

Physical Chemistry--CHEM 401
Final Exam
12 December 1997

Name _____

Glossary

1 L atm = 101.325 J

1. (40 points) Show that the fugacity of a hard sphere van der Waals' gas (neglect the effects of intermolecular attraction) is given by

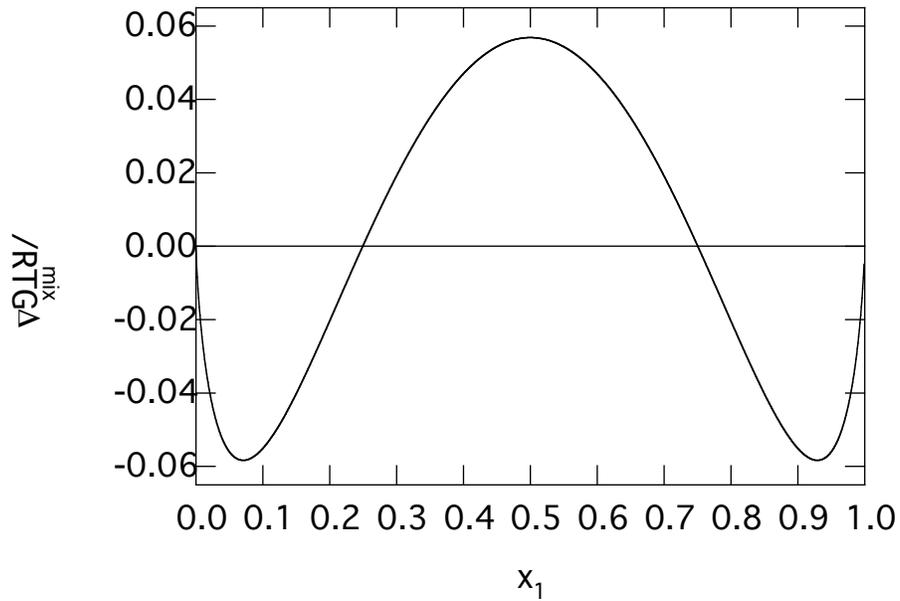
$$f = P \exp\left\{\frac{b P}{RT}\right\}$$

where b is the van der Waals' b constant.

2. (40 points) The slope of the solid-liquid coexistence line in the phase diagram for lead (Pb) has a slope of 74.5 atm L^{-1} . The density of $\text{Pb(s)} = 11.344 \text{ g cm}^{-3}$, and the density of $\text{Pb(l)} = 10.678 \text{ g cm}^{-3}$. Calculate the entropy of fusion, $\Delta S_{\text{fus}}^{\circ}$, and the heat of fusion, $\Delta H_{\text{fus}}^{\circ}$, for lead.

3. (40 points) The vapor pressure of H_2O over pure ice at $-10.0\text{ }^\circ\text{C}$ is 1.950 Torr, and the vapor pressure of H_2O over pure water at $10\text{ }^\circ\text{C}$ is 9.209 Torr. The heat of sublimation of H_2O is $\Delta H_{\text{sub}}^\circ = 51.07\text{ kJ mol}^{-1}$, and the heat of vaporization of H_2O is $\Delta H_{\text{vap}}^\circ = 40.88\text{ kJ mol}^{-1}$. Determine the temperature and pressure at the triple point of water.

4. (40 points) A binary mixture of compounds is made at a temperature such that the constant $A/RT = 3.0$. A plot of the real free energy of mixing is shown below. Label on the plot the range of compositions where the compounds are miscible and immiscible.



The minima on the curve occur at $x_1 = 0.071$ and $x_1 = 0.929$, and the maximum occurs at $x_1 = 0.500$. If equal amounts of a compound 1 and 2 are combined, how many phases will result, and what will be the composition of those phases?

5. (40 points) 2.00 moles of an ideal gas A and 4.00 moles of an ideal gas B are confined within a container of volume 75.0 L. The gases are initially separated by a partition that is then removed, and the gases are allowed to mix. The temperature remains constant at 300 K. Calculate ΔG_{mix} , ΔH_{mix} , ΔS_{mix} , and ΔU_{mix} for this process.