

Dilution: Why κ Falls but Λ_m Rises



$\kappa \downarrow$
(Conductivity)

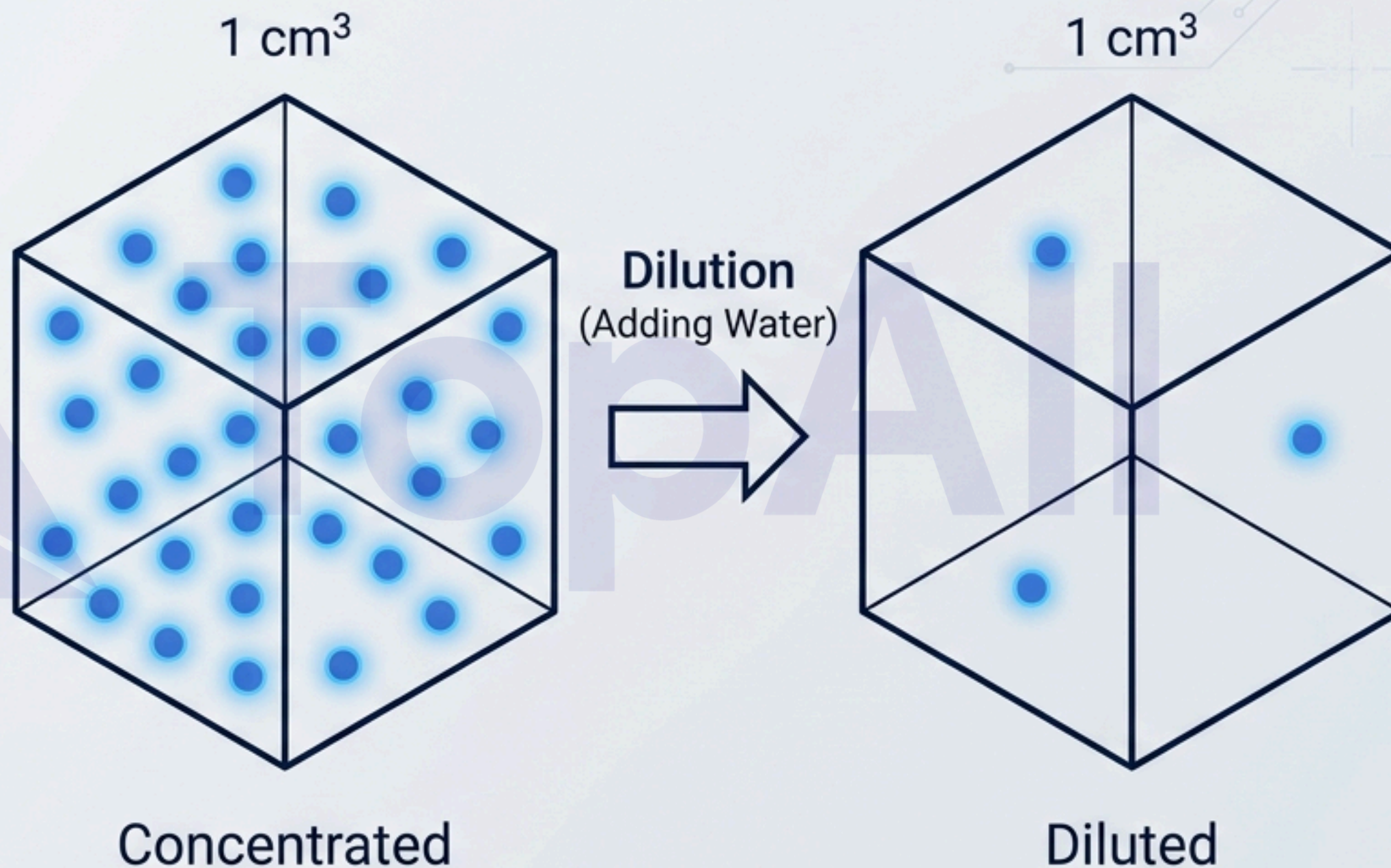


$\Lambda_m \uparrow$
(Molar
Conductivity)

Conductivity (κ) Plummet

- Dilution adds solvent $\rightarrow$ fewer ions per unit volume.
- Fewer charge carriers in the same space $\rightarrow \kappa$ decreases.

The Fixed Volume



Enter Molar Conductivity (Λ_m)

Molar conductivity normalizes general conductivity against concentration.

