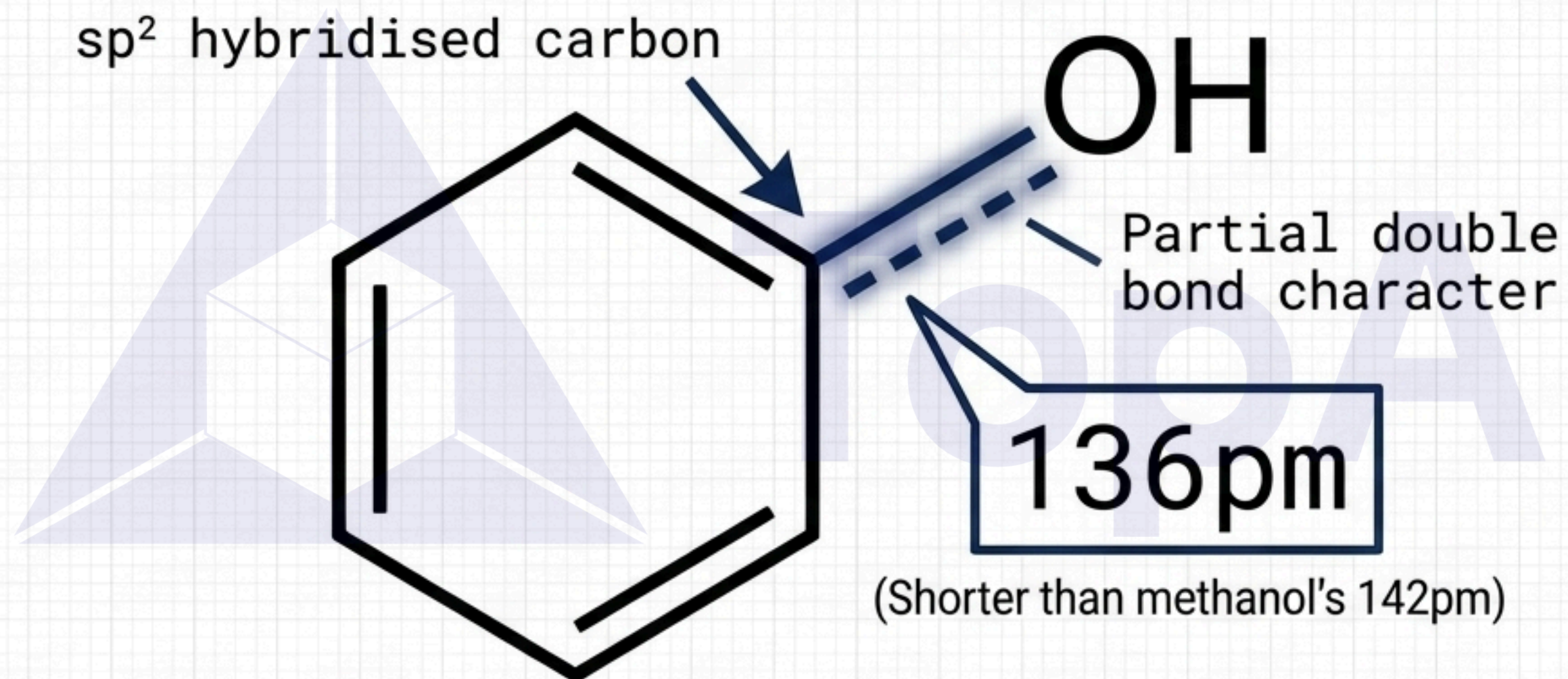
Notice the deviations from the ideal tetrahedral angle (109°28').

Alcohol: The Compression



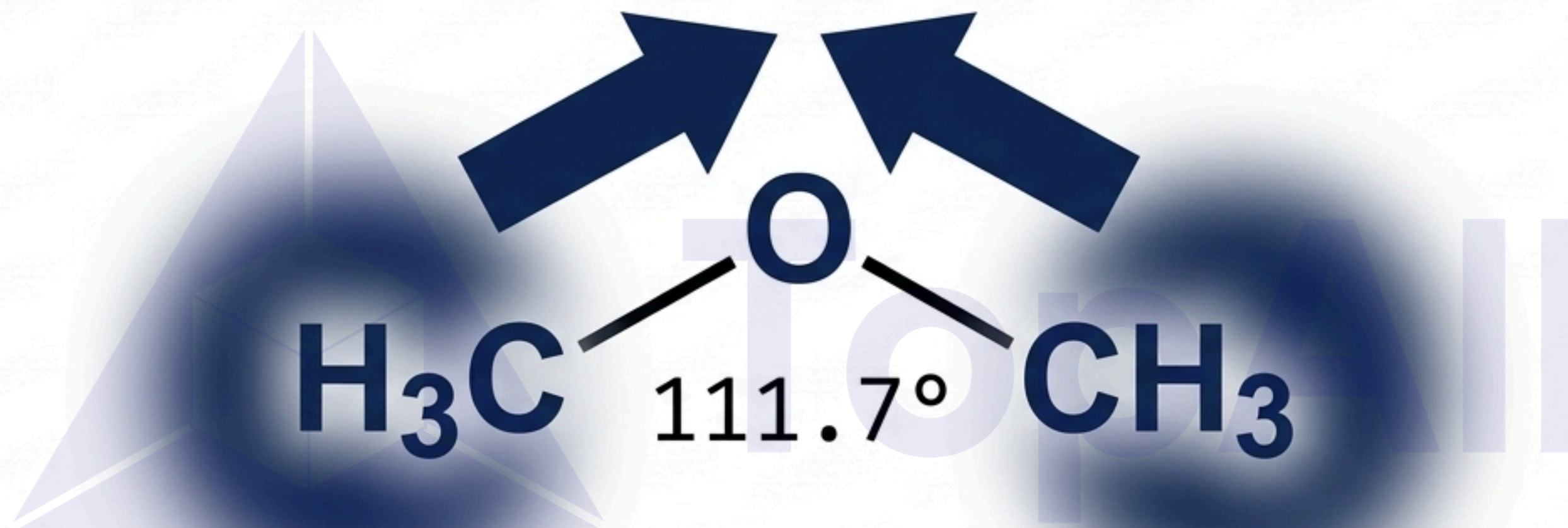
Repulsion between the unshared electron pairs of oxygen forces the bond angle to compress slightly below the tetrahedral ideal.

Phenol: The Contraction



The carbon-oxygen bond length in phenol is significantly shorter than in aliphatic alcohols. This contraction is driven by two synergistic electrostatic factors.

Ether: The Expansion



Despite having the same lone pairs as alcohols, the repulsive interaction between the two bulky alkyl ($-\text{R}$) groups dominates, forcing the bond angle wider than the tetrahedral baseline.

Synthesis

 **Watch for this common MCQ Trap:** When asked why Phenol has a unusually short C-O bond (136pm), remember there are TWO combined reasons: (1) sp^2 hybridization of the carbon, AND (2) partial double bond character from oxygen-ring conjugation. Exam options often try to trick you by listing only one as the 'sole' cause.

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- **Alcohols:** Lone pair repulsion compresses angles ($< 109.5^\circ$).
 - **Alcohols:** Lone pair repulsion compresses angles ($< 109.5^\circ$).
 - **Ethers:** Bulky R-group steric hindrance expands angles ($> 109.5^\circ$).



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