

國立勤益科技大學 101 學年度研究所碩士班招生筆試試題卷

所別：化工與材料工程系

組別：

科目：物理化學

准考證號碼：□□□□□□□□ (考生自填)

考生注意事項：

一、考試時間 100 分鐘。

二、滿分為 100 分

三、

試題一：〈 20 分〉

At 100°C and 2 bar pressure, the degree of dissociation of phosgene is

$6.30 \times 10^{-5}$ . Calculate  $K_p$ ,  $K_c$  and  $K_x$  for the dissociation



試題二：〈 20 分〉

A gas that behaves ideally was allowed to expand reversibly and adiabatically to twice its volume. Its initial temperature was  $25.0^{\circ}\text{C}$ , and  $C_{v,m}=(5/2)R$ . Calculate final temperature ( $T_2$ ),  $U_m$  and  $H_m$  for the expansion process.

試題三：〈 10 分〉

請說明 Joule-Thomson coefficient，並解釋當氣體的  $\mu=0$  或  $\mu>0$  或  $\mu<0$  時各表示氣體的特性為何？

試題四：〈 8 分〉

完成下列 Maxwell relations

$$\left(\frac{\partial H}{\partial P}\right)_S = \underline{\hspace{2cm}}, \quad \left(\frac{\partial G}{\partial T}\right)_P = \underline{\hspace{2cm}}, \quad \left(\frac{\partial A}{\partial V}\right)_T = \underline{\hspace{2cm}}, \quad \left(\frac{\partial U}{\partial S}\right)_V = \underline{\hspace{2cm}}$$

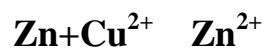
**試題五：〈 12 分〉**

**One mole of oxygen gas, which can be regarded as ideal gas with  $C_p=29.4\text{JK}^{-1}\text{mole}^{-1}$ (independent of temperature) , is maintained at 273K in a volume of  $10.00\text{ dm}^3$ . Suppose the gas is reversibly compressed to half of its volume at constant temperature (273K).**

- a. What is the final pressure?**
- b. How much work is done on the system?**
- c. How much heat flows out of the system?**

**試題六：〈 10 分〉**

**Calculate the equilibrium constant at  $25^\circ\text{C}$  for the reaction occurring in the Daniell cell, if the standard emf is 1.10V.**



試題七：〈20 分〉

- [ ]1. 已知兩相 (phase)  $\alpha$  ,  $\beta$  達到了平衡 (equilibrium) 時, 則?  
(A)  $\mu_i^{(\alpha)} = \mu_i^{(\beta)}$  (B)  $U_i^{(\alpha)} = U_i^{(\beta)}$  (C)  $H_i^{(\alpha)} = H_i^{(\beta)}$  (D)  $A_i^{(\alpha)} = A_i^{(\beta)}$ 。  
( $\mu$ : chemical potential, U: internal energy, H: enthalpy, A: Helmholtz energy)
- [ ]2. 已知一個系統在溫度、壓力是常數時, 當達到了平衡 (equilibrium) 時, 以下何者為非? (A)  $\left(\frac{\partial G}{\partial x}\right)_{T,P} = 0$  (B)  $dG=0$  (C)  $\left(\frac{\partial^2 G}{\partial x^2}\right)_{T,P} \geq 0$  (D)  $\left(\frac{\partial^2 G}{\partial x^2}\right)_{T,P} \leq 0$ 。(G: Gibbs energy, x: process)
- [ ]3. 某系統中有  $\text{CaCO}_{3(s)}$ ,  $\text{CaO}_{(s)}$  以及  $\text{CO}_{(g)}$  三種物質, 若其中之  $\text{CaO}_{(s)}$  及  $\text{CO}_{(g)}$  是由  $\text{CaCO}_{3(s)}$  分解而來, 則此系統之自由度 (degree of freedom) 為 (A) 0 (B) 1 (C) 2 (D) 3。
- [ ]4. 下列有關逸壓 (fugacity) 的敘述, 何者為錯誤? (A) 對想氣體而言逸壓及壓力 (B) 逸壓的單位與壓力的單位相同 (C) 逸壓是在固定的溫度及體積下以理想氣體公式所估算的壓力與真實氣體間之壓力差。(D) 液體與固體也都有逸壓。
- [ ]5. 氣體在液體中之溶解度的敘述, 下列何者錯誤? (A) 汽水瓶打開時, 容易噴出, 因瓶內氣體的壓力大於外界的壓力 (B) 可依據亨利定律說明之 (C) 於定溫時, 充填氣體的壓力愈大, 在液體中之溶解度愈高 (D)  $\text{CO}_2$  氣體在同溫同壓下, 於水中較於乙醇中更易溶解。

