

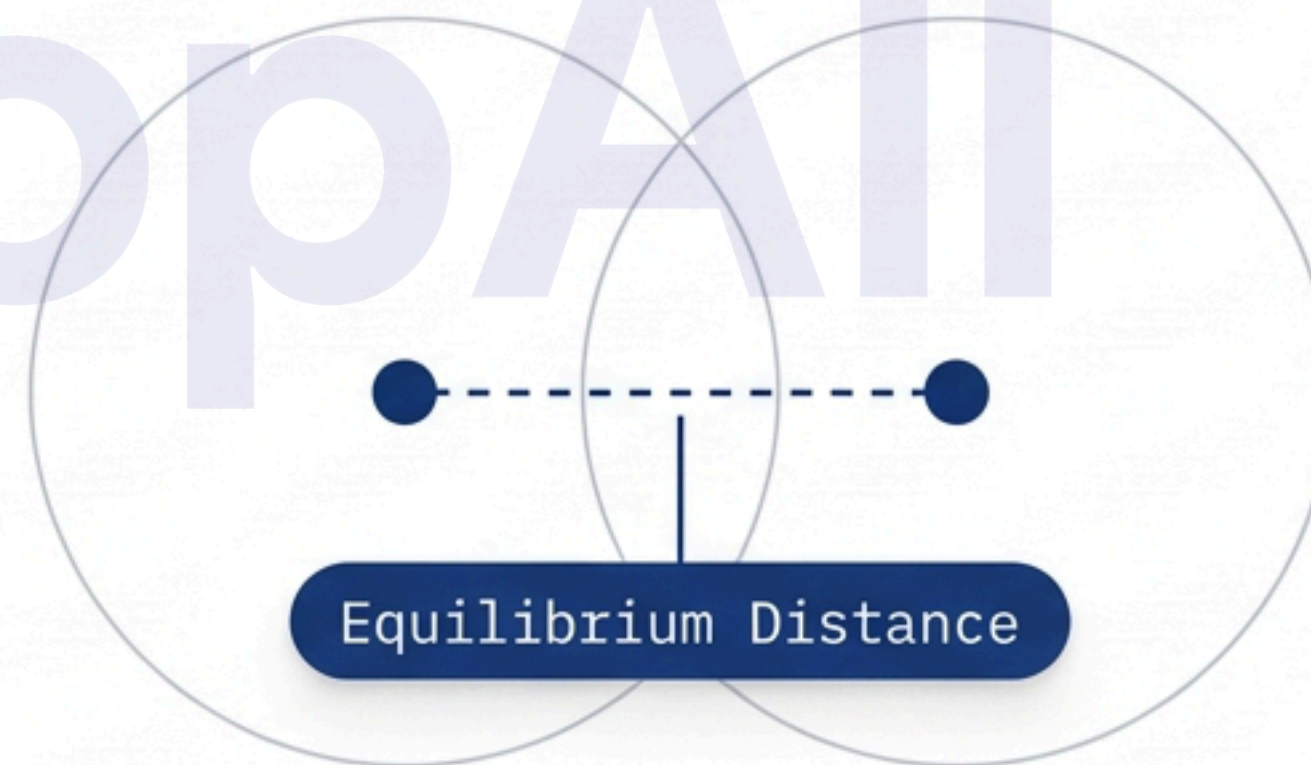
4.3.1 Bond Length

Understanding the spatial mechanics and equilibrium distances between atomic nuclei.

