

Module 4.5

UNIT 4 | CHEMICAL BONDING

4.5 Valence Bond Theory



TopAll

The Gap in Lewis & VSEPR Theories



Lewis & VSEPR Models

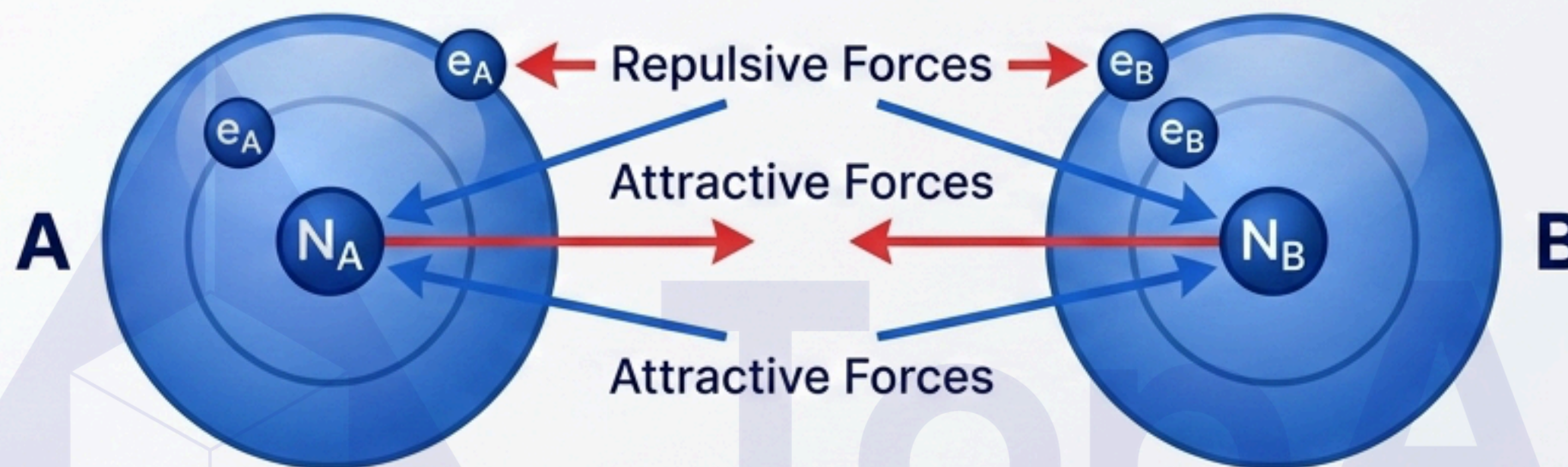
- ⚠ Excellent for predicting geometry and basic molecular shapes.
- ⚠ Fails to explain exactly how covalent bonds physically form.
- ⚠ Cannot account for the massive difference in bond dissociation enthalpies and bond lengths (e.g., H_2 vs F_2)



Valence Bond (VB) Theory

- ✓ Introduced by Heitler & London (1927).
- ✓ Utilizes quantum mechanical principles and atomic orbital overlap.
- ✓ Successfully calculates bond formation, exact energies, and directional properties.

Dynamic Forces in H_2 Formation



Pulls Together

Nucleus N_A attracts electron e_B ;
Nucleus N_B attracts electron e_A .

Pushes Apart

Nucleus N_A repels N_B ;
electron e_A repels e_B .

Experimentally, the magnitude of new attractive forces is strictly greater than new repulsive forces.



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

$$E=mc^2$$



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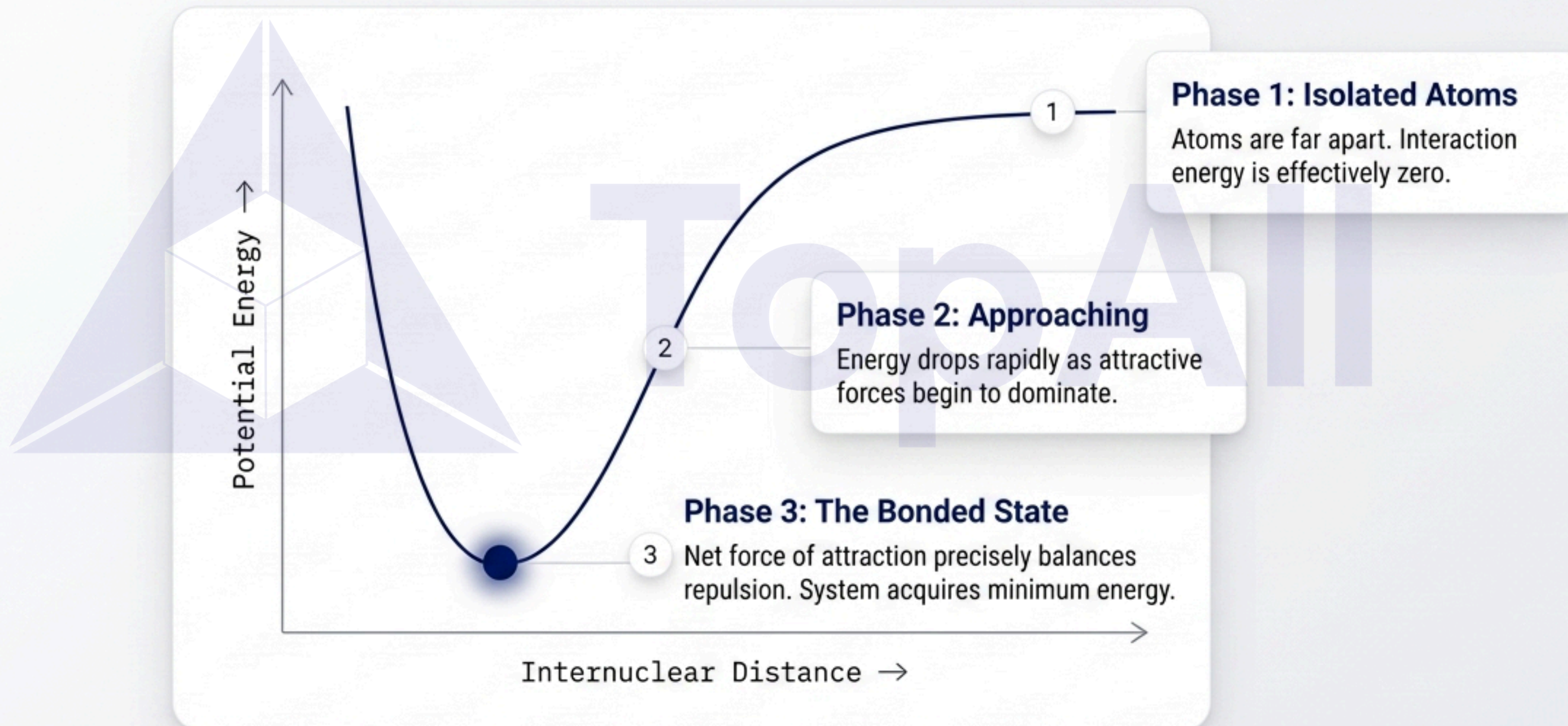
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Key Highlights

