

Raoult's law, and the four properties that only count particles

Ways of saying how concentrated it is

- molarity M = moles of solute per litre of SOLUTION, and it changes with temperature because volume does
- molality m = moles of solute per kg of SOLVENT, and it does NOT change with temperature, which is why every colligative formula uses it
- mole fraction x = moles of one component over total moles, and the fractions of a mixture sum to 1
- mass per cent and parts per million are mass over mass, the second multiplied by 10^6 and used for traces
- converting molarity to molality needs the density, so a question that gives density is asking for exactly that conversion

Solubility, and the two rules that govern a gas

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- like dissolves like : polar solutes dissolve in polar solvents because the solute solvent attraction can replace what it breaks
- for most solids dissolving is endothermic, so solubility rises with temperature; where dissolving is exothermic it falls, and cerium sulphate is the standard example
- Henry's law : the partial pressure of a gas over a solution is proportional to its mole fraction in solution, $p = K_H x$
- so a LARGER K_H means a LESS soluble gas, and K_H rises with temperature, which is why a warm fizzy drink goes flat and why cold water holds more oxygen
- the law explains both the bends in divers and the sealing of soft drinks under high carbon dioxide pressure

Raoult's law, in its two forms

volatile solute and solvent

$$p_A = p_A^0 x_A, \text{ and total } p = p_A^0 x_A + p_B^0 x_B$$

non volatile solute

$$p = p^0 x_{\text{solvent}}, \text{ so only the solvent contributes}$$

relative lowering

$$(p^0 - p) / p^0 = x_{\text{solute}}$$

vapour composition

$$y_A = p_A / p_{\text{total}}, \text{ and the vapour is richer in the more volatile component}$$

Henry, for comparison

$$p = K_H x, \text{ the same shape with a different constant}$$



partial pressure against mole fraction: a straight line through the origin is what obeying Raoult's law looks like
Raoult's law is Henry's law with K_H equal to the pure component's own vapour pressure, so the two are one statement in different regimes