Standard Definition

$$\Lambda_m = \frac{\kappa}{c}$$

Diagram illustrating the standard definition of Molar Conductivity (Λ_m):

- MOLAR CONDUCTIVITY** is indicated by an arrow pointing to Λ_m .
- CONDUCTIVITY** is indicated by an arrow pointing to κ .
- CONCENTRATION** is indicated by an arrow pointing to c .

JEE Exam Ready

$$\Lambda_m = \frac{\kappa \times 1000}{M}$$

Diagram illustrating the JEE Exam Ready formula for Molar Conductivity (Λ_m):

- UNIT CONVERSION FACTOR** is indicated by an arrow pointing to the 1000 in the numerator.
- MOLARITY (mol L⁻¹)** is indicated by an arrow pointing to M in the denominator.



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

$$E=mc^2$$



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Key Highlights

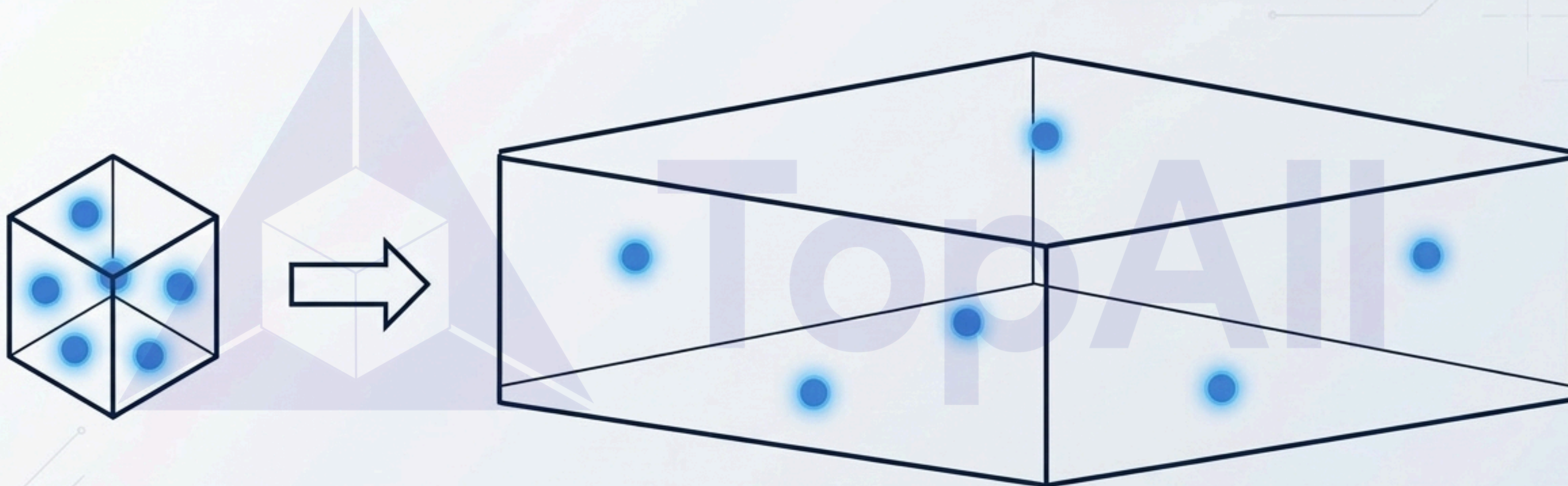
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The Volume that Holds One Mole

$$\Lambda_m = \kappa \times V$$

(where V is the volume containing exactly 1 mole of electrolyte)



Low Volume (V) | High κ

Huge Volume (V) | Low κ

While κ drops, the Volume (V) required to hold 1 mole increases so dramatically that their product (Λ_m) rises.

The Infinite Dilution Limit

As concentration approaches zero, the electrolyte is completely dissociated, and ions are infinitely far apart, acting completely independently.

$$c \rightarrow 0 \Rightarrow \Lambda_m \rightarrow \Lambda_m^\circ$$

Λ_m° = Limiting Molar Conductivity

Adding solvent...

