Solutions & Concentration

Percent, molarity, molality, dilution, mixing, and the concepts behind dissolving.

01 Mass percent — CORE RULE

Mass % = (mass of component / mass of solution) × 100, where mass of solution = solute + solvent. For an ion target, convert ion mass ↔ compound mass with mole ratios and molar masses.

02 Volume percent — CORE RULE

Volume % = (component volume / total solution volume) × 100. Given one volume and a target %, solve x / (x + V_other) = target/100.

03 Solubility & saturation — CORE RULE

Solubility = grams of solute per 100 g water at a stated temperature (supplied). Saturated-solution mass % = solubility / (solubility + 100) × 100.

04 Molarity — CORE RULE

Molarity M = moles solute / litres of solution. Convert mL → L (÷1000); mass → moles via molar mass. For hydrates use the full hydrate molar mass.

05 Molarity of each ion — CORE RULE

For a soluble strong electrolyte (complete dissociation): write the dissociation equation, then multiply the compound molarity by each ion's coefficient. 0.10 M $CaCl_2$ → 0.10 M Ca^{2+} and 0.20 M Cl^-.

06 Dilution — CORE RULE

$M_1V_1 = M_2V_2$ (moles conserved). 'Diluted to' a volume → V_2 is the final total; water 'added' → $V_2 = V_1$ + V_water. Units just have to match (they cancel).

07 Stock solutions — CORE RULE

Use $M_1V_1 = M_2V_2$ with 1 = stock (concentrated), 2 = target (dilute). Volume of stock $V_1 = M_2V_2 / M_1$; stock concentration $M_1 = M_2V_2 / V_1$.

08 Mixing same-compound solutions — CORE RULE

Final M = $(M_1V_1 + M_2V_2) / (V_1 + V_2)$. The result lands between the two, nearer the larger-volume solution (a quick sanity check).

09 Molality — CORE RULE

Molality m = moles solute / kg of solvent (mass, not volume; solvent, not solution). Add hydrate water to the solvent mass. Unlike molarity, m is temperature-independent.

10 Molarity ↔ molality — METHOD

You need the density ρ. Take a reference amount (1 L for M, 1 kg solvent for m); mass of solution = ρ × V; solvent mass = solution − solute. Then m = n/kg_solvent, M = n/L_solution. No density → not convertible.

11 ppm & ppb — CORE RULE

ppm = (mass solute / mass solution) × 10^6; ppb = (mass solute / mass solution) × 10^9. For dilute water, 1 ppm ≈ 1 mg/L. Use these for trace levels where mass % is inconveniently small.

12 Like dissolves like — CORE RULE

Polar dissolves polar; non-polar dissolves non-polar. Ionic solids dissolve in polar solvents via ion-dipole forces. Mismatched polarity → immiscible layers or an insoluble solid.