## ※請務必在答案卷作答區內作答※

1. (10%) Assuming that an Au-Ag alloy is a random mixture of Au and Ag atoms, calculate the increase in entropy when 10g of Au mixed with 20g of Ag to form an ideal homogeneous alloy. The gram atomic weights of Au and Ag are 198 and 107.9, respectively.

2. (20%) One mole hydrogen gas at 298 K is compressed from 1 atm to 100 atm. The virial equation for hydrogen is $PV = RT (1 + 6.4 \times 10^{-4} P)$. Calculate (a) the work be done on the system and (b) the fugacity of hydrogen at 100 atm.

3. (20%) Calculate the change in enthalpy and the change in entropy at 1000 K for the reaction

$$C + 1/2\ O_2 = CO$$

Given: $\Delta H^0_{298} (CO) = -110500\ J \qquad \Delta S^0_{-298} (CO) = 197.5\ J/K \qquad \Delta S^0_{298} (C) = 5.73\ J/K$
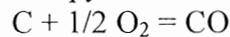
$\Delta S^0_{298} (O_2) = 205.1\ J/K \quad C_p(C) = 0.11 + 38.94 \times 10^{-3} T - 1.48 \times 10^5 T^{-2}\quad J/mole.K$

$C_p (O_2) = 29.96 + 4.18 \times 10^{-3} T - 1.67 \times 10^5 T^{-2} \qquad J/mole.K$

$C_p (CO) = 28.41 + 4.10 \times 10^{-3} T - 0.46 \times 10^5 T^{-2} \qquad J/mole.K$

4. (15%) The activity coefficient of Zn in liquid Zn-Cd alloys at 708 K can be represented as

$$\ln \gamma_{Zn} = 0.875\ X^2_{Cd} - 0.3\ X^3_{Cd}$$

Derive the corresponding expression for the dependence of $\ln \gamma_{Cd}$ on composition and calculate the activity of cadmium in the alloy of $X_{Cd} = 0.9$ at 708 K.

5. (1) (10%) Prove the relation between activity coefficient of $A$ ($\gamma_A$) and temperature ($T$) in a regular $A$-$B$ solution system to be $\dfrac{\ln \gamma_{A(at\ T_2)}}{\ln \gamma_{A(at\ T_1)}} = \dfrac{T_1}{T_2}$

   (2) (10%) In a solution system, explain why if $\gamma_i > 1$ ($\gamma_i$: activity coefficient) then an increase in temperature cause $\gamma_i$ to decrease toward unity, and if $\gamma_i < 1$ an increase in temperature cause $\gamma_i$ to increase toward unity. (Hint: using Gibbs free energy of mixing $\Delta \overline{G}^M_i = RT \ln a_i$)

6. Consider the binary system Au-Pb, the phase diagram of which is shown in Fig. 1. It is known that the system contains two equilibria $2Au + Pb = Au_2Pb$, and $Au + 2Pb = AuPb_2$.
   (1)(3%) Show the compounds (or phases) in (a), (b) and (c) in the Fig. 2.
   (2)(12%) Draw respectively their schematic Gibbs free energies and activities of the mixing curves in the system Au-Pb at the temperatures of 650K and 450K. (each phase should be indicated)
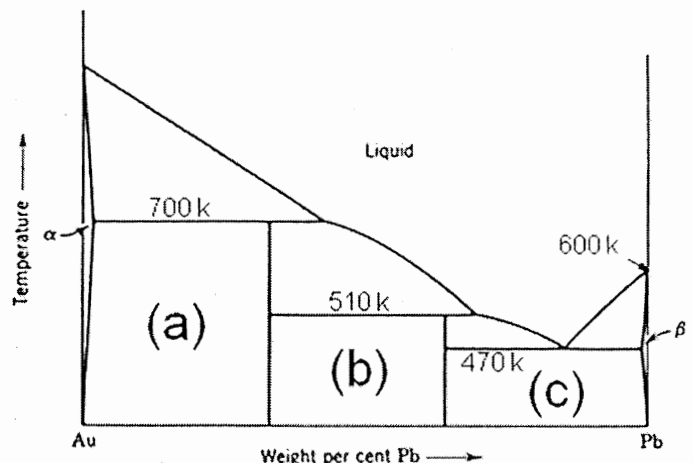


Figure 1.