504302

國立臺灣科技大學101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 9 大題。

1. (a) Determine the reaction heat of the following reaction at temperature T K,

$$M_{(l)} + O_{2(g)} = MO_{2(l)}$$

where the reaction temperature T comparing with phase transformation temperatures of $T_{MO_2, m}$, $T_{MO_2, trans}$, $T_{M, m}$, $T_{M, trans}$ for $MO_{2(\beta)} = MO_{2(l)}$, $MO_{2(\alpha)} = MO_{2(\beta)}$, $M_{(\beta)} = M_{(l)}$ and $M_{(\alpha)} = M_{(\beta)}$, respectively. The temperature order is like $T > T_{MO_2, m} > T_{MO_2, trans} > T_{M, m} > T_{M, trans}$. The expressions of c_p for $MO_{2(l)}$, $MO_{2(\alpha)}$, $MO_{2(\beta)}$, $M_{(l)}$, $M_{(\alpha)}$, and $M_{(\beta)}$ are $c_p(MO_2, l)$, $c_p(MO_2, \alpha)$, $c_p(MO_2, \beta)$, $c_p(M, l)$, $c_p(M, \alpha)$, and $c_p(M, \beta)$. tip: You can assume any thermodynamics parameters you need. **(5 points)**

(b) Illustrate the diagram of relationship of H and T and explain each reaction process. **(10 points)**

2. Compare the work done for (i) ideal gas; (ii) non-ideal gas expressed in Virial Equation with the first pressure term only. And draw the P-V diagram for these two gases, as well. **(15 points)**

3. Show that $(\partial S/\partial V)_P = C_p/(\alpha_V TV)$. (10%)

4. Make a ΔG^M-X_B plot for the A-B phase diagram at $T = T_4$ (dotted line). (10%)

5. A-B binary system forms regular liquid solutions and regular solid solutions. This system has Ω(liquid) = -20,000 J in the liquid solution and Ω(solid) = 0 J in the solid solution. The melting temperatures of A and B are, respectively, 800 and 1200 K, and the molar Gibbs free energies of melting are

$\Delta G_{m,(A)}$= 8000-10T ; $\Delta G_{m,(B)}$= 12,000-10T

Write down the formula of Gibbs free energies of mixing for the liquid solution of ΔG^M_{liquid} and the solid solution of ΔG^M_{solid} at (a) 1000 K and (b) 400 K. (10%) (a)(b)各佔5%

6. Calculate the oxygen pressure at 1000K for the reaction of $2Mn_{(s)} + O_{2\,(g)} = 2\,MnO_{(s)}$ with $\Delta G^\circ = -769{,}400 + 145.6\times T$. (5%)

(Note: write down the right expression can obtain the full score)

7. Which one of the following expressions is correct? (5%)

(1) The entropy of the system can only increase according to the second law of thermodynamics.

(2) The solution of certain salts in water involves a decrease in entropy.

(3) In a reversible process, there is no net change of the entropy of the universe.

(4) For any process to occur spontaneously there must be increase in entropy of the system.

國立臺灣科技大學101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)

8. When the heat flows from the system to the surrounding, it is defined by $Q_{sys} < 0$ (system) but $Q_{surr} > 0$ (surrounding). When the system does work on the surrounding, it is defined by $W_{sys} > 0$ (system) but $W_{surr} < 0$ (surrounding). Based on the definitions above, answer the following questions.

   1000 mole of an ideal gas is compressed isothermally at 400 K from 100 kPa to 1000 kPa in a piston-and-cylinder arrangement. Calculate the entropy change of the gas, ΔS_{sys}, the entropy of the surroundings, ΔS_{surr}, and the total entropy change resulting from process, ΔS_{total}, as the following conditions.

   (1) The process is mechanically reversible and the surroundings consist of a heat reservoir at 400 K. The temperatures of system (gas) and the surrounding do not changed after the process. (10%)

   (2) The process is mechanically reversible and the surroundings consist of a heat reservoir at 300 K. The temperatures of system (gas) and the surrounding do not changed after the process. (5%)

   (3) The process is mechanically irreversible, requiring 20% more work than the mechanically reversible compression, and the surroundings consist of a heat reservoir at 300 K. The temperatures of system (gas) and the surrounding do not changed after the process. (5%)

9. The constant pressure molar heat capacity of SiC varies with temperature as

$$C_p = 50.79 + 1.97 \times 10^{-3}T - 4.92 \times 10^{6}T^{-2} + 8.20 \times 10^{8}T^{-3}\,\frac{J}{mole \times K}$$

   (1) Calculate the change in the enthalpy from 25°C to 1000°C of 1 mole of SiC. (5%)

   (2) Calculate the change in the entropy from 25°C to 1000°C of 1 mole of SiC. (5%)