

NEET/JEE • CHEMISTRY • SOLUTIONS • UNIT 1.7

Abnormal Molar Masses & the van't Hoff Factor



HIGH WEIGHTAGE

The most JEE Advanced-loved sub-topic in the entire chapter. Master the transition between theoretical properties and observed reality.

The van't Hoff Formula Bank

Inclusion of the van't Hoff factor (i) modifies all standard colligative property equations to account for the true number of particles in solution.

$$i = \text{Normal molar mass} / \text{Abnormal molar mass}$$

$$i = \text{Observed colligative property} / \text{Calculated colligative property}$$

$$\Delta T_b = i \cdot K_b \cdot m$$

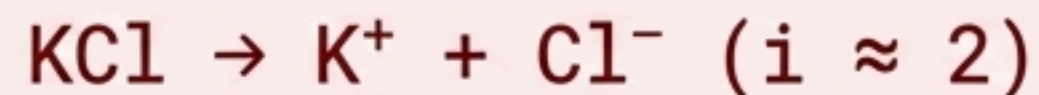
$$\Delta T_f = i \cdot K_f \cdot m$$

$$\Pi = i \cdot (n_2/V) \cdot RT$$

The Two Scenarios: Splitting vs. Joining

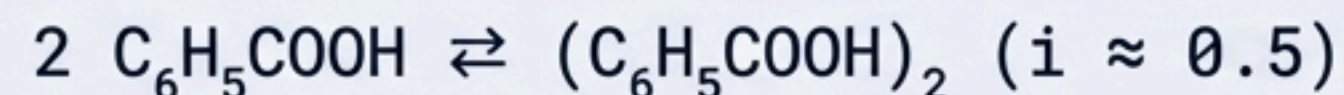
Dissociation $\rightarrow i > 1$

Solute breaks apart into multiple ions. The number of particles increases, making the observed molar mass lower than normal.



Association $\rightarrow i < 1$

Solute molecules link together (often via H-bonds) in non-polar solvents. The number of particles decreases, making observed molar mass higher.





