國立臺灣科技大學102學年度碩士班招生試題

系所組別： 材料科學與工程系碩士班丙組

科　　目： 熱力學

（總分為100分）

總分 100 分，共 8 大題。

1. In a volume of $11.2\times10^{-3}m^3$at 273 K, 2 mole of oxygen gas, which can be regarded as ideal gas with C_p=29.4 J K^{-1} $mole^{-1}$ (independentof temperature). Suppose the gas is reversibly compressed to half its volume at constant temperature.
   (1) What is the change of internal energy (ΔU)? **(2%)**
   (2) What is the final pressure? **(2%)**
   (3) How much work is done on the system? **(2%)**
   (4) How much heat flows of the system? **(2%)**
   (5) What is the change of enthalpy (ΔH)? **(2%)**

2. Initially at 300 K and 1 atm pressure, 1 mole of an ideal gas undergoes an irreversible isothermal expansion in which its volume is doubled, and the work it performs is 500 J $mole^{-1}$. What are the values of heat (q), ΔU, ΔH, ΔG and ΔS? **(10%)**

3. Take the heat capacities of water and ice to be constant at 75.3 and 37.7 J K^{-1} $mole^{-1}$, respectively, and the latent of fusion of ice as 6020 J $mole^{-1}$. Answer the following questions.
   (1) Calculate the entropy change when 1 mole of ice is heated from 250 K to 300 K, whichthe melting point is 273.15 K. **(5%)**
   (2) Now 1 mole of supercooled water at 263.15 K and 1 atm pressure turns into ice. Calculate the entropy changes in the system, the surrounding and the net entropy change. Prove that this process is irreversible. **(10%)**

4. Derive the following thermodynamic relations.
   (1) Drive an expression for $\left(\frac{\partial H}{\partial P}\right)_T$ with a gas obeying $P(V-nb)=nRT$. **(5%)**
   (2) Using the fact $PV=\frac{2}{3}U$ in an ideal gas, show that $\left(\frac{\partial T}{\partial P}\right)_S$ in terms of T, P and constant number. **(10%)**

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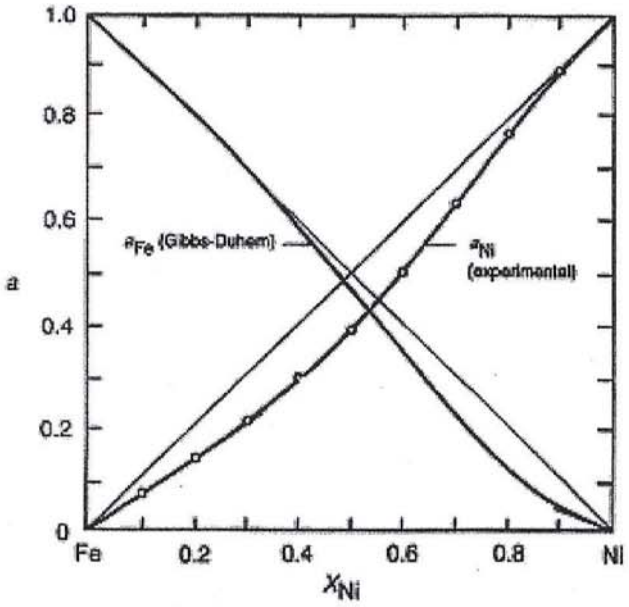
5. For *one-mole* nonideal gas, (a) write down the van der Waals equation (5%) and (b) derive the parameters of T_{cr}, V_{cr}, and P_{cr} at the critical point (5%). For oxygen, V_{cr}= 97.74 cm^3/mole and T_{cr}= –118.82°C. (c) Find P_{cr} (in atm unit) for oxygen (5%).

6. Ni of 10 mole% in the Fe-Ni nonideal solution shows a negative deviation in activity. Calculate the activity of a_{Ni}, based upon the Raoult system, for x_{Ni}= 0.1 in the Fe-Ni solution system obeying the Henry law. (7%)



7. Based upon the assumption of ideal solution for the Cu-Ni and Bi-Cd systems, derive the equations for (i) Line (a) (8%) and (ii) Line (b) (5%) in terms of the Gibbs free energy of individual component at their own melting point.

