

Name: Solutions

Problem 1: A concentrated binary solution containing mostly species 2 (but $x_2 \neq 1$) is in equilibrium with a vapor phase containing both species 1 and 2. The pressure of this two-phase system is **1 bar**; the temperature is 25°C . Determine from the following data good estimates of x_1 and y_1 , stating all assumptions.

$$H_1 = 200 \text{ bar} \quad p_2^*(25^\circ\text{C}) = 0.10 \text{ bar}$$

Assumptions: Ideal Solution
Ideal Gas

(Assume $p_2^* \approx p_2$ is OK)

$$P = x_1 H_1 + (1 - x_1) p_2^*$$

$$\Rightarrow x_1 = 0.0045$$

$$y_1 = \frac{p_1}{P} = \frac{x_1 H_1}{P} = 0.9$$

Problem 2: Are the following statements true or false? Explain your reasoning.

1) The chemical potential of a component in a system is the partial molar internal energy for the component.

False

Chemical potential = partial molar Gibbs free energy = $\left(\frac{\partial G}{\partial n_i} \right)_{T, P, n_j, \dots}$

2) The partial molar enthalpy of component 1 is given by $\bar{H}_1 = a + b$, when the total solution enthalpy is given by $\hat{H} = ax_1 + b$.

$$\begin{aligned} \bar{H}_1 &= \hat{H} + x_2 \frac{d\hat{H}}{dx_1} \\ &= ax_1 + b + x_2(a) \end{aligned}$$

$$\begin{aligned} &= ax_1 + b + (1 - x_1)a \\ &= ax_1 + b - ax_1 + a \end{aligned}$$

$$\boxed{\bar{H}_1 = a + b} \quad \text{True}$$

Useful Equations: Henry's Law $y_i P = x_i \mathcal{H}_i(T)$; $\bar{M} = \sum x_i \bar{M}_i$; $\frac{dM_1}{dx_1} = \bar{M}_1 - \bar{M}_2$

Typo $\rightarrow \frac{d\bar{M}}{dx_1}$