

UNIT 1: SOLUTIONS | SECTION 1.6



COLLIGATIVE PROPERTIES & DETERMINATION OF MOLAR MASS

Understanding how solute particle count drives physical property changes in solutions.



Identity Doesn't Matter. Quantity Does.

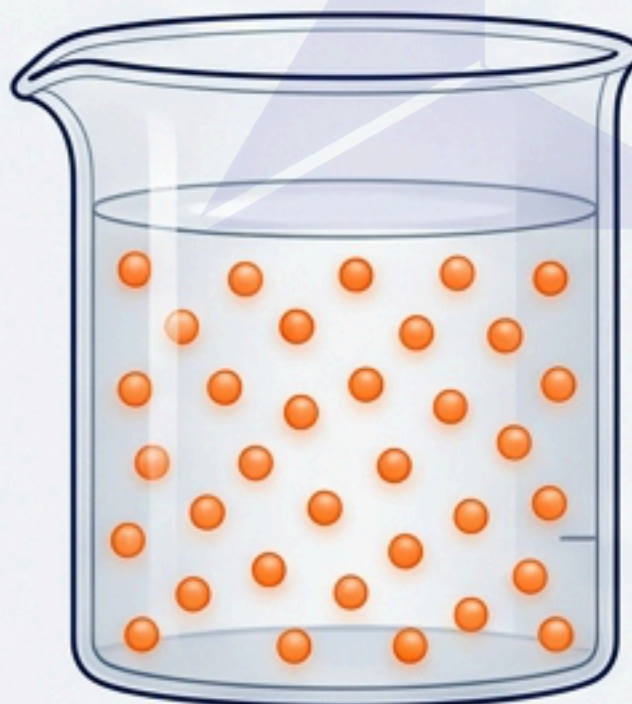
The Definition

Properties of solutions that depend **ONLY** on the number of solute particles **relative to the total number of particles**, regardless of their chemical nature.

The Etymology

From Latin: "co" (together) + "ligare" (to bind).

1.0 mol Urea

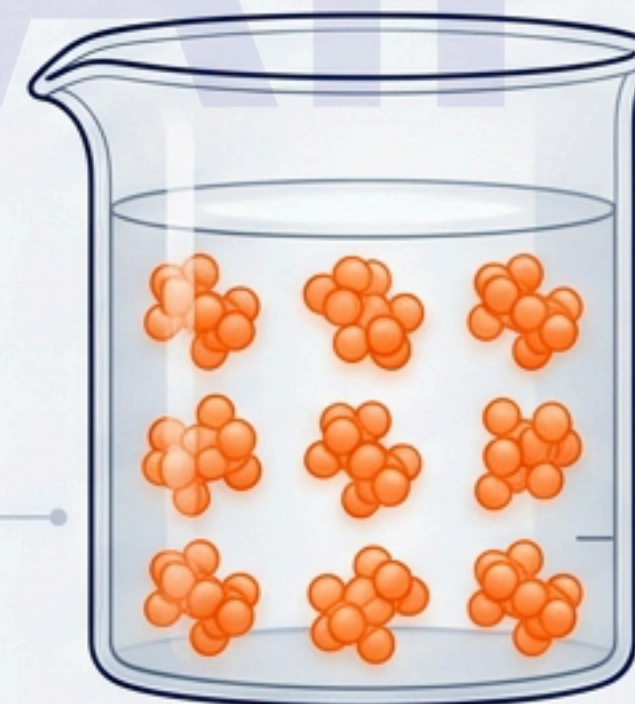


$\Delta T = 0.51\text{ }^{\circ}\text{C}$
 $\pi = 24.4\text{ atm}$



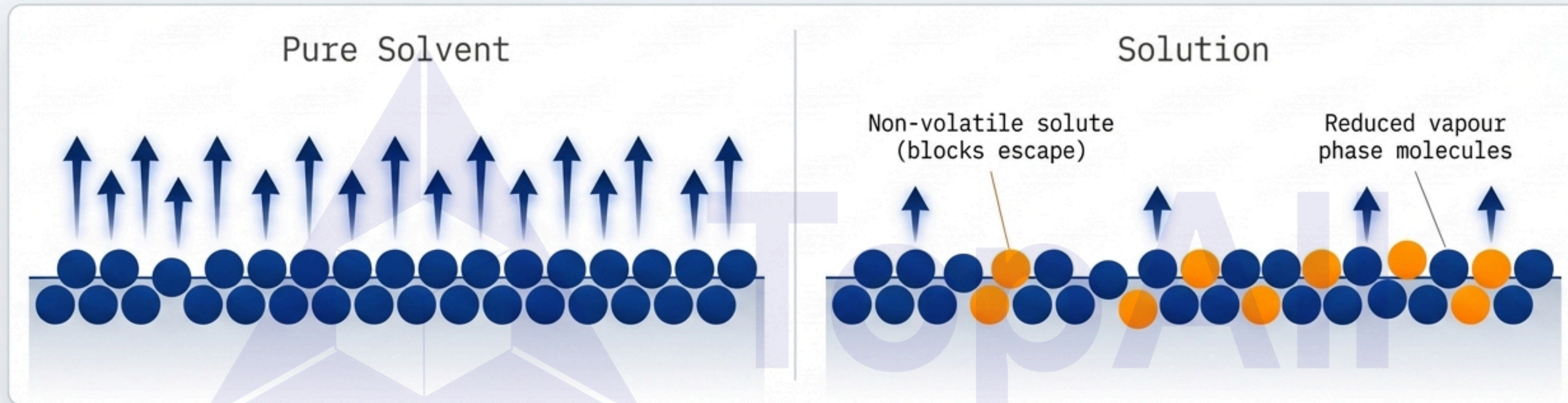
$\Delta T = 0.51\text{ }^{\circ}\text{C}$
 $\pi = 24.4\text{ atm}$

1.0 mol Sucrose



Different molecules.
Same **number of particles**.
Same **physical change**.