High Concentration (c)

0

Strong Electrolyte Behavior

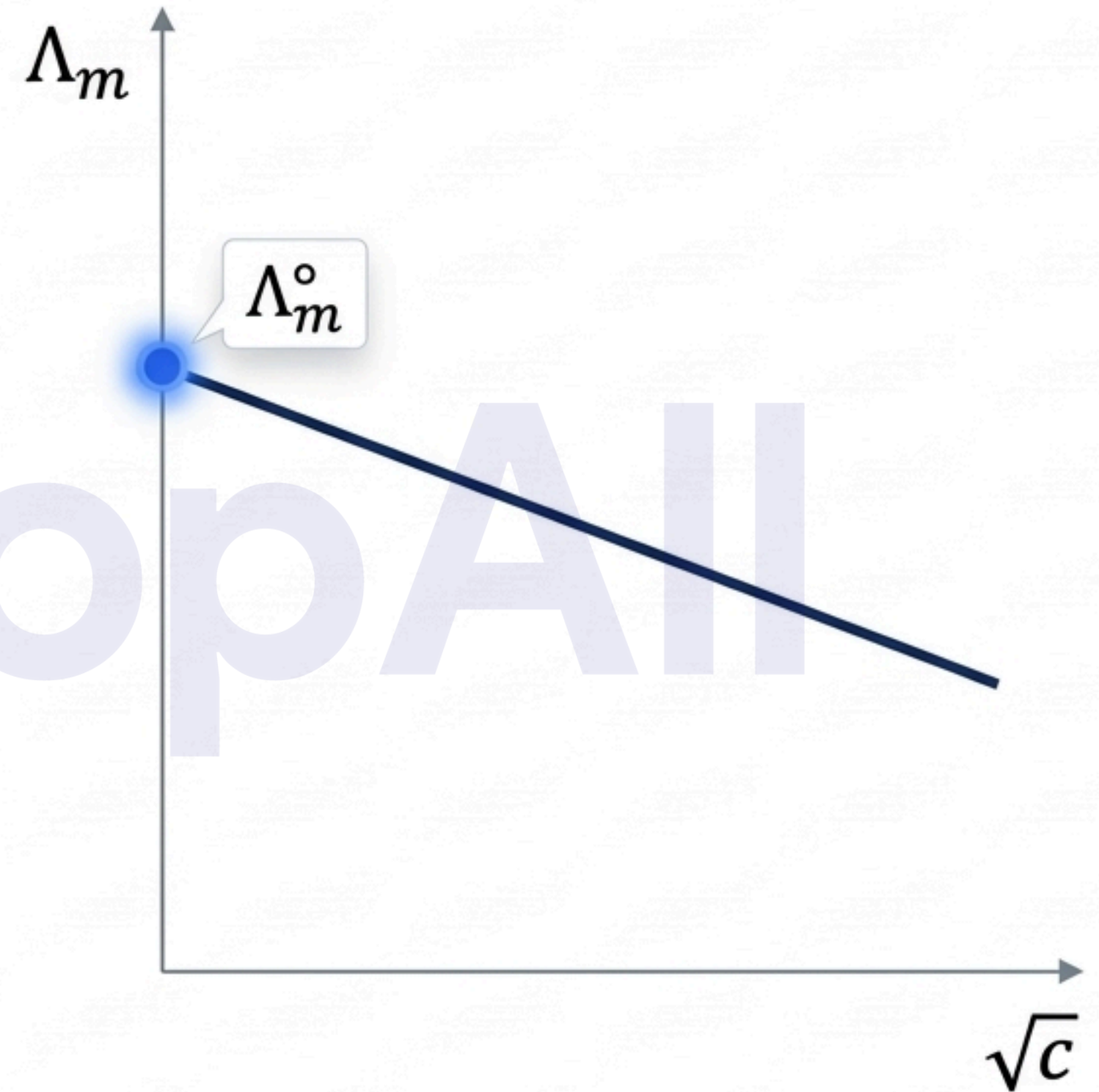
$$\Lambda_m = \Lambda_m^\circ - A\sqrt{c}$$

