

Unit 1: Solutions

1.2 Expressing Concentration of Solutions

From Qualitative Descriptions to Quantitative Mastery

Class 12 Chemistry

Exam-Ready Summary

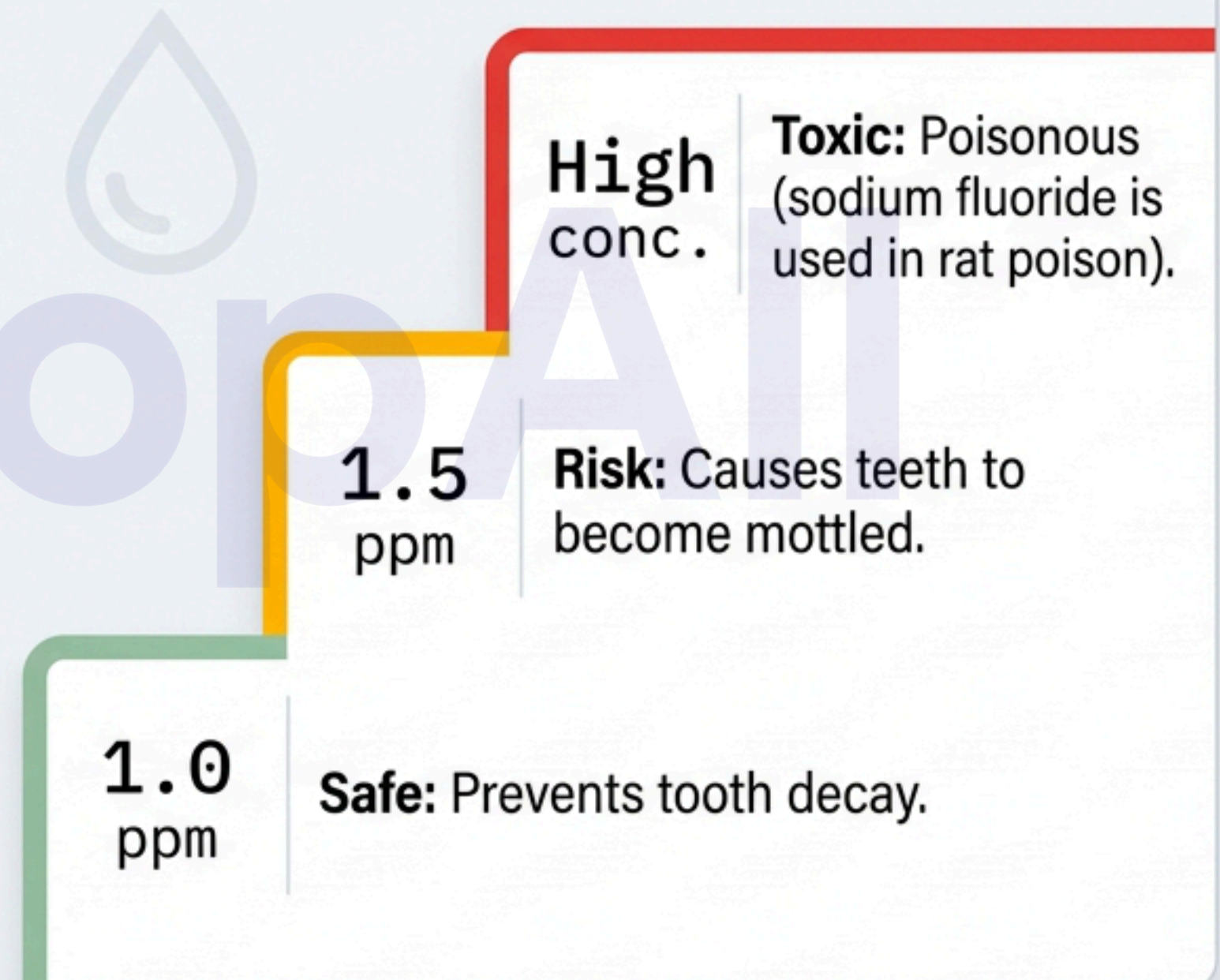
Dashboard Interface

The Problem

Beyond "Dilute" & "Concentrated".
Qualitative descriptions cause confusion.
In industry, environment, and medicine,
exactness is literally a matter of life or
death.

