

Physical Chemistry--CHEM 401
Final Exam
13 December 1996

Name _____

1. (40 points) When two phases of a pure substance are in equilibrium, the chemical potentials of the phases are equal: $\mu_1(T, P) = \mu_2(T, P)$. Consider a small change in the temperature, dT , and pressure, dP , along the phase transition coexistence line. Derive the Clapeyron equation for the phase transition:

$$\left(\frac{dP}{dT}\right)_\phi = \frac{\Delta\bar{H}_\phi}{T_\phi \Delta\bar{V}_\phi}$$

2. (30 points) The vapor pressure of carbon tetrachloride is given at two temperatures. Calculate the heat of vaporization, ΔH_{vap} , from this information.

<u>T (K)</u>	<u>vapor pressure (atm)</u>
323.2	0.4165
343.2	0.8182

3. (30 points) Draw the phase diagram of a pure substance assuming the solid exists in only one phase and the solid is more dense than the liquid [$\rho(s) > \rho(l)$].

4. (40 points) Express the chemical potential of a component in a real solution, $\mu_i(T, x_i)$, and identify for each term of the expression the source of the contribution to the chemical potential.

5. (30 points) Determine the freezing point of an aqueous solution saturated with $\text{Au}(\text{OH})_3$. $K_{\text{sp}} = 3 \times 10^{-6}$, $K_f(\text{H}_2\text{O}) = 1.86 \text{ K kg mol}^{-1}$.

6. (30 points) At the eutectic point, a solution of methanol (CH_3OH) and chloroform (CHCl_3) has a composition of $x_{\text{CH}_3\text{OH}} = 0.804$. At what temperature will this solution freeze?

$$T_{\text{fus}}^{\circ}(\text{CH}_3\text{OH}) = -97.8 \text{ }^{\circ}\text{C}$$

$$T_{\text{fus}}^{\circ}(\text{CHCl}_3) = -63.6 \text{ }^{\circ}\text{C}$$

$$\Delta H_{\text{fus}}(\text{CH}_3\text{OH}) = 3.177 \text{ kJ mol}^{-1}$$

$$\Delta H_{\text{fus}}(\text{CHCl}_3) = 8.801 \text{ kJ mol}^{-1}$$