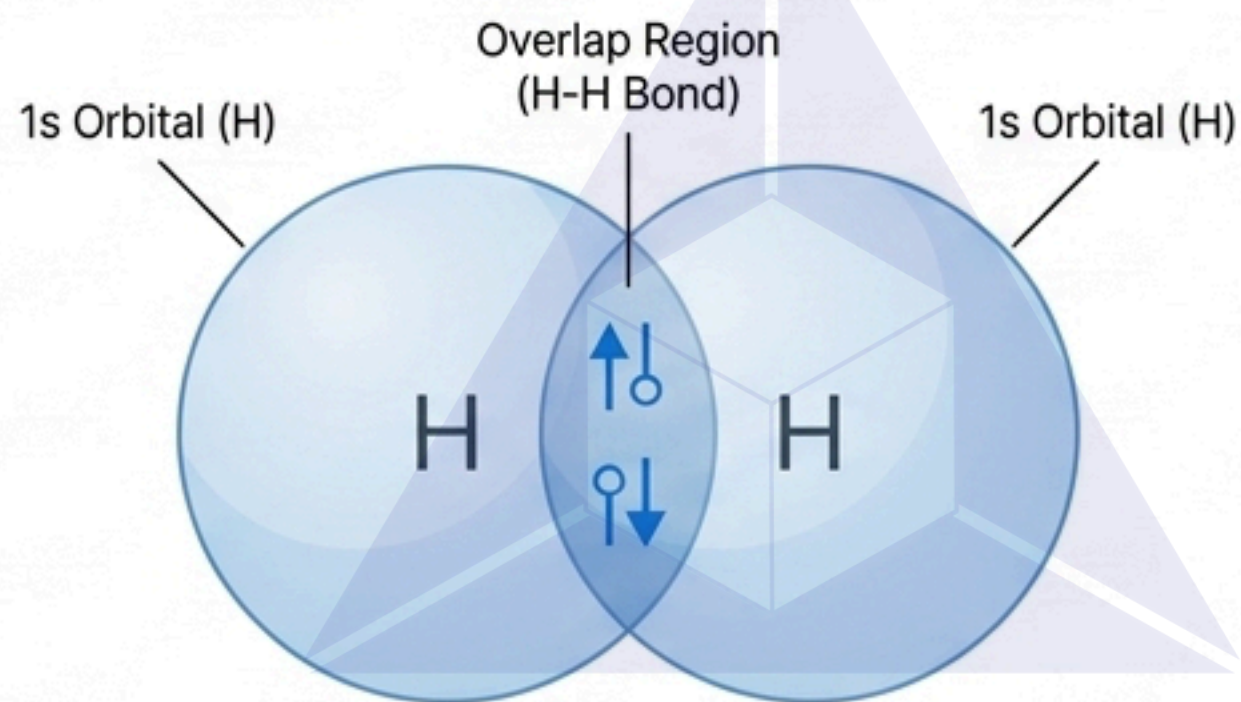
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Reaching the Energy Minimum



Physical Properties of the H₂ Bond



Constructive interference leads to bond formation

Bond Length

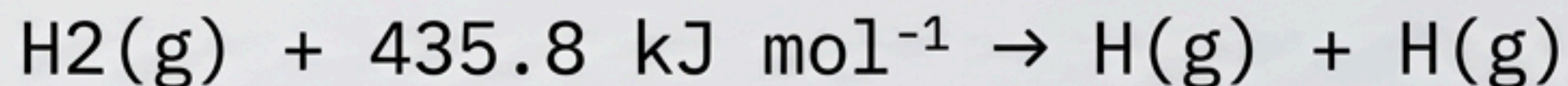
74 pm

Picometers

Bond Enthalpy

**435.8
kJ/mol**

Kilojoules per mole



Summary: Valence Bond Theory

Pillar 1

Orbital Overlap

Covalent bonds form through the partial merging (interpenetration) of atomic orbitals, pairing electrons with opposite spins.

Pillar 2

Force Balance

Bonds successfully stabilize only when the attractive forces between nuclei and electrons overpower the repulsive forces.

Pillar 3

Energy Lowering

Bonding is nature's mechanism for lowering systemic potential energy to attain maximum thermodynamic stability.

Valence Bond Theory connects abstract quantum overlap with measurable molecular geometry and stability.



You've Learned the Theory.

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