H1 Defining Bond Length

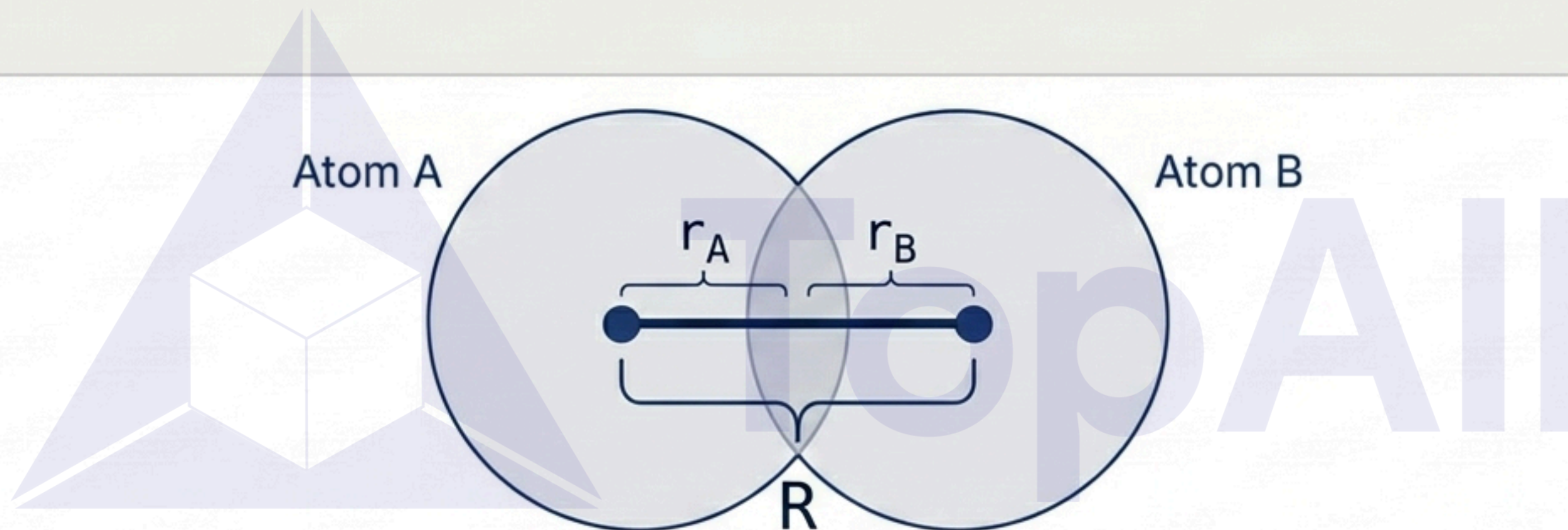
Atoms do not just crash into one another. They settle at a **specific distance** where **attractive and repulsive forces** perfectly balance out to achieve **maximum stability** (lowest potential energy).

- **Bond Length:** The equilibrium distance between the centers (nuclei) of two bonded atoms in a molecule.
- **Measurement:** Determined via advanced techniques: Spectroscopic, X-Ray diffraction, and Electron-diffraction.
- **Contribution:** Each atom in the bonded pair contributes a specific portion to the overall measured length.



H1 The Covalent Radius

In a covalent bond, the overall bond length is simply the sum of the individual covalent radii of the participating atoms.



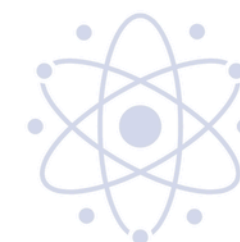
$$R = r_A + r_B \quad \text{Where } R \text{ is bond length, and } r_A / r_B \text{ are the covalent radii.}$$

The **covalent radius** (r_c) is measured as the radius of an atom's core that is in direct contact with the core of an adjacent atom in a bonded situation.



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

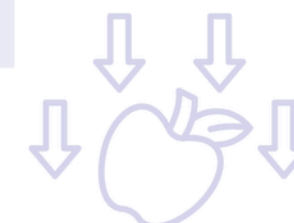
$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**



Practice Now → [At prep.topall.app](https://prep.topall.app)



