

## 國立臺灣科技大學 104 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)

1. (5%) For one mole ideal gas, which is its work ( $W$ ) with reversible isothermal condition? (A)  $-C_v(T_2-T_1)$ , (B)  $RT \ln(V_2/V_1)$ , (C)  $P(V_2 - V_1)$ , (D) 0.
2. (5%) Three moles of ideal gases under reversible isothermal expansion until the volume is doubled. If the work from expansion of ideal gases is 5 KJ, the temperature will be (A) 0.121 K, (B) 109.5 K, (C) 289.2 K, (D) 219.0 K (E) 12.3 K.
3. (10%) At 300 K, two moles of ideal gases undergo a reversible, isothermal expansion during which its volume increases to 4 times. Please calculate the entropy change of the gases.
4. (10%) For ideal gases, please prove that in reversible adiabatic process,  $P_1V_1^\gamma = P_2V_2^\gamma =$  constant, where  $\gamma = C_p/C_v$  and  $C_p - C_v = R$  for ideal gases.
5. For each of the following processes, indicate whether  $\Delta S$  is less than, equal to, or greater than zero (note that  $\Delta S$  refers to the system):
  - (1) (2%) Melting of ice in a room at 25°C
  - (2) (2%) Reversible melting of ice at 0°C
  - (3) (2%) Reversible adiabatic expansion of an ideal gas
  - (4) (2%) Reversible adiabatic expansion of a van der Waals gas
  - (5) (2%) Reversible isothermal expansion of an ideal gas
6. (10%) An ideal gas obeys the following thermodynamic formula:

$$PV = \frac{2}{3}U$$

Show that:

$$\left(\frac{\partial T}{\partial P}\right)_S = \frac{2T}{5P}$$

7. A substance follows the below phase-equilibrium curves:

Solid-Liquid:  $P = 0.0053T - 0.6$

Liquid-Vapor:  $P = 0.0023T - 0.1429$

The units of  $P$  and  $T$  are atm and K, respectively. The densities of solid and liquid are 1.2 and  $0.8 \text{ g cm}^{-3}$ , where the molecular weight is  $40 \text{ g mol}^{-1}$ .

Calculate the following questions.

- (1) (2%) The normal boiling temperature and the normal melting temperature
- (2) (2%) The pressure and the temperature of triple point
- (3) (2%) The heat of fusion at the normal melting temperature
- (4) (2%) The heat of evaporation at the normal boiling temperature
- (5) (2%) The heat of sublimation at the triple point
- (6) (2%) The difference between the heat capacity of solid ( $C_{p,s}$ ) and the heat capacity of liquid ( $C_{p,l}$ ), described by the function or number of  $C_{p,l} - C_{p,s}$ .



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8. A solution is consisted of two liquids, A and B, which the total volume is followed by:

$$V_{total} = 100 - 15x_A - 3x_A^2$$

where  $x_A$  and  $x_B$  are the molar fractions of A and B, respectively.

- (1) (4%) The functions of partial molar volumes for A and B
- (2) (4%) Compared to the ideal solution, the function of the volume change of the mixed solution,  $\Delta V_{mix}$

9. (10%) Can you explain why the pressure is increased than 1 atm, the ice will melt spontaneously at 0°C?

10. (12%) A quantity of supercooled liquid tin is adiabatically contained at 490K. Calculate the fraction of the tin which spontaneously freezes. Given

$$\Delta H_{m,(Sn)} = 7070 \text{ J at } T_m = 505 \text{ K}$$

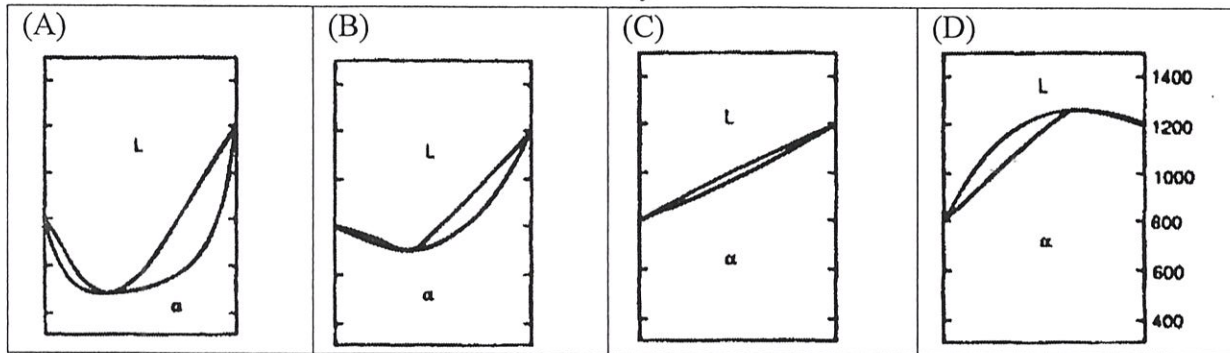
$$C_{p,Sn(l)} = 34.7 - 9.2 \times 10^{-3}T \frac{\text{J}}{\text{K}} \quad \& \quad C_{p,Sn(s)} = 18.5 + 26 \times 10^{-3}T \frac{\text{J}}{\text{K}}$$

以下為選擇題。可能為單選題，亦可能為複選題。

11. (2%) The value of degree of freedom of water at triple point is (A) 0, (B) 1, (C) 2, (D) 3.
12. (2%) In the binary system, which following reactions are classified to the  $A=B+C$  invariant reaction? (A) eutectic reaction, (B) peritectic reaction, (C) syntactic reaction, (D) monotectic reaction
13. (2%) The mixing Gibbs free energy of the A-B binary solution is expressed as

$$\Delta G_1^m = x_B \Delta^0 G_{m,B} + RT(x_A \ln x_A + x_B \ln x_B) + \Omega_l x_A x_B$$

Which phase diagram has the maximum value of  $\Omega_l$ ?



備註：水平軸代表是 B 原子莫爾分率( $x_B$ )由 0 到 1 之變化；縱軸為溫度變化，刻度皆為由 400 K 至 1400 K。

14. (2%) The figure in the right side is the Ellingham diagram for  $\text{AgO}_2$ . Which description is wrong?

- (A) Equilibrium temperature for the reaction is at 462 K.
- (B) The pressure is 1 atm, when the temperature is at 462 K.
- (C) At  $T_1$ , Ag is easy to reduce.
- (D) At  $T_2$ , the  $\text{O}_2$  pressure is larger than 1 atm.

