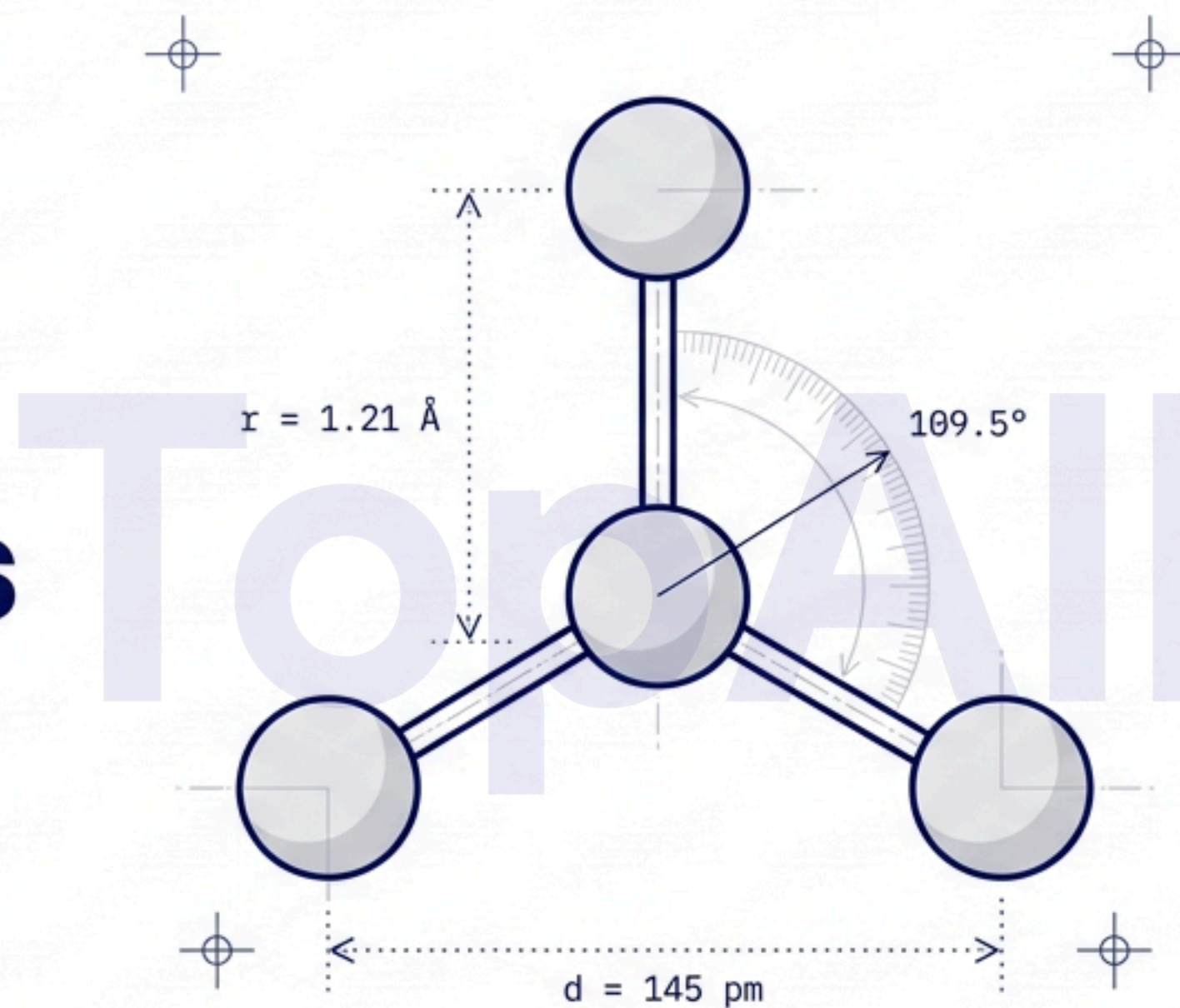


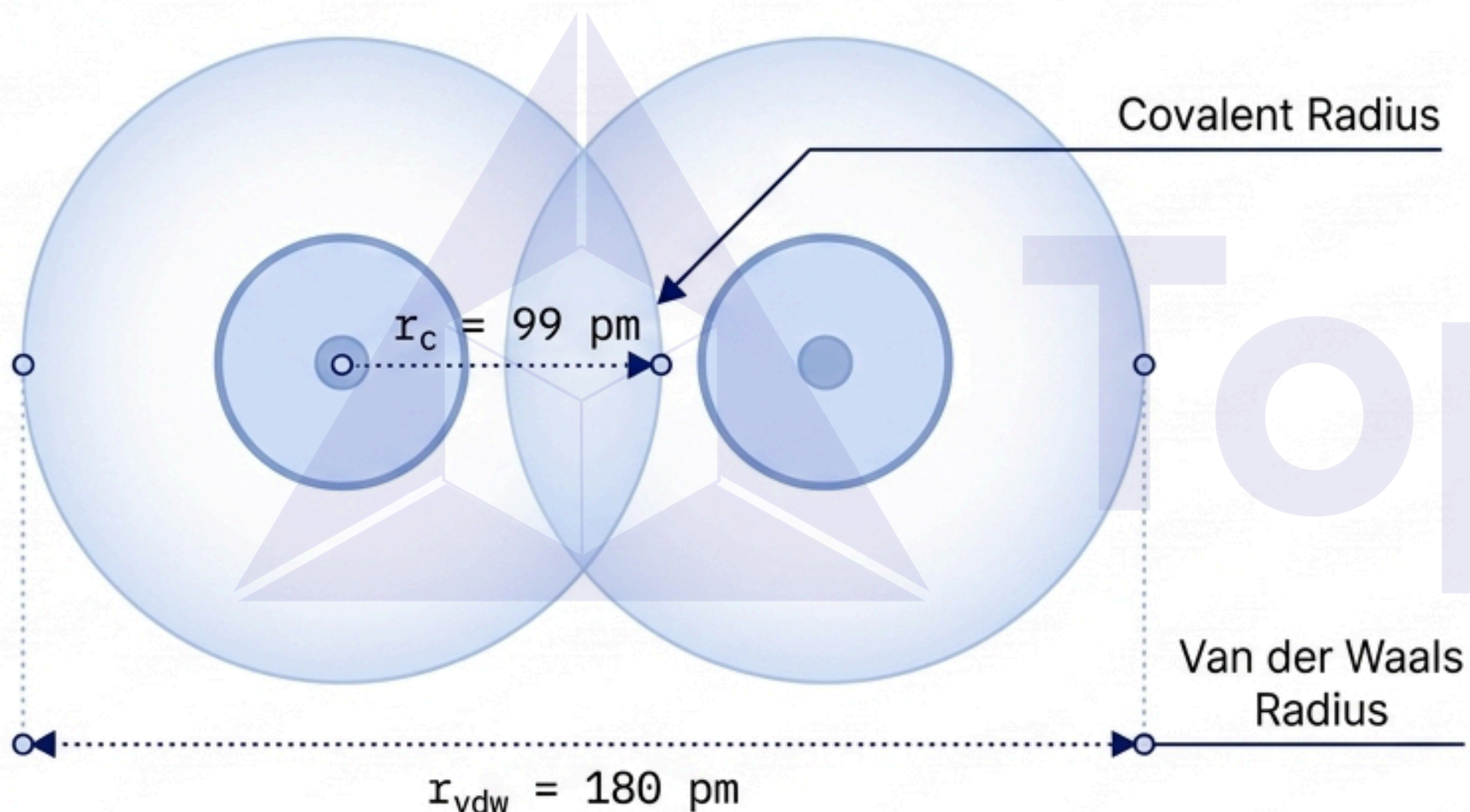
Unit 4

4.3 Bond Parameters

The structural schematics of chemical bonding.



Bond Length: Measuring 1D Space



The equilibrium distance between the nuclei of two bonded atoms.