$y \rightarrow \Lambda_m$

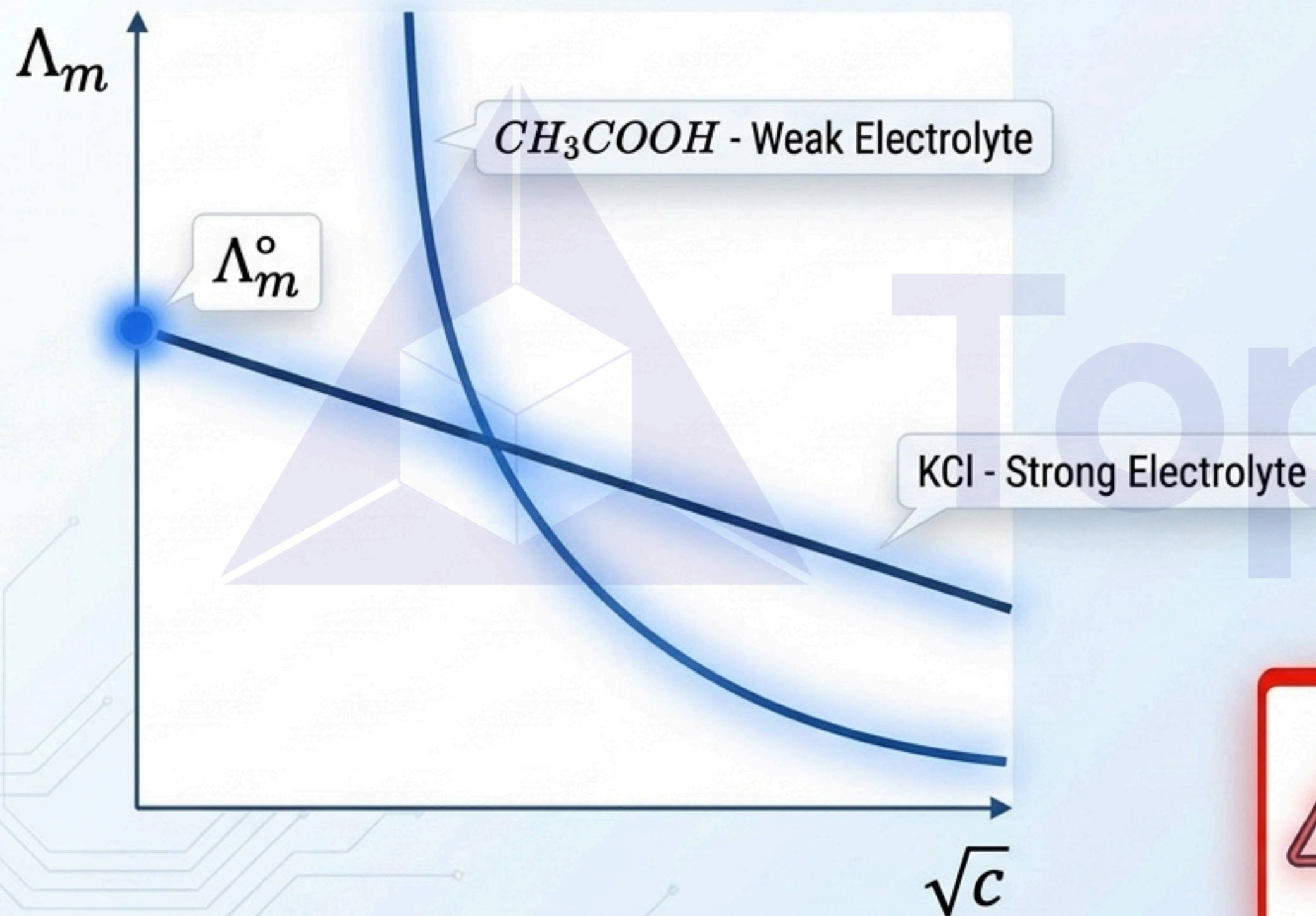
$c \rightarrow \Lambda_m^\circ$ (Intercept)

$m \rightarrow -A$ (Slope depending on electrolyte type)

$x \rightarrow \sqrt{c}$



The Grand Comparison

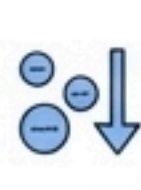


TRAP: You **CANNOT** find Λ_m° for weak electrolytes by extrapolating the graph. The curve never touches the axis! You must use Kohlrausch's Law.

Ultimate Revision Cheat Sheet

Dilution Effect

 Concentration ↓

 κ ↓ (Fewer ions per unit volume)

 Λ_m ↑ (Volume expansion dominates)

Strong (e.g., KCl)

Follows: $\Lambda_m = \Lambda_m^\circ - A\sqrt{c}$

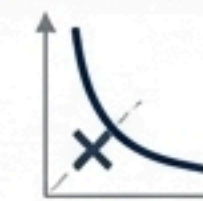
Graph: Straight line.



Λ_m° : Found by Y-intercept extrapolation.

Weak (e.g., CH_3COOH)

Graph: Steep asymptotic curve.



Λ_m° : Extrapolation fails.

Requirement: Needs Kohlrausch's Law.

Core Rule: In $\Lambda_m = \kappa \times V$, the massive growth of Volume (V) always overcompensates for the drop in ion density (κ).



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