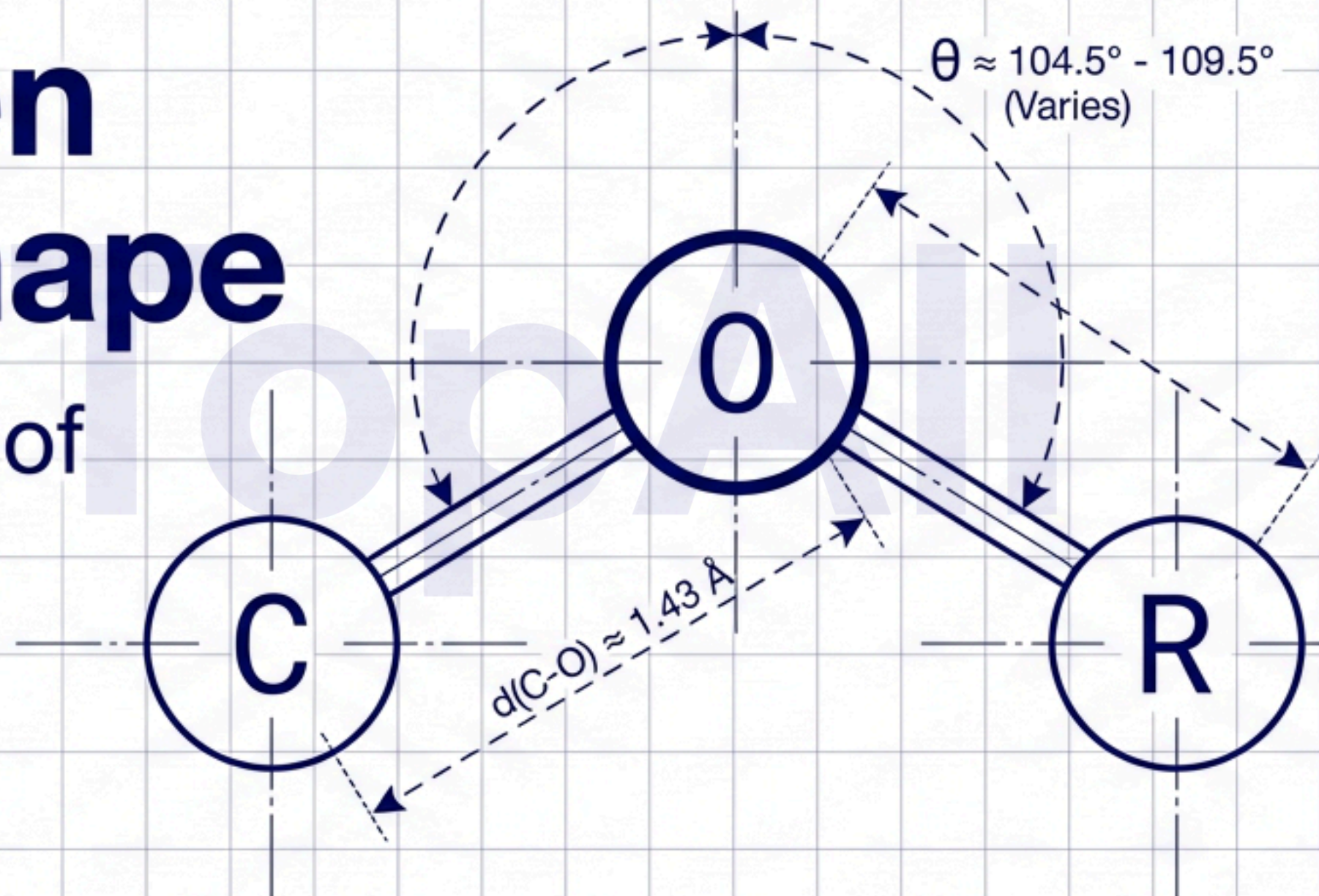
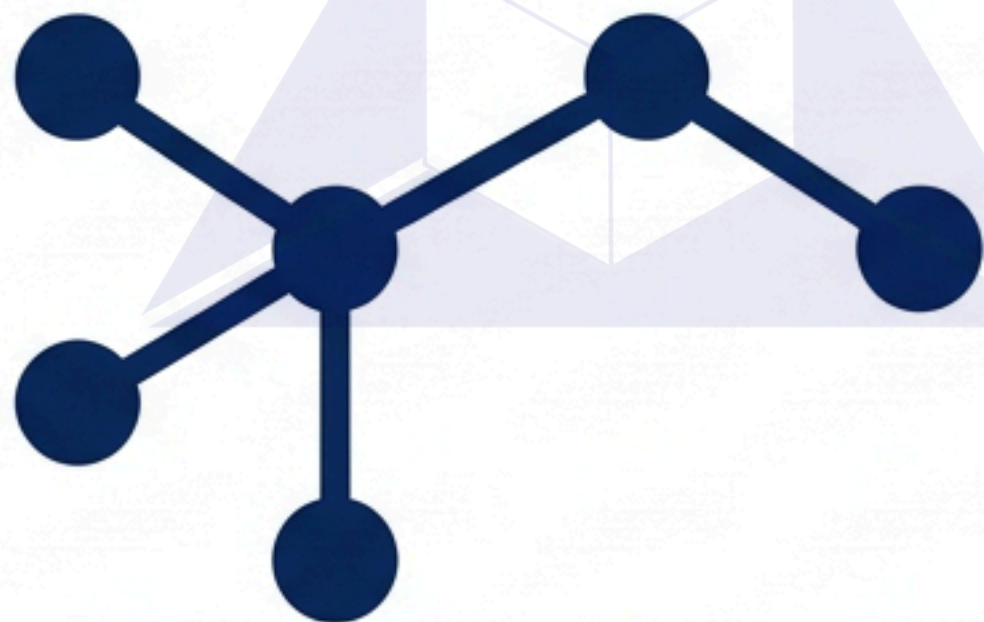
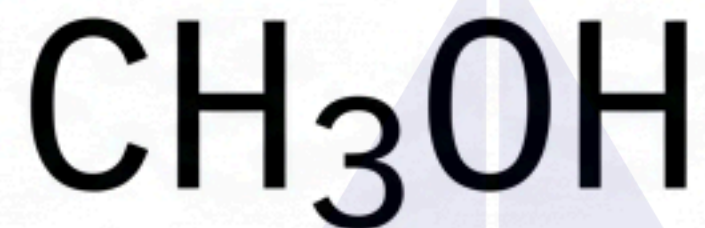