The Vapour Pressure Cascade



Concept Strip



Recap Badge

ALL colligative properties stem from this fundamental lowering of vapour pressure.



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$$E=mc^2$$



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The Colligative Property Matrix

Relative Lowering of Vapour Pressure

$$\frac{p_1^{\ominus} - p_1}{p_1^{\ominus}} = \mathbf{x_2}$$

Elevation of Boiling Point

$$\Delta T_b = K_b \cdot \mathbf{m}$$

Depression of Freezing Point

$$\Delta T_f = K_f \cdot \mathbf{m}$$

Osmotic Pressure

$$\Pi = \mathbf{C} \cdot R \cdot T$$

Formula Strip

m = molality

C = molarity

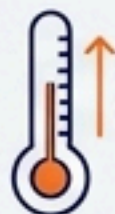
x_2 = mole fraction of solute

$p_1^{\ominus}$ = vapour pressure of pure solvent

Reverse-Engineering the Unknown (M_2)

Flowchart Narrative

Measure



Observe the macroscopic change in the laboratory (e.g., ΔT_b , ΔT_f , or Π).

Isolate Moles



Use the colligative formulas to calculate the concentration (m or C), which reveals the number of moles of solute (n_2).

Calculate M_2



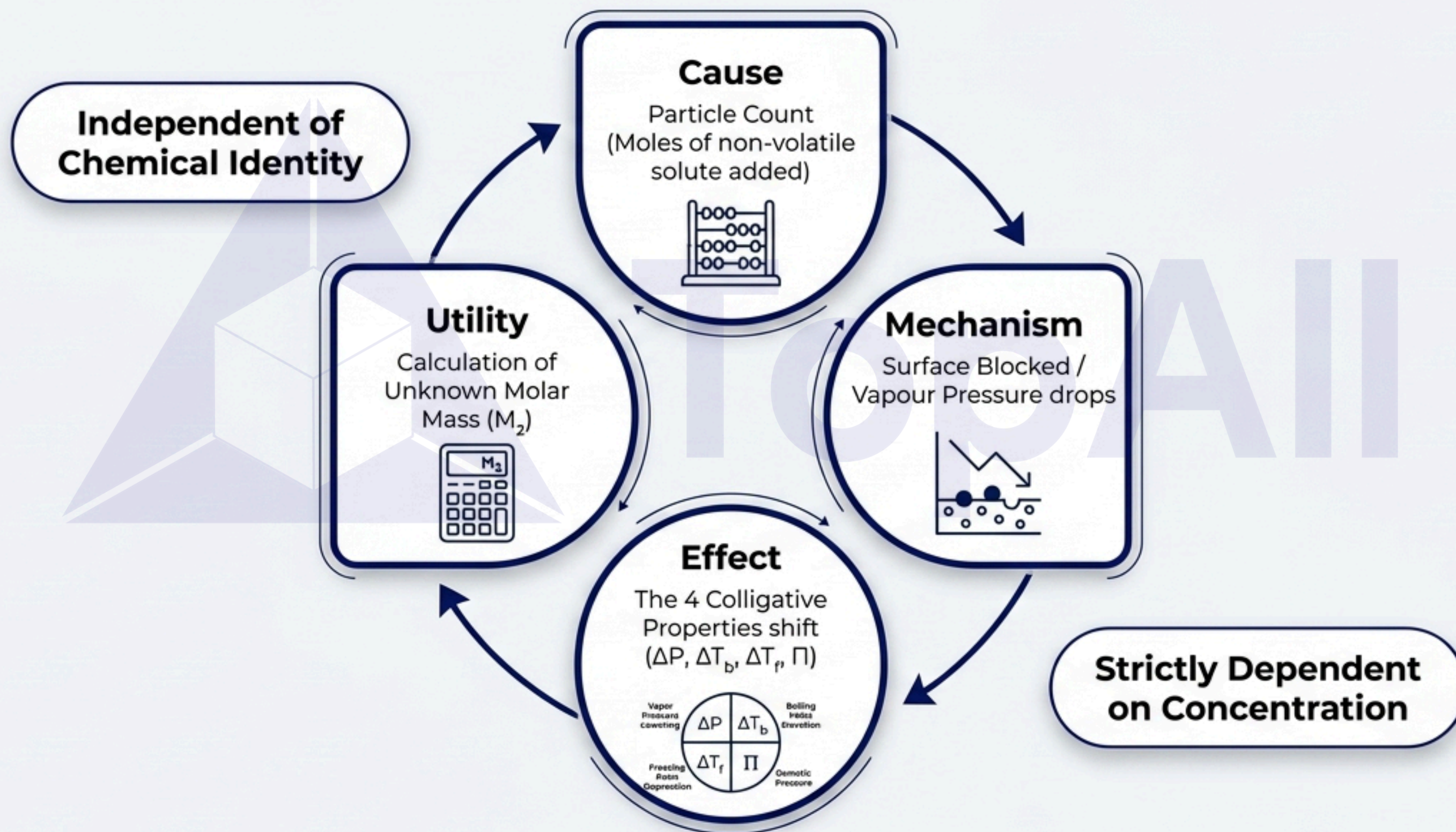
Since the physical mass of the solute (w_2) is known, divide mass by moles to find Molar Mass:
$$M_2 = w_2 / n_2$$

Key-Takeaway Box

The Biomolecule Advantage

Osmotic pressure (Π) is uniquely measured at room temperature using molarity (C). This makes it the **safest** and most accurate method for determining the **molar mass** of **fragile proteins and polymers** that would degrade at high boiling temperatures.

The Macro-Micro Connection





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