國立勤益科技大學 101 學年度研究所碩士班招生筆試試題卷

所別：化工與材料工程系

組別：

科目：物理化學

准考證號碼：□□□□□□□□ (考生自填)

考生注意事項：

一、考試時間 100 分鐘。

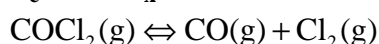
二、滿分為 100 分

三、應考人不得自行攜帶電子計算器，一律由本校統一提供

試題一：〈 20 分〉

At 100°C and 2 bar pressure, the degree of dissociation of phosgene is

$6.30 \times 10^{-5}$ . Calculate  $K_p$ ,  $K_c$  and  $K_x$  for the dissociation



Sol:

Suppose that, if there were no dissociation, the partial pressure of  $\text{COCl}_2$  was  $P$ ; then the actual partial pressures are



$$P(1 - \alpha) \qquad \qquad P \qquad P$$

$$P = P_0 = 2 \text{ bar}$$

$$\text{With } \alpha = 6.30 \times 10^{-5}$$

$$P = \frac{2 \text{ bar}}{1 + (6.3 \times 10^{-5})} \approx 2 \text{ bar}$$

$$K_p = \frac{(2 \times 6.3 \times 10^{-5})^2}{2[1 - (6.3 \times 10^{-5})]} \approx 2 \times (6.3 \times 10^{-5})^2 \text{ bar} = 7.94 \times 10^{-9} \text{ bar} \quad (10\%)$$

$$K_c = K_p(RT)^{-1} = 7.94 \times 10^{-9} \text{ bar} \times (0.0831 \times 373.15 \text{ dm}^3 \text{ bar mol}^{-1})^{-1} \\ = 2.56 \times 10^{-10} \text{ mol dm}^{-3} \quad (5\%)$$

$$K_x = K_p P^{-1} = 7.94 \times 10^{-9} \text{ bar} (2 \text{ bar})^{-1} = 3.97 \times 10^{-9} \quad (5\%)$$

試題二：〈 20 分〉

A gas that behaves ideally was allowed to expand reversibly and adiabatically to twice its volume. Its initial temperature was 25.0°C, and  $C_{v,m}=(5/2)R$ . Calculate final temperature ( $T_2$ ),  $U_m$  and  $H_m$  for the expansion process.

Sol:

$$C_{v,m} = \frac{5}{2}R \text{ and } C_{p,m} = \frac{7}{2}R \text{ then } \gamma = \frac{7}{5}$$

$$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{\gamma-1} \text{ for ideal gas in an adiabatic process}$$

$$\text{Therefore } T_2 = T_1 \left(\frac{V_1}{V_2}\right)^{\gamma-1} = 298.15 \times \left(\frac{1}{2}\right)^{2/5} = 226.0\text{K} \text{ (10\%)}$$

$$\Delta U_m = C_{v,m} (T_2 - T_1) = \frac{5}{2}R(226.0 - 298.15)\text{K} = -1501\text{J mol}^{-1} = -1.5\text{KJ mol}^{-1} \text{ (5\%)}$$

$$\Delta H_m = C_{p,m} (T_2 - T_1) = \frac{7}{2}R(226.0 - 298.15)\text{K} = -2101\text{J mol}^{-1} = -2.1\text{KJ mol}^{-1} \text{ (5\%)}$$