Intravenous (`IV`) injections must
perfectly match blood plasma ionic
concentrations. Close isn't good enough.

The Fluoride Threshold



Scale: Macro

Mass Percentage (w/w)

Formula Strip

$$\text{Mass \%} = \frac{\text{Mass of component}}{\text{Total mass of solution}} \times 100$$

App Chip



Industrial: Commercial bleaching solution is exactly 3.62% mass of sodium hypochlorite in water.

Scale: Macro

Volume Percentage (v/v)

Formula Strip

$$\text{Volume \%} = \frac{\text{Volume of component}}{\text{Total volume of solution}} \times 100$$

App Chip



Liquid Solutions: 35% (v/v) ethylene glycol is used as car antifreeze. It lowers water's freezing point to 255.4 K (-17.6°C).

Scale: Hybrid

Mass by Volume Percentage

Mass of solute dissolved in exactly 100 mL of solution.

App Chip



Medicine: The standard unit for medicine and pharmaceutical formulations.

Scale: Trace

Parts per Million (ppm)

Used when a solute is present in trace quantities.

Formula Strip

$$\text{ppm} = \frac{\text{Parts of component}}{\text{Total parts of all components}} \times 10^6$$



Environment: Trace pollutants. E.g., 5.8 g of dissolved O₂ in 10⁶ g of seawater is expressed as 5.8 ppm.



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

$$E=mc^2$$



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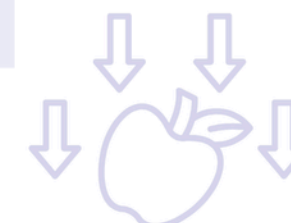
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Mole Fraction x

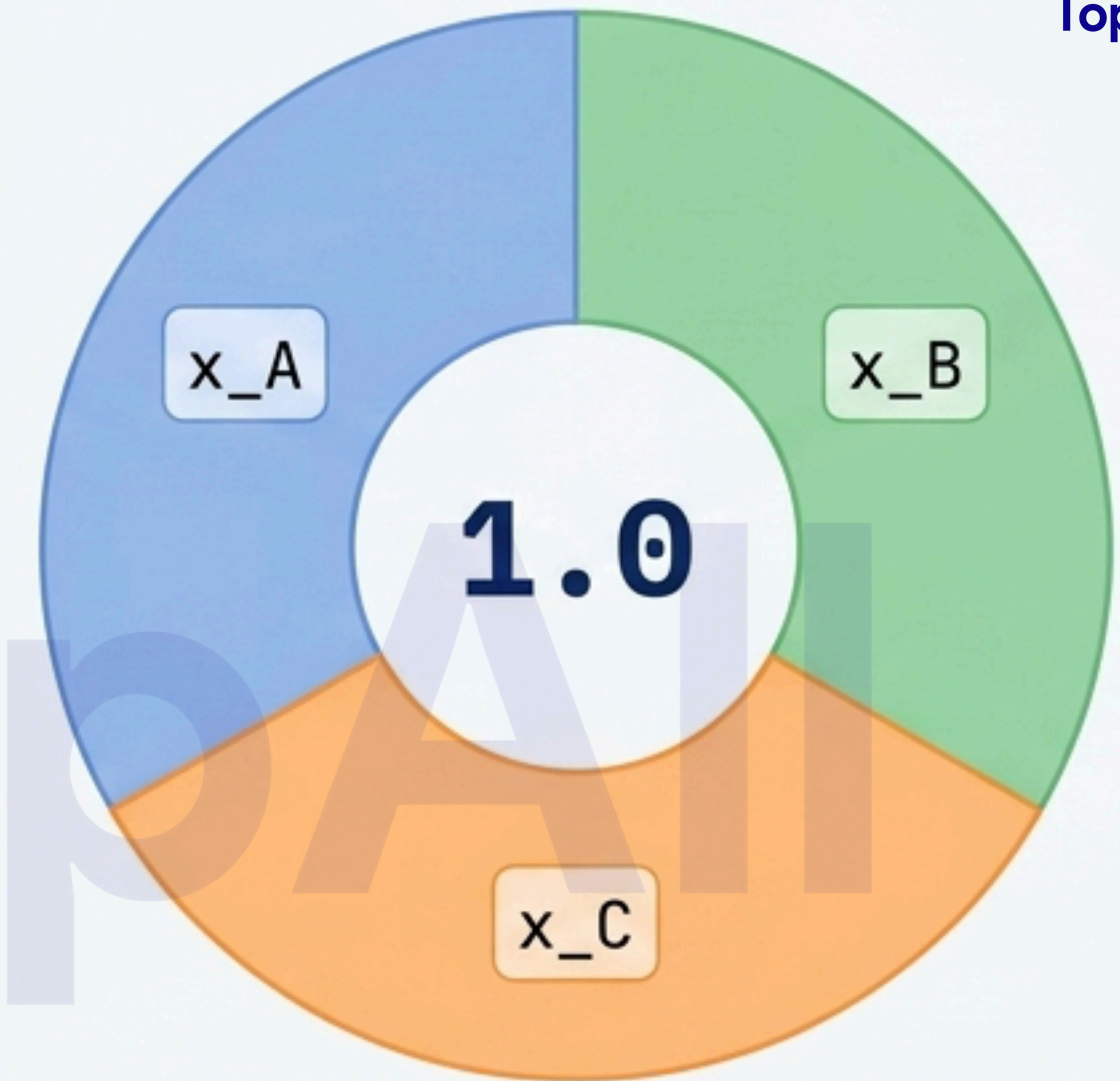
Moles of a specific component divided by the total moles of all components.