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$$E=mc^2$$



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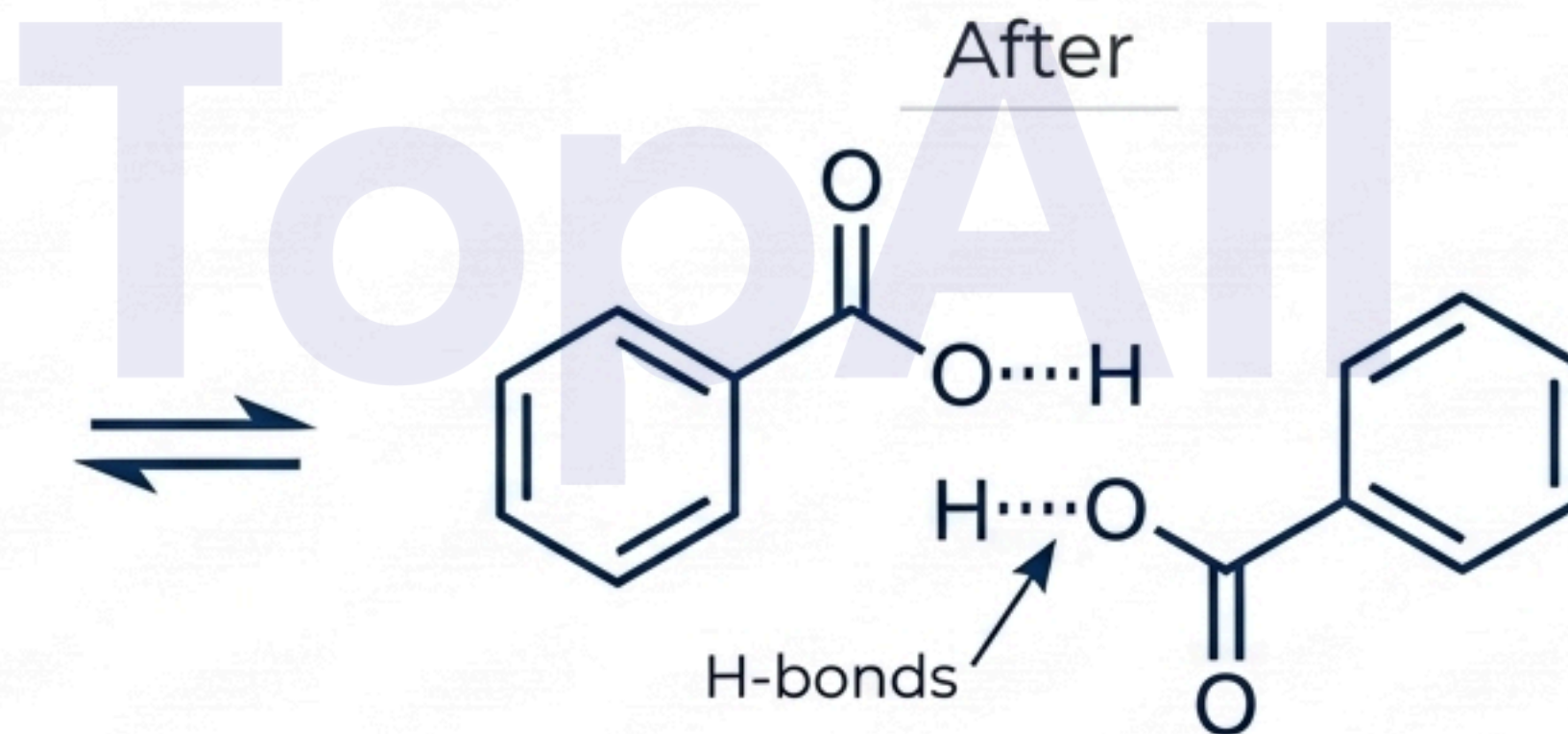
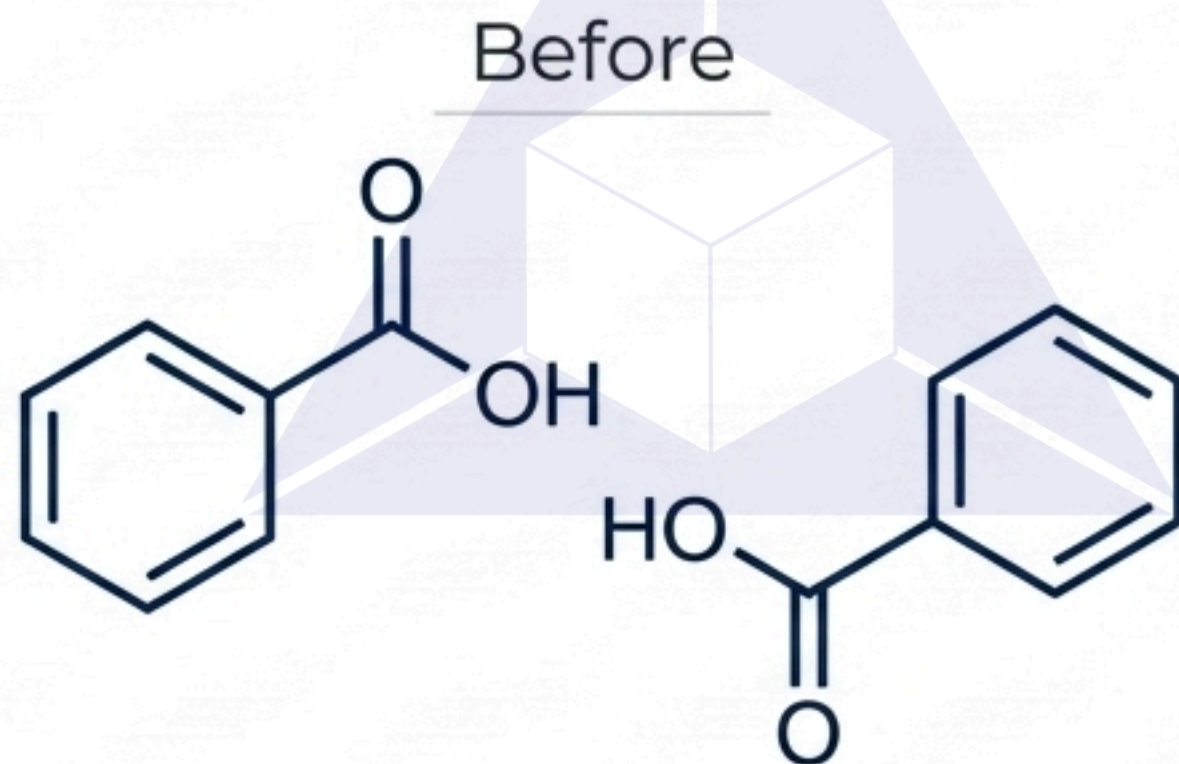
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Visualizing Association: The Dimer

In low dielectric solvents like benzene, carboxylic acids form dimers. The particle count literally halves.



2 particles act as 1 particle

Master the Math: NCERT Example 1.12

2g benzoic acid in 25g benzene shows a freezing point depression of 1.62K. ($K_f = 4.9$). What is the percentage association?

Solution Card

- 1 Calculate Abnormal Molar Mass
$$M_2 = (1000 \cdot K_f \cdot w_2) / (\Delta T_f \cdot w_1) = 241.98 \text{ g/mol}$$
- 2 Find the van't Hoff Factor (i)
$$i = \text{Normal } M_2 / \text{Abnormal } M_2 = 122 / 241.98 = 0.504$$
- 3 Relate i to Degree of Association (x)
$$1 - x + x/2 = 0.504$$
$$1 - x/2 = 0.504 \rightarrow x = 0.992$$

Final Result Block: 99.2% associated

Don't Lose Easy Marks

Trap: Stopping at i instead of finding x .

A common exam error is calculating the van't Hoff factor (i) and assuming it is the final answer. The question almost always asks for the degree of association/dissociation (x or α).

Always take the extra algebra step relating i to the specific stoichiometry of the equilibrium equation (e.g., $1 - x + nx$).

Time-Saver for the Exam

✓ The 1:1 Dissociation Hack

For weak electrolytes dissociating into exactly **2** ions (e.g., weak acids like **CH₃COOH**), skip the long equilibrium setup.

$$i = 1 + x \rightarrow x = i - 1$$

If an exam problem yields **$i = 1.041$** , the degree of dissociation is instantly **0.041 (4.1%)**. Use this to save 30 seconds on multiple-choice questions.

Consolidation

Key Takeaways

- Calculate **abnormal molar mass** first, then derive i from it using the standard formula ratio.
- Match $i > 1$ to **dissociation** (breaking apart) and $i < 1$ to **association** (dimerizing).
- Convert i into the **degree of dissociation/association** (x) using the correct stoichiometry of the reaction.



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