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

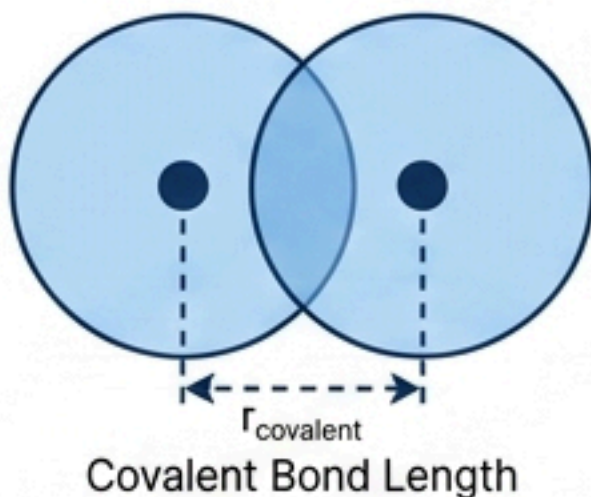
Radius Comparison

H1: Covalent vs. Van der Waals Radius

How do we measure an atom's size when it isn't sharing electrons?

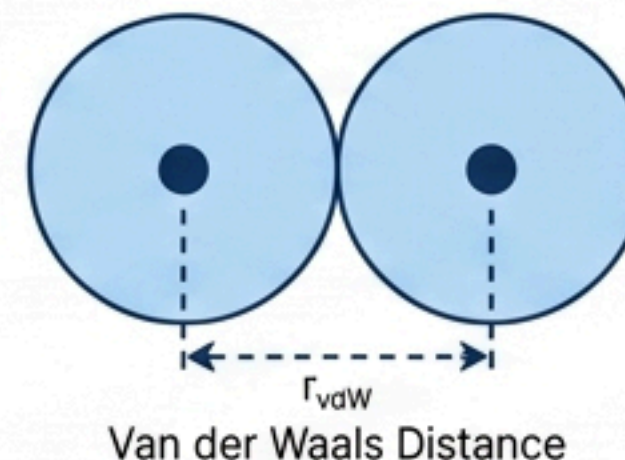
Covalent Radius (Bonded)

- **Scenario:** Atoms are chemically bonded within the same molecule.
- **Overlap:** Yes. Electron clouds actively merge.
- **Size:** Always smaller than the Van der Waals radius.



Van der Waals Radius (Non-Bonded)

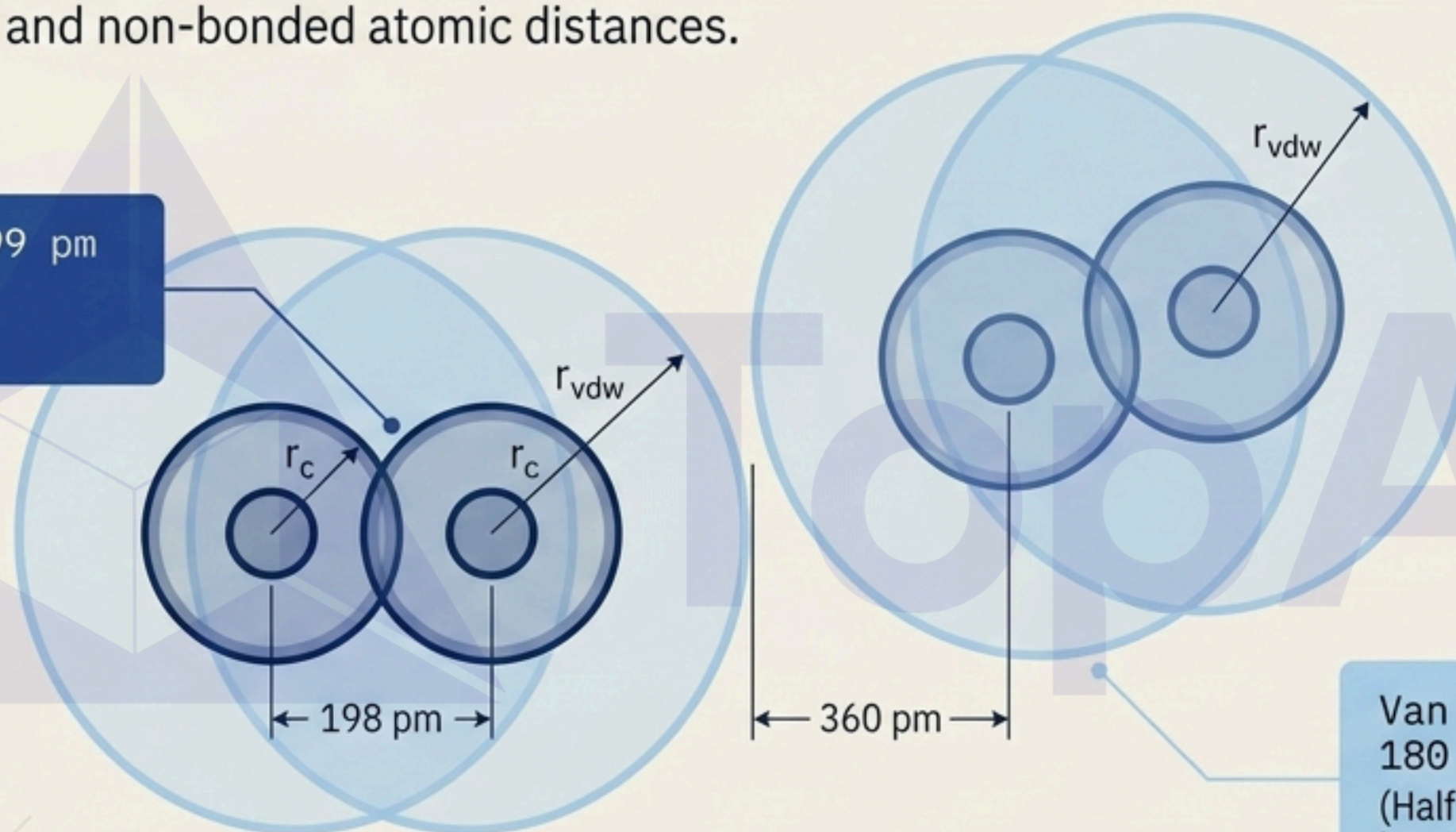
- **Scenario:** Atoms in separate molecules touching in a solid state.
- **Overlap:** No. Represents the overall size of the atom including its full valence shell.
- **Size:** Always larger because electron clouds repel rather than merge.



