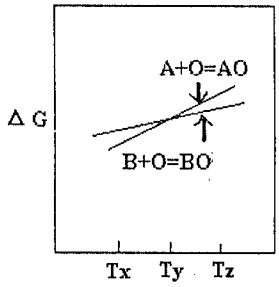
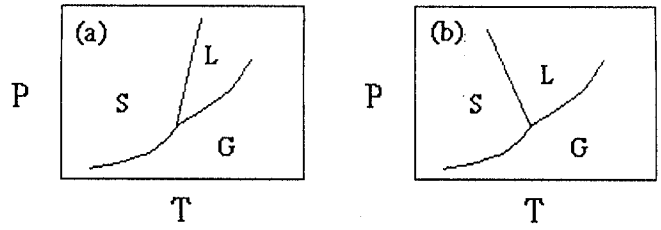
1. There are two closed chambers (I), with A, AO and relatively small amount of BO and (II) with B, BO and relatively small amount of AO. Using the following Ellingham diagram and considering pO_2, predict what will happen if (a) Chamber (I) is heated to temperatures Tx and Tz respectively (b) Chamber II is also heated to temperatures Tx and Tz. Explain both answers in detail, (15 points)



2. In the following phase diagrams of one component system, the main difference is the variation of melting point versus pressure change. What is the reason to cause such a difference, use P (pressure), T (temperature), S (entropy), and V(volume) to discuss it. (12 points)



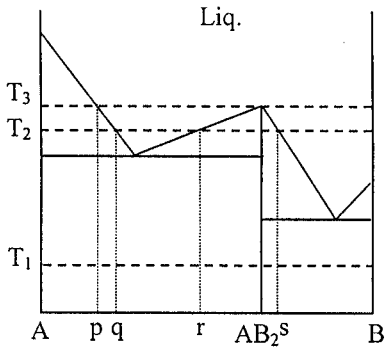
3. Assuming that a silver-gold alloy is a random mixture of gold and silver atoms, calculate the increase in entropy when 20 g of gold are mixed with 10 gram of silver to form a homogeneous alloy. The gram atomic weights of Au and Ag are 198, and 107.9, respectively. (8 points)

4. A rigid container is divided into two compartments, I and II, by a partition. The volume of compartment I is twice as large as that of compartment II.of equal volume by a partition. (1) The compartment I contains 1 mole of ideal gas A at 1 atm, and the compartment II contains 1 mole of ideal gas B at 1 atm. Calculate the increase in entropy which occurs when the partition between the two compartments is removed. (2) If the compartment I had contained two moles of ideal gas A, and the compartment II contained one mole of ideal gas B, what would have been the increase in entropy when the partition was removed? (3) In (1) and (2), if both compartments had contained ideal gas only, calculate the corresponding increase in entropy ? (15 points)

(背面仍有題目,請繼續作答)

5. [14 points] The Gibbs free energy of mixing for a binary *A-B* solution can be expressed as: $\Delta G^M=RT(X_A ln X_A+X_B ln X_B)+kT^2X_AX_B$, where k is a positive constant. (a) Find out a_A (thermodynamic activity of component *A*) and γ_A (activity coefficient of component *A*) as functions of X_A. (b) Prove that the mixing process is exothermic. (c) Is the *A-B* solution a regular solution? Explain your answer.

6. [12 points] Materials A and B form a binary phase diagram shown as right. Sketch the ΔG^M vs. X_B plots, for T_1, T_2 and T_3. In these plots, you must indicate $G^\circ_{A(s)}$, $G^\circ_{A(l)}$, $G^\circ_{B(s)}$, $G^\circ_{B(l)}$, and show how compositions p, q, r, s are determined. (ΔG^M: integral Gibbs free energy of mixing; G°: Gibbs free energy of standard state)



7. [14 points] A liquid Fe-Mn metallic alloy is in equilibrium with a liquid FeO-MnO oxide alloy and an atmosphere containing oxygen. Both alloys are Raoultian solutions. (a) Use the phase rule, determine the number of degrees of freedom of the equilibrium when (i) the atmosphere is pure oxygen; (ii) the atmosphere is an Ar-O_2 mixture. (b) Given T=1800 °C, explain the reason why there exist compositional tie lines between the equilibrated metallic and oxide alloys in the system Fe-Mn-O. How will oxygen and Ar partial pressure affect the end points of tie lines when the gas phase is an Ar-O_2 mixture?

DATA: $Fe_{(l)}+0.5O_{2(g)} \rightarrow FeO_{(l)}$ $\Delta G^\circ= -232{,}700+45.31T$ J

$Mn_{(l)}+0.5O_{2(g)} \rightarrow MnO_{(l)}$ $\Delta G^\circ= -344{,}800+55.90T$ J

8. [10 points] A specimen of titanium is to be heat treated in a furnace at 1600 K in a flow of hydrogen gas at 1 atm. How dry should be the hydrogen in order to prevent oxidation (i.e., what partial pressure of H_2O can you tolerate)? At 1600 K, the Gibbs free energies of formation of TiO, TiO_2 and H_2O are –397,320, -656,460 and –159,300 J/mol, respectively.