

Worksheet # 10 (Total number of points you can get is 3 pts)

1. (1.0pts) Assume an ideal solution of two components A and B. At $T=280$ K, $P^*(A) = 4$ kPa, and $P^*(B) = 8$ kPa. Compute the vapor pressure of a solution containing 0.7 mol fraction of A. What is the mole fraction of A in the vapor over the liquid?

$$\begin{aligned}
 P &= \chi_A P_A^* + (1 - \chi_A) P_B^* \quad (\chi_B = 1 - \chi_A) \\
 &= 0.7 \cdot 4 \cdot 10^3 \text{ Pa} + 0.3 \cdot 8 \cdot 10^3 \text{ Pa} \\
 &= 2.8 \cdot 10^3 \text{ Pa} + 2.4 \cdot 10^3 \text{ Pa} \\
 &= 5.2 \cdot 10^3 \text{ Pa} \\
 &= 5.2 \text{ kPa}
 \end{aligned}$$

$$\begin{aligned}
 P_A &= \chi_A^{\text{vap}} P \Rightarrow \chi_A^{\text{vap}} = \frac{P_A}{P} = \frac{\chi_A \cdot P_A^*}{P} = \frac{2.8 \text{ kPa}}{5.2 \text{ kPa}} \\
 &= 0.54
 \end{aligned}$$

2. (1.5pts) In an experiment, the vapor pressure of a liquid is measured as 3 kPa at 298K, and as 102 kPa at 374 K. Calculate from these data the enthalpy of vaporization $\Delta_{\text{vap}}H$ of the liquid.

$$\begin{aligned}
 \ln \frac{P_2}{P_1} &= \frac{\Delta_{\text{vap}}H}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right) = \frac{\Delta_{\text{vap}}H}{R} \frac{T_2 - T_1}{T_1 T_2} \\
 \Rightarrow \Delta_{\text{vap}}H &= R \cdot \ln \frac{P_2}{P_1} \cdot \frac{T_1 T_2}{T_2 - T_1} \\
 &= 8.3145 \cdot \ln \frac{102}{3} \cdot \frac{374 \cdot 298}{374 - 298} \text{ J} \\
 &= 8.3145 \cdot \ln 34 \cdot \frac{111452}{76} \text{ J} \\
 &= 8.3145 \cdot 3.526 \cdot 1466.474 \text{ J} \\
 &= 42492.5 \text{ J} = 42.49 \text{ kJ}
 \end{aligned}$$

3. (0.5 pts) How many different phases can at most co-exist in an one-component system? Why?

$$f = c - P + 2 \quad c = 1 \quad f \geq 0 \Rightarrow P_{\text{max}} = 3$$