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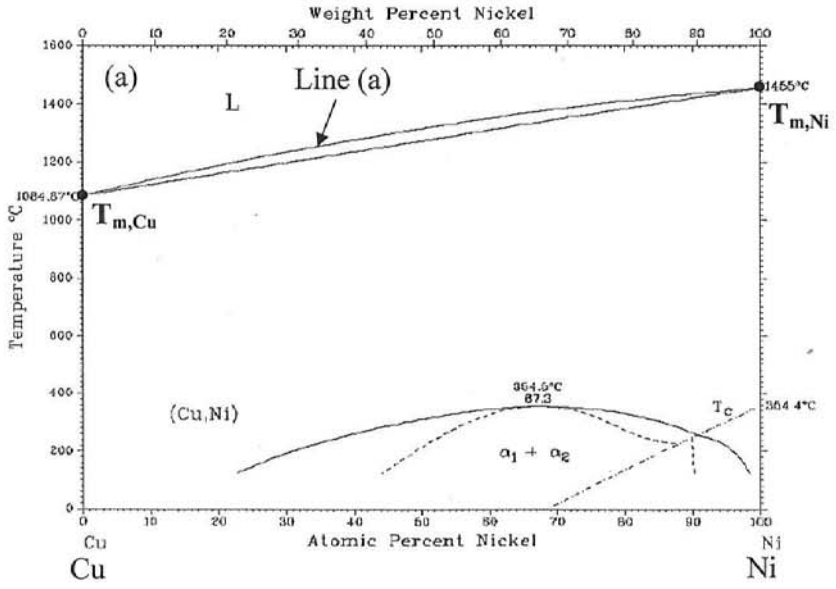

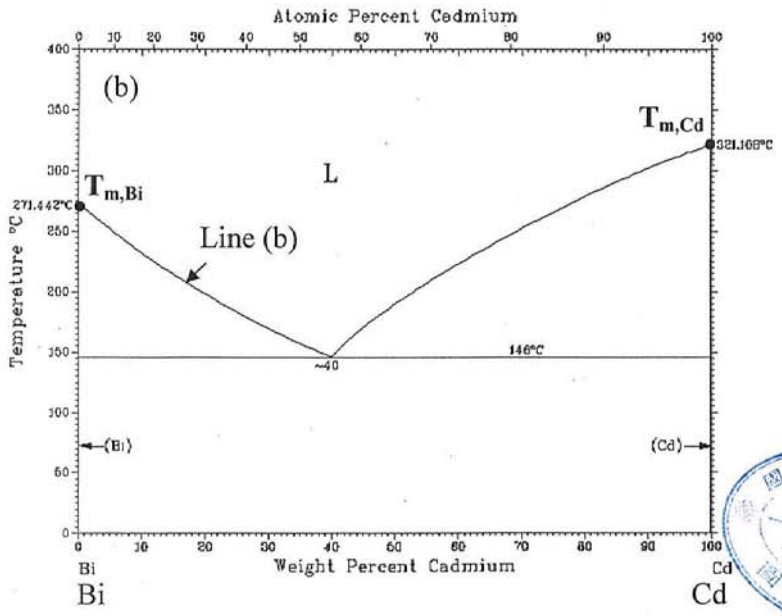

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8. (a) Draw the Mg-Si liquid-phase curve in a ΔG^M-X_{Si} plot at 1358 K, at which the Mg_2Si phase starts to form (5%). (b) Calculate the Gibbs free energy of the liquid solution at 1358 K with the composition of x_{Si}=0.33 (x_{Mg}= 0.67) (5%). (c) If this solution follows the regular solution model, calculate the Ω value (Ω= αRT, related to excess free energy and α: the nonideal α function. 方程式列出即可，自然對數計算可免除), which is related to the excess free energy (5%).

Given: energy in joule unit

$$\Delta G^{\circ}_{m,Mg} = 8790 - 9.54T$$

$$\Delta G^{\circ}_{m,Si} = 50630 - 30.0T$$

$$2Mg_{(l)} + Si_{(s)} = Mg_2Si_{(s)}; \quad \text{------ (i)}$$

$$\Delta G^{\circ}_{(i)} = -100400 + 39.3T$$