$$x_A = n_A / (n_A + n_B)$$

The Unity Rule

$$x_1 + x_2 + \dots + x_i = 1$$

(The sum of all mole fractions in a solution is always exactly 1).



Exam-Smart Takeaway Box: Highly useful for calculating physical properties like vapour pressure (Raoult's Law) and analyzing gas mixtures.

Molarity M

Moles of solute dissolved in one litre (or cubic decimetre) of solution.

$$M = \frac{\text{Moles of solute}}{\text{Volume of solution in L}}$$

0.25 M NaOH means exactly
0.25 mol of NaOH is
dissolved in exactly 1 L of
total solution.



Temperature Dependent. Liquids expand and contract with heat. Because Molarity relies on volume, a solution's Molarity shifts as the temperature changes!

Molality m

Number of moles of solute per kilogram (kg) of the solvent (Note: not the total solution!).

$$m = \frac{\text{Moles of solute}}{\text{Mass of solvent in kg}}$$

1.00 m KCl means exactly 1 mol (74.5 g) of KCl is dissolved in exactly 1 kg of water.



Temperature Independent. Mass does not fluctuate with heat. Molality remains perfectly constant regardless of thermal conditions.

Diagnostic Framework: When to use which unit?

Unit Name	Symbol	Math Basis	Temp Dependent?	Best Used For
Mass % (w/w)	%	Mass	✓ No	Industrial chemicals
Volume % (v/v)	%	Volume	⊗ Yes	Liquid-in-liquid mixtures (Antifreeze)
Parts per Million	ppm	Varies	Varies	Trace pollutants / Medicine
Mole Fraction	x	Moles	✓ No	Gas mixtures & Vapour Pressure
Molarity	M	Moles / Vol	⚠ Yes	General lab titrations
Molality	m	Moles / Mass	✓ No	Colligative properties & varying temps

Exam Rule: Volume expands/contracts with temperature; mass does not. Therefore, any concentration unit containing a volume term in its formula is inherently temperature-dependent.



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