$$R = r_A + r_B$$

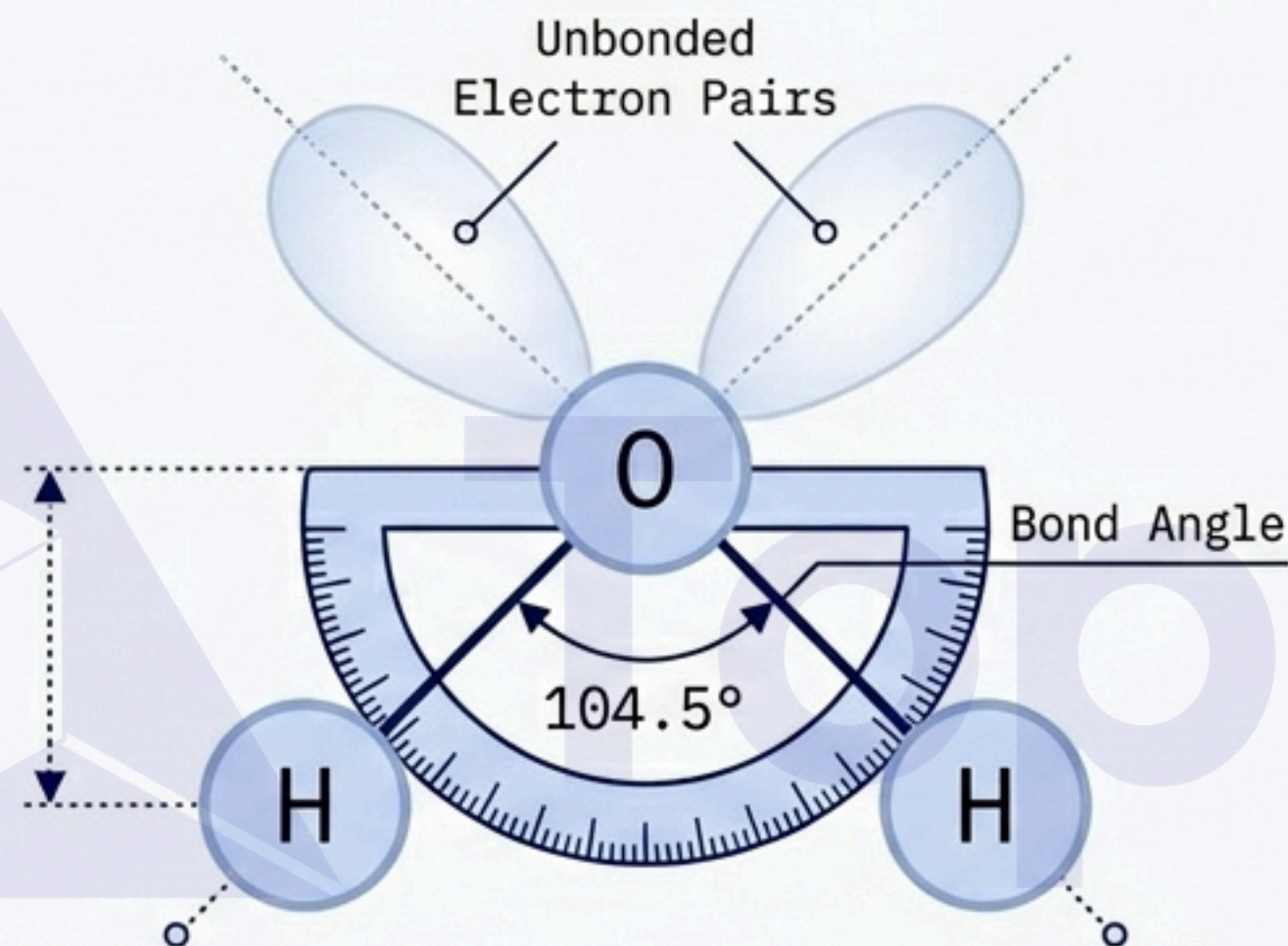
(where R is total bond length, and r is the covalent radius of each atom)

Unit: Picometers (pm)

Techniques: X-ray Diffraction, Spectroscopy, Electron-Diffraction

Bond Angle: Defining 3D Geometry

It is the angle between the orbitals containing bonding electron pairs around the central atom.



It reveals the distribution of orbitals in space, helping to map the exact architectural shape of the molecule.

Angle = Geometry

Bond angles force molecules into specific 3D configurations to minimize electron repulsion (e.g., 104.5° creates water's bent shape).



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Multiplicity & Strength: Order vs. Enthalpy

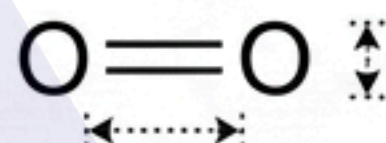
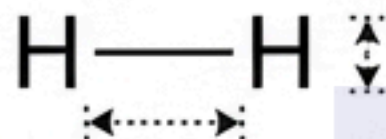
Structural Metric Bond Order

The number of shared electron pairs between two atoms.

H - H (Order: 1)

O = O (Order: 2)

N $\equiv$ N (Order: 3)



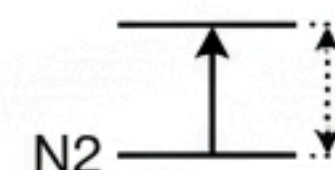
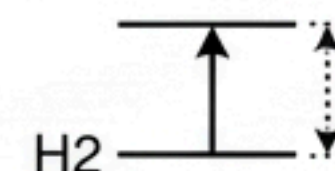
Energetic Metric Bond Enthalpy

Energy required to break one mole of bonds in a gaseous state.

H₂: 435.8 kJ mol⁻¹

O₂: 498.0 kJ mol⁻¹

N₂: 946.0 kJ mol⁻¹



The Stability Trend:

[Bond Order $\uparrow$] $\rightarrow$ [Bond Enthalpy $\uparrow$] $\rightarrow$ [Bond Length $\downarrow$]

The Diagnostic Matrix

How parameters interlock to define molecular identity.

1	Parameter	What it Measures	What it Predicts	Unit/Identifier
2	Bond Length	1D Distance	Atomic Size	pm
3	Bond Angle	3D Space	Molecular Geometry	degrees (°)
4	Bond Enthalpy	Bond Strength	Energetic Stability	kJ mol^{-1}
5	Bond Order	Multiplicity	Chemical Reactivity	Integer (1, 2, 3)

Every system tends to be more stable. Bonding is nature's way of lowering energy to attain that stability.



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