Molecular Physics (Prof. Käs) **WS 2007/08**

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Problem Set 5

Due date: November 12, 2007

Problem 17)
A container of 420 mL volume is divided into two compartments which have equal size. One compartment contains argon at 120 kPa and 10°C, while there is neon at the same temperature and pressure in the other compartment. Calculate the entropy and the Gibbs energy of mixing when the separation between compartments is removed under the assumption that both gases are perfect.
(2 points)

Problem 18)
By measuring the osmotic pressure *Π* at 20.00 °C and expressing the pressure in terms of height of the solvent, the molar mass of an enzyme was determined. The following data were obtained:

c / mg cm^{-3}	5.579	7.999	8.854	11.648
h / cm	8.126	11.650	12.896	16.956

Plot the data, extrapolate to zero concentration, and determine the slope. Use the slope and the van't Hoff equation

$$\Pi = \frac{n_B RT}{V}$$

where n_B is the number of moles of the solute, to calculate the molar mass of the enzyme. The density of water at 20.00 °C is given with 1.000 g cm^{-3}.
(4 points)

Problem 19)
The excess Gibbs energies of solutions of cyclohexanone and xylene at 293.15 K were found to fit the expression

$$G^E = RTx(1-x)\left[0.3251 - 0.0923(2x-1) + 0.0183(2x-1)^2\right]$$

where x is the mole fraction of cyclohexanone. Calculate the Gibbs energy of mixing when a mixture of 1.25 mole cyclohexanone and 2.75 mole xylene is prepared.
(4 points)

Problem 20)
Use the *Gibbs-Helmholtz* equation to find an expression for $d\ln x_A$ in terms of dT. Integrate $d\ln x_A$ from $x_A = 0$ to the value of interest, and integrate the right-hand side from the transition temperature for the pure liquid *A* to the value in the solution. Show that, if the transition enthalpy is constant, the following expression for ΔT, the freezing point depression, can be obtained:

$$\Delta T = x_B \frac{RT^{*2}}{\Delta_{fus} H}$$

(5 points)