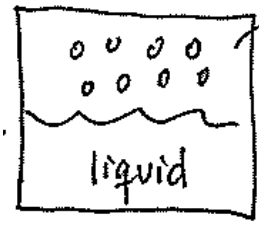
Name:_____

Break-out session #15: Colligative Properties

(1) Explain why the vapor pressure decreases when you add a solute to a solvent? Hint, (a) first define vapor pressure, (b) think about entropy – when a solvent evaporates what happens to entropy; when you mix a solute with solvent, what happens to entropy?

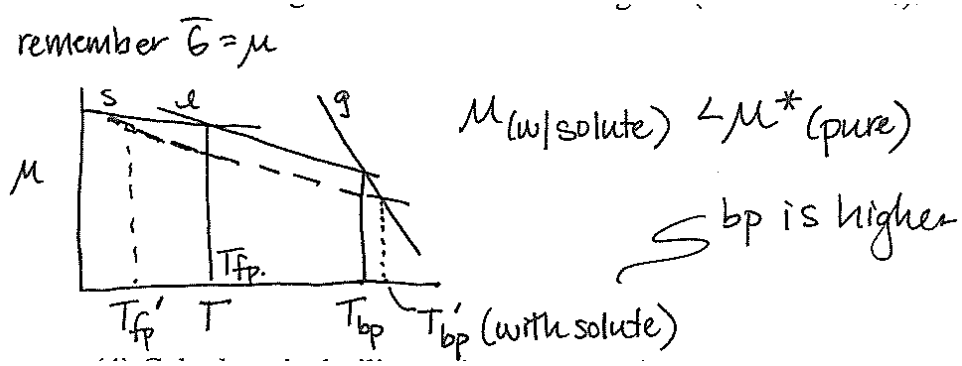


Vapor pressure is proportional to the # moles of vapor and therefore is related to how many molecules escape into the gas phase.
Evaporation: *formation of a gas causes an increase in* ΔS_{univ} *because gas has greater entropy than the liquid.* ***Formation of a solution****: involves an increase in* ΔS_{univ} *because* $\Delta S_{mix} > 0$. ***In a soln*** *(vs a pure solvent) evaporation results in a smaller increase in entropy so the molecules don't escape as readily into the gas phase.*

(2) Explain why the boiling point increases when you add a solute. Again – think of how the boiling point relates to the vapor pressure.

Boiling point = Temp at which the vapor pressure equals the external atmospheric pressure. If the vapor pressure decreases upon adding solute, you will need to heat the solution to a higher temperature in order for the vapor pressure to equal the external atmospheric pressure.

(3) Show this boiling point elevation graphically by plotting the chemical potential for all three phases of pure H_2O vs. temperature (i.e μ vs. T). Now imagine you add a solute to the H_2O. Draw the changes that occur on the diagram (in dashed lines). Think – which phase do you think is affected by addition of solute!



(4) Calculate the boiling point elevation for a solution of 45.20 g sucrose (molar mass = 342.3 g/mol) in 316.0 g water. The K_b = 0.51 kg K/mol.

$\Delta T_b = K_b m$, where m = molality of sucrose

$$m = 45.20g \times \left(\frac{mol}{342.3g}\right) \times \left(\frac{1}{316gH_2O}\right) \times \left(\frac{1000g}{kg}\right) = 0.417 mol/kg$$

$\Delta T_b = K_b m = (0.51 kgK/mol)(0.417 mol/kg) = 0.21K$ This will be the increase in T_{bp}.