How Oxygen Controls Shape

Structural Geometry of
Alcohols, Phenols,
and Ethers



Methanol (The Aliphatic Baseline)



Carbon is sp^3 hybridized.

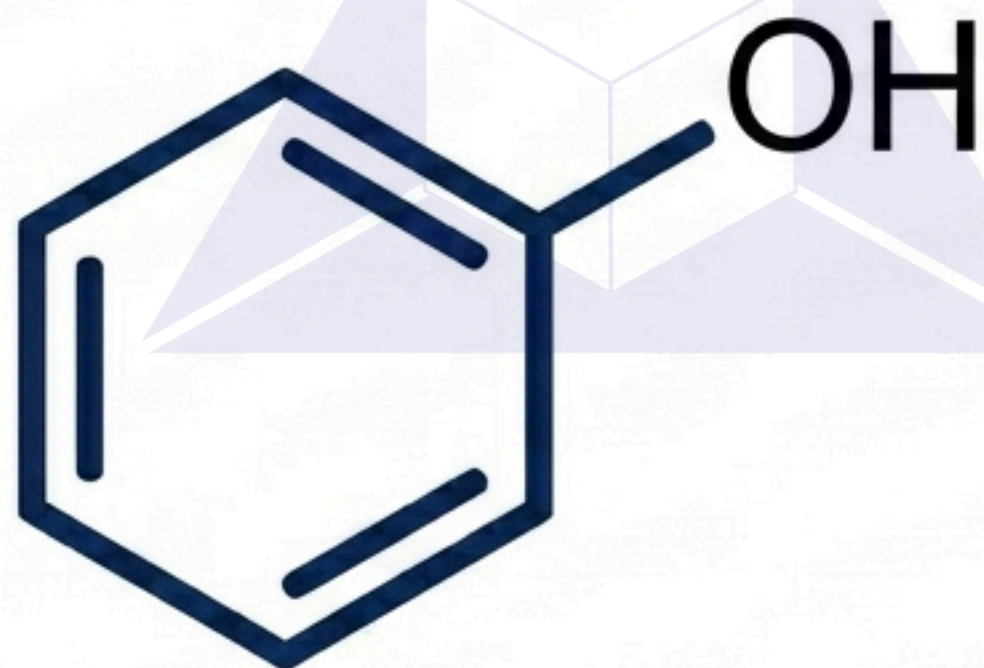
Oxygen is sp^3 hybridized.

