國立高雄大學 103 學年度研究所碩士班招生考試試題

科目：材料熱力學
考試時間：100 分鐘

系所：化學工程及材料工程學系
（乙組）
本科原始成績：100 分

是否使用計算機：是

1. (a) Please plot a phase diagram which exhibits a miscibility gap. (4 %) (b) Please plot a diagram regarding the molar Gibbs free energies of mixing of binary components in a system which exhibits a miscibility gap. In this diagram, please indicate the composition range that the phase separation may occur by spinodal decomposition; and at what composition ranges that the phase separation may occur by nucleation and growth. Why? (8 %)

2. The vapor pressures of zinc have been written as

$$\ln p\,(\text{atm}) = -\frac{15780}{T} - 0.755 \ln T + 19.25 \qquad \text{(I)}$$

and

$$\ln p\,(\text{atm}) = -\frac{15250}{T} - 1.255 \ln T + 21.79 \qquad \text{(II)}$$

Which of the two equations is for solid zinc? (10 %)

3. The variation, with composition, of G^{xs} for liquid Fe-Mn alloys at 1863K is listed below.
   a. Does the system exhibit regular solution behavior? (3%)
   b. Calculate $\overline{G}_{Fe}^{xs}$ and $\overline{G}_{Mn}^{xs}$ at $X_{Mn} = 0.6$. (3%)
   c. Calculate ΔG^{M} at $X_{Mn} = 0.4$. (3%)

X_{Mn}	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
G^{xs}, joules	395	703	925	1054	1100	1054	925	703	395

4. The virial equation of state for n-butane at 460 K is $Z = 1 + A/V + B/V^2$ in which A = -265 cm^3/g.mole and B = 30,250 cm^6/g.$mole^2$. (a) Calculate the change in the Gibbs free energy when the volume of one mole of n-butane is decreased from 400 to 100 cm^3 at 460 K. (b) Calculate the work required to reversibly compress one mole of n-butane from 20 to 100 atm at 460 K. (10 %)

5. What are the difference between ideal solution, regular solution and subregular solution? (please explain in terms of excess functions) (8%)

6. When SO_3 is decomposed at the constant P and T = 1000 K, the partial pressure of O_2 in the equilibrium gas is 0.05 atm. What is the pressure P? If the pressure of this equilibrated gas is increased to 1 atm, to what value must the temperature be decreased to produce a gas mixture in which $P_{O_2} = 0.05$ atm ? ($SO_3 = SO_2 + \frac{1}{2}O_2$, $\Delta G^o = 94{,}600 - 89.37T$ J) (10%)

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7. What is Ellingham diagram? (3%) Explain why oxidation reactions involving solid phases (ex. $A_{(s)} + O_{2(g)} \rightarrow AO_{2\ (s)}$ and $B_{(s)} + O_{2(g)} \rightarrow BO_{2\ (s)}$) have similar line slope in an Ellingham diagram. (4%) Please describe the effect of phase transformations on the Ellingham line. (3%)

8. Figure 1a shows a phase diagram for the system A-B in which three stoichiometric compounds are forms. Figure 1b shows a phase diagram for the system A-B in which A and B are partially soluble in one another and the compounds have measureable ranges of nonstoichinetry. Please draw the molar free energies and the activities of B of these two A-B systems at the temperature T1. (10%)

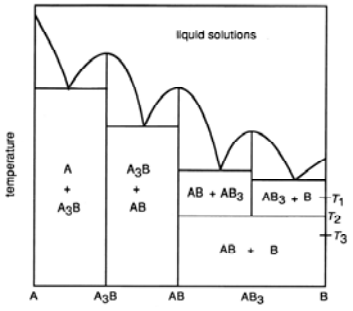

Figure 1a

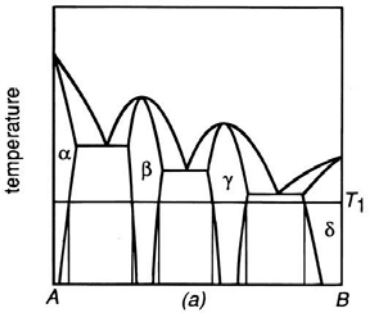

Figure 1b

9. At 298 K, the EMF of the cell

$$Pb \mid PbCl_2 \mid Hg_2Cl_2 \mid Hg$$

is 0.5357 volts and the temperature coefficient of the EMF is 1.45×10^{-4} volts/degree. Calculate,

(a) the maximum work available from the cell at 298 K per mole of Pb reacted. (3%)
(b) the change in entropy for the cell reaction. (3%)
(c) the heat absorbed by the cell at 298 K per mole of Pb reacted when the cell is operating reversibly. (3%)
(d) the Hg electrode in the cell is replaced by an Hg-X alloy in which $X_{Hg} = 0.3$ and where X is inert. The EMF of the cell at 298 K is found to increase by 0.0089 volts. Calculate the activity of Hg in the alloy at 298 K. (3%)

10. Please explain the following terms:
    a. 1 wt% standard state (3%), b. Fugacity (3%), c. Interaction parameter (3%).

ln2 = 0.693, ln3 = 1.099, ln2.63 = 0.967, ln2.98 = 1.092, ln5 = 1.609, ln10 = 2.303