1. Raoult’s law, *p*A=*x*A*p*A\*, defines the behaviour of ideal solutions. Like idea gases, what makes the behaviour ideal can be expressed in terms of intermolecular interactions. Unlike ideal gases, however, the interactions in an ideal solution cannot be neglected. Instead, ideal behaviour amounts to having the same interactions among molecules of the mixture’s different components as molecules of each component have with other molecules of the same component. In short, ideal behaviour consists of A-B interactions being the same as A-A and B-B interactions. If that is the case, then the cohesive forces that would keep the molecule in the liquid phase would be the same in a solution as in a pure liquid and the vapour pressure of a component will differ from that of a pure liquid only in proportion to its abundance (mole fraction). Thus, we expect Raoult’s law to be valid for mixtures of components that have very similar chemical structures. Similar structures imply both similar intermolecular interactions (governed largely by polarity) and similar sizes (implying that the mole fraction is a good approximation of the relative proportion of the surface area occupied by each component – a factor that is relevant to rates of evaporation and condensation).

The mole fractions are equal so *x*A=*x*B=0.50. Because the gases are prefect, *pV*=*nRT*. Therefore;

1. At the boiling point of the solution (*T*b) the chemical potential of the liquid solvent is equal to that of the solvent vapour; *μ*A(*l*,*T*b)=*μ*A(*g*,*T*b). Substituting the ideal solution expressions for these chemical potentials yields: .

The last term vanishes because *p*A=*p*° at the boiling point of the solution. We are interested in comparing *T*b to *T*b°, the boiling point of the pure solvent. As , , if is small.

Thus we can express the chemical potential at the boiling point of the solutions (*T*b), in terms of differences from the chemical potential at the boiling point of the pure substance (*T*b\*): , if *x*B is small.

The differences in the left side of the equation are simply Δ*T*b and *Δ*vap*S*, so we have if and so , as .

1. The ionic strength of the original solution is *I*(KNO3)=0.250, *i.e.* *b*/*b*° for a singly-charged salt. So the added salt must contribute an additional ionic strength of 0.200.
2. *I*[Ca(NO3)2]=1/2(22+2\*12)*b*/*b*°=3*b*/*b*°=0.200, so *b*=(0.200/3)*b*°=0.667 mol kg-1, and *m*[Ca(NO3)2]=0.667 mol kg-1 \* 0.800 kg \* 261.32 g mol-1 = 8.75 g.
3. An additional 0.200 NaCl must be added per kg solvent, so *m*(NaCl)=0.200 mol kg-1 \*