試題三：〈 10 分〉

請說明 Joule-Thomson coefficient，並解釋當氣體的  $\mu=0$  或  $\mu>0$  或  $\mu<0$  時各表示氣體的特性為何？

試題四：〈 8 分〉

完成下列 Maxwell relations

$$\left(\frac{\partial H}{\partial P}\right)_S = \underline{\mathbf{V}} \quad , \quad \left(\frac{\partial G}{\partial T}\right)_P = \underline{\mathbf{-S}} \quad , \quad \left(\frac{\partial A}{\partial V}\right)_T = \underline{\mathbf{-P}} \quad , \quad \left(\frac{\partial U}{\partial S}\right)_V = \underline{\mathbf{T}}$$

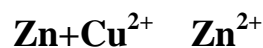
**試題五：〈 12 分〉**

**One mole of oxygen gas, which can be regarded as ideal gas with  $C_p=29.4\text{JK}^{-1}\text{mole}^{-1}$ (independent of temperature) , is maintained at 273K in a volume of  $10.00\text{ dm}^3$ . Suppose the gas is reversibly compressed to half of its volume at constant temperature (273K).**

- a. What is the final pressure?**
- b. How much work is done on the system?**
- c. How much heat flows out of the system?**

**試題六：〈 10 分〉**

**Calculate the equilibrium constant at  $25^\circ\text{C}$  for the reaction occurring in the Daniell cell, if the standard emf is 1.10V.**



試題七：〈20 分〉

- [ A ] 1. 已知兩相 (phase)  $\alpha$  ,  $\beta$  達到了平衡 (equilibrium) 時, 則?  
(A)  $\mu_i^{(\alpha)} = \mu_i^{(\beta)}$  (B)  $U_i^{(\alpha)} = U_i^{(\beta)}$  (C)  $H_i^{(\alpha)} = H_i^{(\beta)}$  (D)  $A_i^{(\alpha)} = A_i^{(\beta)}$  。  
( $\mu$  : chemical potential, U: internal energy, H: enthalpy, A: Helmholtz energy)
- [ D ] 2. 已知一個系統在溫度、壓力是常數時, 當達到了平衡 (equilibrium) 時, 以下何者為非? (A)  $\left(\frac{\partial G}{\partial x}\right)_{T,P} = 0$  (B)  $dG=0$  (C)  $\left(\frac{\partial^2 G}{\partial x^2}\right)_{T,P} \geq 0$  (D)  $\left(\frac{\partial^2 G}{\partial x^2}\right)_{T,P} \leq 0$  。(G: Gibbs energy , x : process)
- [ B ] 3. 某系統中有  $\text{CaCO}_{3(s)}$ ,  $\text{CaO}_{(s)}$  以及  $\text{CO}_{(g)}$  三種物質, 若其中之  $\text{CaO}_{(s)}$  及  $\text{CO}_{(g)}$  是由  $\text{CaCO}_{3(s)}$  分解而來, 則此系統之自由度 (degree of freedom) 為 (A) 0 (B) 1 (C) 2 (D) 3 。
- [ C ] 4. 下列有關逸壓 (fugacity) 的敘述, 何者為錯誤? (A) 對想氣體而言逸壓及壓力 (B) 逸壓的單位與壓力的單位相同 (C) 逸壓是在固定的溫度及體積下以理想氣體公式所估算的壓力與真實氣體間之壓力差。 (D) 液體與固體也都有逸壓。
- [ D ] 5. 氣體在液體中之溶解度的敘述, 下列何者錯誤? (A) 汽水瓶打開時, 容易噴出, 因瓶內氣體的壓力大於外界的壓力 (B) 可依據亨利定律說明之 (C) 於定溫時, 充填氣體的壓力愈大, 在液體中之溶解度愈高 (D)  $\text{CO}_2$  氣體在同溫同壓下, 於水中較於乙醇中更易溶解。