Mechanism: The Carbon-Oxygen bond is a σ (sigma) bond formed by the direct overlap of sp^3 hybridized orbitals.

Bond Angle: 108.9°

Bond Length: 142 pm

Phenol (The Aromatic Variation)



Oxygen is attached directly to an sp^2 hybridized carbon.

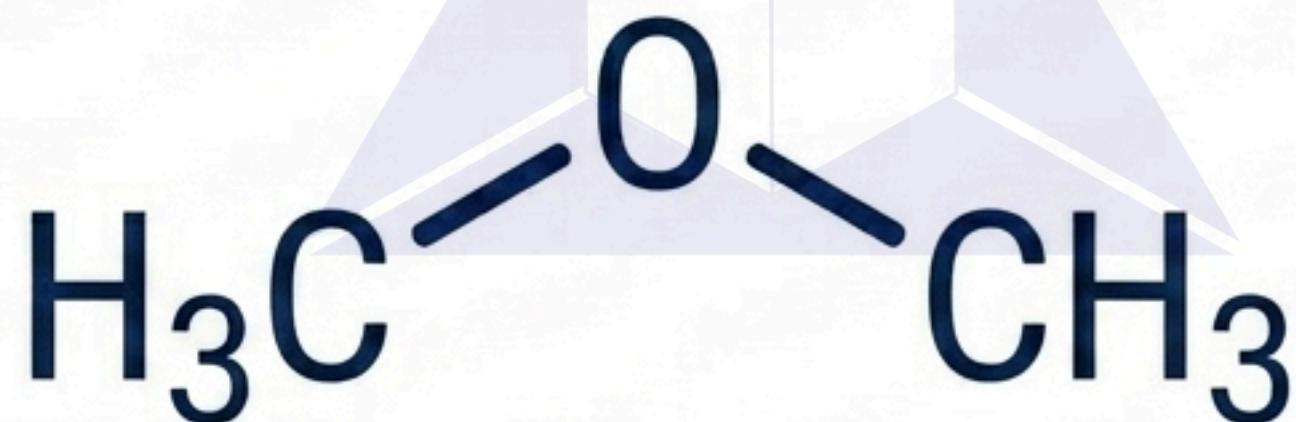
Oxygen is sp^3 hybridized.

Mechanism: The unshared electron pair on the oxygen atom undergoes conjugation with the aromatic benzene ring.

Bond Angle: 109°

Bond Length: 136 pm

Methoxymethane (The Ether Squeeze/Expansion)



Oxygen hosts four electron pairs (two bond pairs, two lone pairs).

Oxygen is sp^3 hybridized.

Mechanism: These four pairs arrange themselves in an approximately tetrahedral arrangement around the central oxygen atom.

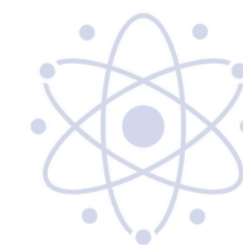
Bond Angle: 111.7°

Bond Length: 141 pm



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$$E=mc^2$$



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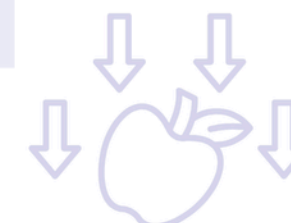
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Key Highlights

