Handin Homework 11: Phase transitions and Ideal Solutions

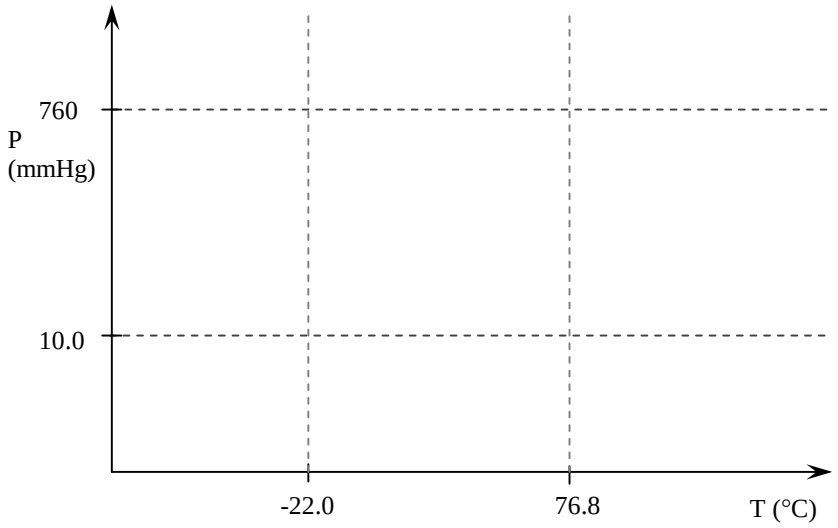
1. A 0.1000 m aqueous urea solution and pure water are separated by a membrane that is impermeable to urea and permeable to water, at 25°C and 1 bar. Calculate the chemical potential of urea in the solution, relative to the Henry's Law standard state chemical potential, at equilibrium. The density of the solution is 0.99873 g $mL^{-1}$and the data necessary to obtain partial molar volume is given in Example 18.1.1.

2. The chemical potential of an ideal solvent in solution is $\mu_A(x_A) = \mu_A^*(l) + RT \ln x_A$. The chemical potential of the pure solid solvent is $\mu_A^*(s)$. Prove that the dependence of the freezing point of a solution on the concentration of the solvent is given by:

$$\ln x_A = -\frac{\Delta_{fus}H_A}{R}\left(\frac{1}{T} - \frac{1}{T_m^*}\right)$$

3. The normal melting point of CCl_4 is -22.0°C. At -22.0°C the vapor pressure is 10.0 mmHg. The liquid and solid densities are 1.63 and 1.80 g cm^{-3}, respectively. The normal boiling point is 76.8°C.

(a). Make a qualitative plot of the phase diagram for CCl_4. Use several specific points to guide the drawing of your lines. Mark the liquid, vapor, and solid regions.



(b). Calculate the enthalpy of vaporization of CCl_4.