The Chlorine Molecule (Cl_2)

Mapping both radii on a real molecule highlights the stark difference between bonded and non-bonded atomic distances.

Covalent Radius (r_c) = 99 pm
(Half the distance of the 198 pm
internal bond length)



Van der Waals Radius (r_{vdw}) = 180 pm
(Half the distance of the 360 pm gap
between separate molecules)

Notice that r_{vdw} (180 pm) is nearly double r_c (99 pm). The covalent bond pulls the nuclei significantly closer together than the resting size of the non-bonded atoms.

H1: The Impact of Multiple Bonds

Bond length is not static. As atoms share more electron pairs, the bond order increases, pulling the nuclei closer together.

	Bond Type	Shared Electrons	Bond Order	Bond Length	Bond Enthalpy
1	C-C (Single)	1 Pair	1	154 pm	Lowest
2	C=C (Double)	2 Pairs	2	133 pm	Medium
3	C≡C (Triple)	3 Pairs	3	120 pm	Highest

Exam Rule of Thumb:

As **Bond Order Increases** → Bond **Length Decreases** → Bond **Strength** (Enthalpy) **Increases**.



You've Learned the Theory.

Now Let's Test It.

Reading notes gets you knowledge.

Practicing MCQs gets you marks.

That's exactly what TopAll Pro is built for.

Try TopAll Pro Now

What TopAll Pro Does Differently

-  **Stuck? Snap it. Solve it. — Doubts AI**
Photo → step-by-step solution in seconds, 24/7
-  **Your AI Coach finds your blind spots**
Concept-level weakness detection — not just chapter-level
-  **4.5 Lakh+ questions. Never run out.**
13× more content than any other prep app in India
-  **Build your own test in 60 seconds**
Pick a chapter, set difficulty — AI does the rest instantly.
-  **AI Recommendation that helps you improve**
AI Recommendation Analysis your Tests and tell you where you need to improve.



Practice the moment you finish studying
Jump in while the concept is still fresh in your head

4.5L+
MCQs

1.5L+
Students

AI Powered
In-Depth Analysis