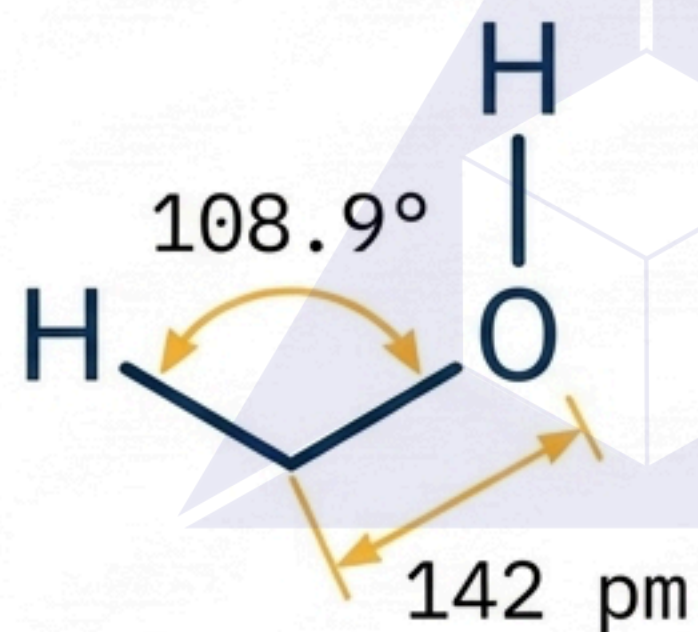
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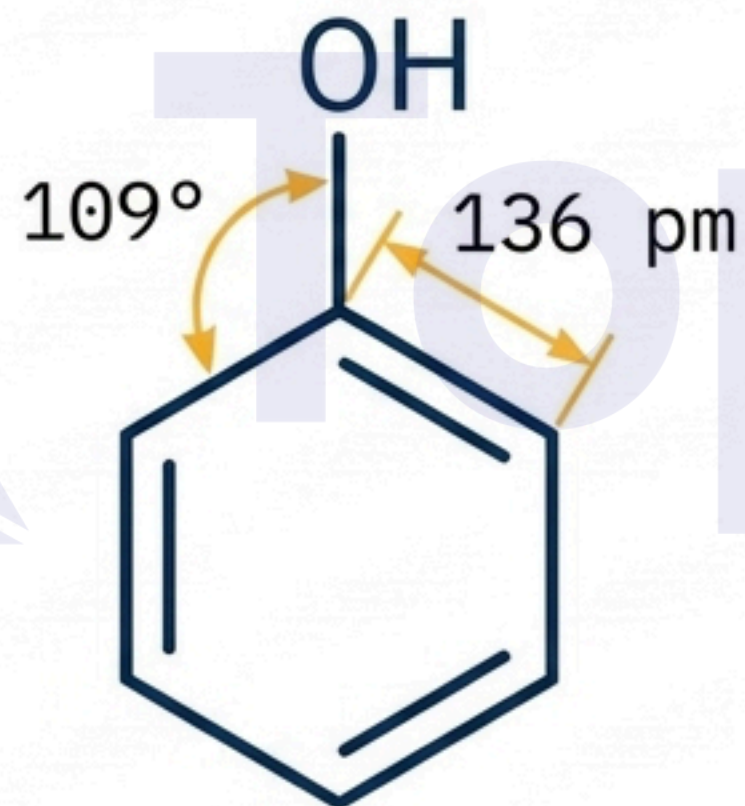
Structural Comparison Dashboard



