

Solutions & Concentration

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

01 Mass percent

CORE RULE

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

02 Volume percent

CORE RULE

Volume % = (component volume / total solution volume) $\times$ 100. Given one volume and a target %, solve $x / (x + V_{\text{other}}) = \text{target}/100$.

03 Solubility & saturation

CORE RULE

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

04 Molarity

CORE RULE

Molarity M = moles solute / litres of solution. Convert mL $\rightarrow$ L ($\div 1000$); mass $\rightarrow$ 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. $0.10 \text{ M CaCl}_2 \rightarrow 0.10 \text{ M Ca}^{2+}$ and 0.20 M Cl^- .

06 Dilution

CORE RULE

$M_1V_1 = M_2V_2$ (moles conserved). 'Diluted to' a volume $\rightarrow V_2$ is the final total; water 'added' $\rightarrow V_2 = V_1 + V_{\text{water}}$. 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 $\leftrightarrow$ molality

METHOD

You need the density ρ . Take a reference amount (1 L for M , 1 kg solvent for m); mass of solution = $\rho \times V$; solvent mass = solution – solute. Then $m = n/\text{kg}_{\text{solvent}}$, $M = n/\text{L}_{\text{solution}}$. No density $\rightarrow$ not convertible.

11 ppm & ppb

CORE RULE

$\text{ppm} = (\text{mass solute} / \text{mass solution}) \times 10^6$; $\text{ppb} = (\text{mass solute} / \text{mass solution}) \times 10^9$. For dilute water, 1 ppm $\approx$ 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 $\rightarrow$ immiscible layers or an insoluble solid.