

國立臺灣科技大學101學年度碩士班招生試題

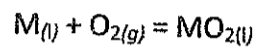
系所組別：材料科學與工程系碩士班丙組

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,



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
- $(\partial S / \partial V)_p = C_p / (\alpha_V T V)$
- . (10%)

4. Make a
- $\Delta G^M - X_B$
- 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
- $\Omega(\text{liquid}) = -20,000 \text{ J}$
- in the liquid solution and
- $\Omega(\text{solid}) = 0 \text{ J}$
- 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 $\Delta G^M_{\text{liquid}}$ and the solid solution of $\Delta G^M_{\text{solid}}$ at (a) 1000 K and (b) 400 K. (10%) (a)(b)各值5%

6. Calculate the oxygen pressure at 1000K for the reaction of
- $2Mn_{(s)} + O_{2(g)} = 2MnO_{(s)}$
- 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.



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8. When the heat flows from the system to the surrounding, it is defined by $Q_{\text{sys}} < 0$ (system) but $Q_{\text{surr}} > 0$ (surrounding). When the system does work on the surrounding, it is defined by $W_{\text{sys}} > 0$ (system) but $W_{\text{surr}} < 0$ (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

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

- (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%)