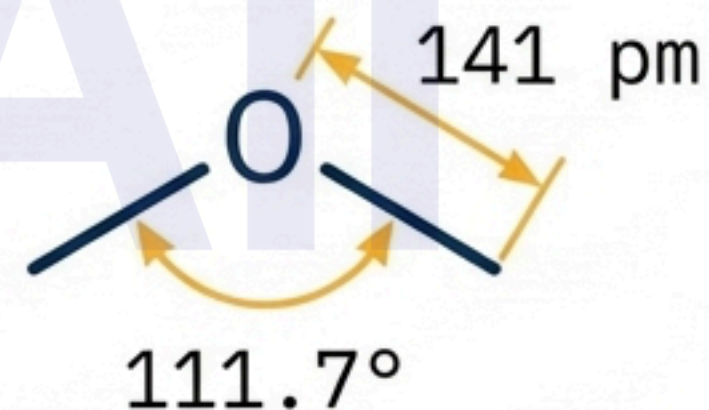
Methanol



Phenol



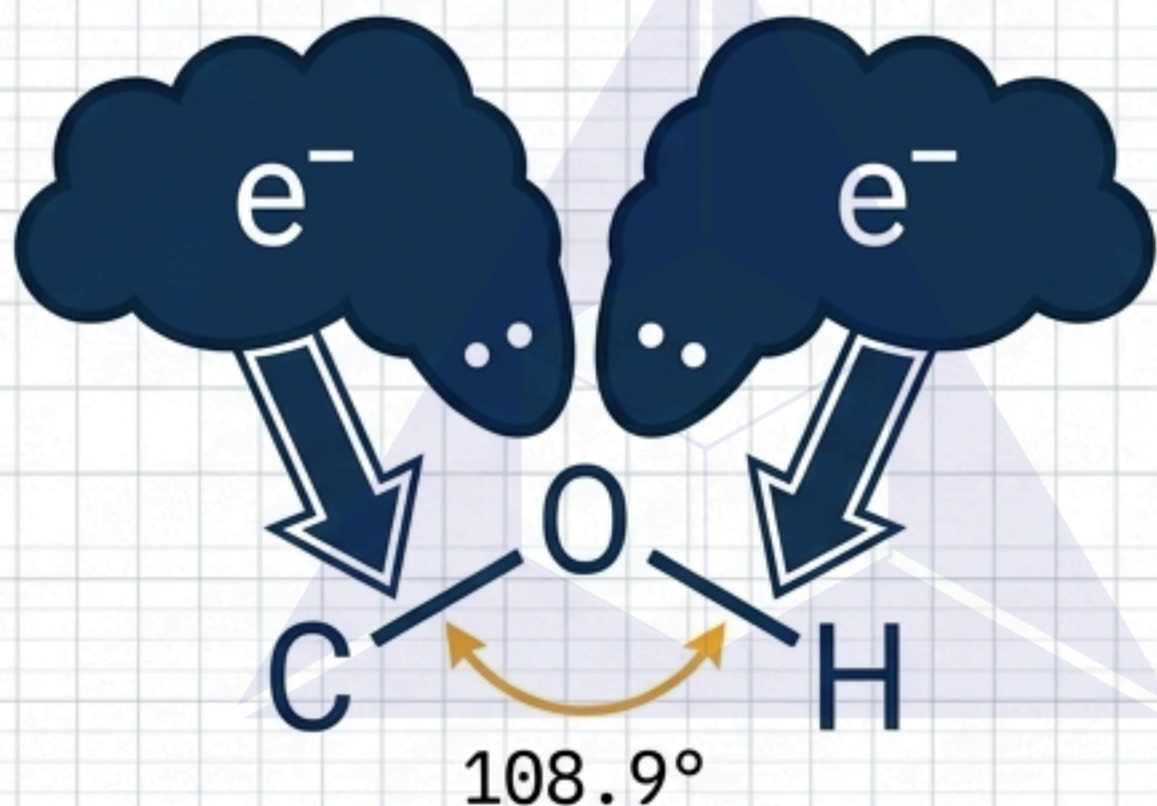
Methoxymethane



The Battle for Space: Bond Angle Effects



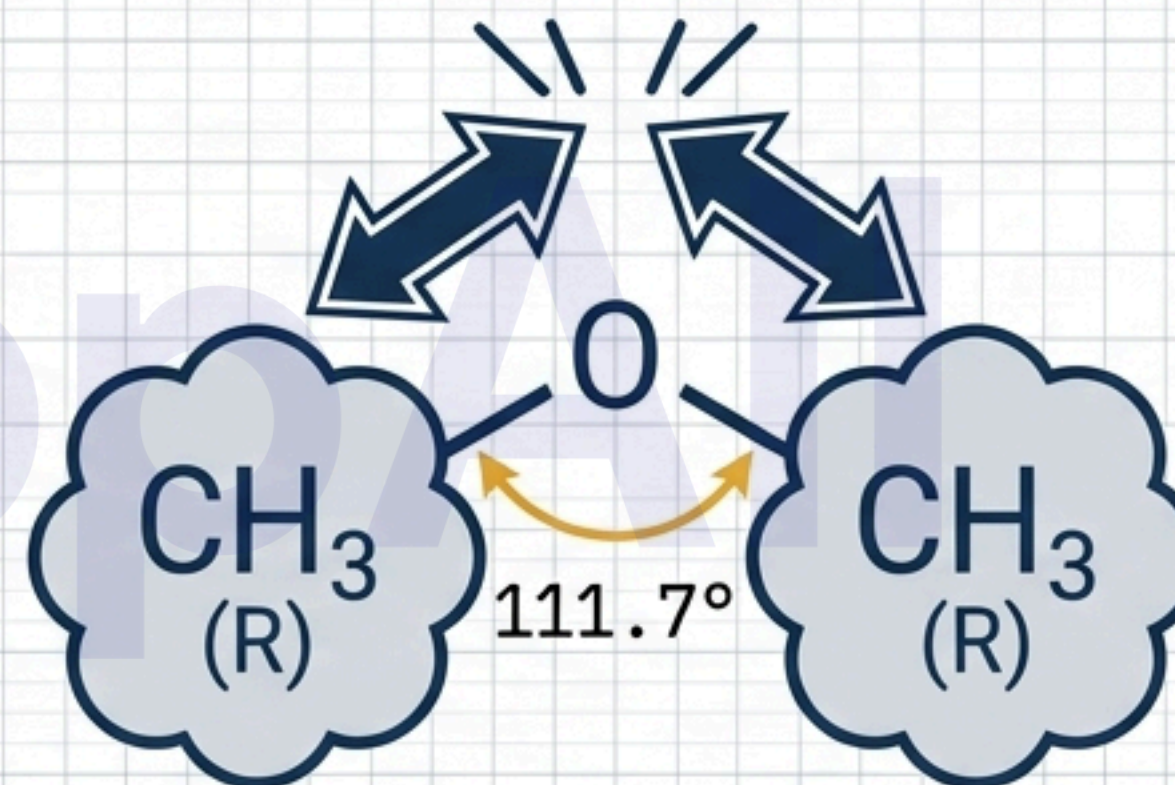
Alcohols



Repulsion between unshared electron pairs compresses the angle slightly below standard (108.9°).

Ideal Tetrahedral Angle: $109^\circ 28'$

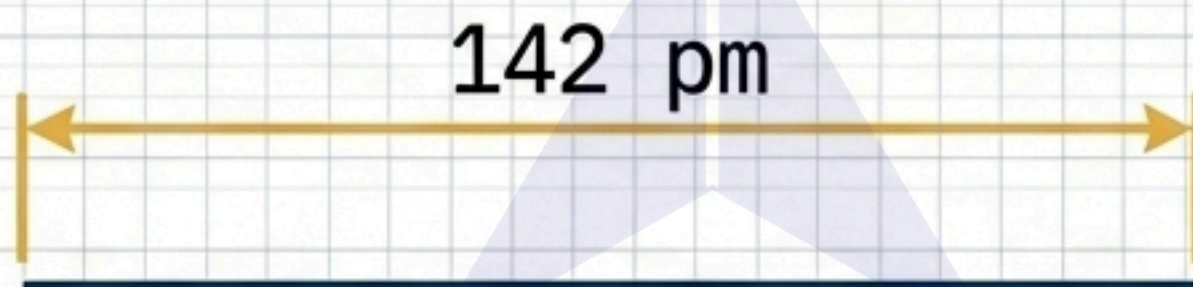
Ethers



Repulsive interaction between bulky -R groups overcomes lone pair pressure, expanding the angle (111.7°).

The Aromatic Squeeze: C-O Bond Lengths

Methanol (Aliphatic)

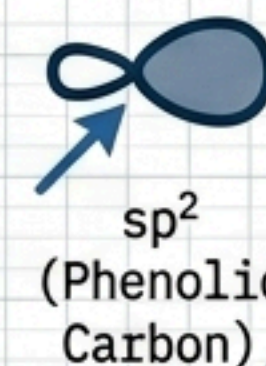
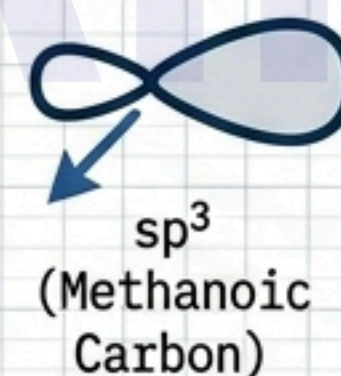


Standard sp^3 to sp^3 single bond.

Phenol (Aromatic)



Force 1: Resonance.
Partial double bond character due to conjugation of unshared oxygen electrons with the aromatic ring.



Force 2: Hybridization.
Oxygen is attached to an sp^2 hybridized carbon, which has more s-character and pulls electrons closer.

Exam Synthesis Matrix



Molecule	Formula	C-Hybridization	Bond Angle	C-O Bond Length	Exam Rationale
Methanol	<chem>CH3OH</chem>	sp^3	108.9°	142 pm	Lone pair repulsion compresses angle.
Phenol	<chem>C6H5OH</chem>	sp^2	109°	136 pm	Resonance & sp^2 carbon shortens bond length.
Methoxymethane	<chem>CH3OCH3</chem>	sp^3	111.7°	141 pm	Bulky -R group repulsion expands angle.

CORE RULE: Oxygen's geometry is dictated by lone-pair repulsion, but heavily modified by the steric bulk and hybridization of its attached carbons.



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