

國立宜蘭大學

107 學年度研究所碩士班考試入學

物理化學(含熱力學與動力學)試題

(化學工程與材料工程學系碩士班)

准考證號碼：

《作答注意事項》

- 1.請先檢查准考證號碼、座位號碼及答案卷號碼是否相符。
- 2.考試時間：100 分鐘。
- 3.本試卷共有 9 題，共計 100 分。
- 4.請將答案寫在答案卷上。
- 5.考試中禁止使用手機或其他通信設備。
- 6.考試後，請將試題卷及答案卷一併繳交。
- 7.本考科可使用非程式型（不具備儲存程式功能）之電子計算機。

1. Explain the following items: (20%, 4% each)
 - (a) Phase rule
 - (b) Chemical potential
 - (c) Critical point
 - (d) Arrhenius equation
 - (e) Steady-state treatment.
2. The latent heat of fusion of water at 0 °C is 6025 J mol⁻¹ and the molar heat capacities ($C_{p,m}$) of water and ice are 75.3 and 37.3 J K⁻¹ mol⁻¹, respectively. The C_p values can be taken to be independent of temperature. Calculate the ΔH value for the freezing of 1 mol of supercooled water at -10.0 °C. (10%)
3. At what temperature and pressure will H₂ be in a corresponding state with CH₄ at 500.0 K 2.00 bar pressure? Given $T_C=33.2$ K for H₂, 190.6 K for CH₄; $P_C=13.0$ bar for H₂, 46.0 bar for CH₄. (10%)
4. Two moles of oxygen gas, which can be regarded as ideal with $C_p = 29.4$ J K⁻¹ mol⁻¹ (independent of temperature), are maintained at 273K in a volume of 11.35 dm³. Suppose that the gas is reversibly compressed to half of its volume at constant temperature (273K).
 - (a) What is the change in U ?
 - (b) What is the final pressure?
 - (c) How much work is done on the system?
 - (d) How much heat flows out of the system?
 - (e) What is the change in H ?(10%)
5. At 25°C 1 mol of ideal gas is compressed isothermally from 10 to 1 dm³. Calculate ΔU , ΔH , ΔS , ΔA , and ΔG . (10%)
6. (a) Derive the Clausius-Clapeyron equation $\ln \frac{P_2}{P_1} = \frac{\Delta_{vap}H}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$. (5%)
 - (b) Calculate the heat of vaporization of water at 373.15 K and 101.325 kPa. The vapor pressure of water is 3.17 kPa at 298.15 K. (5%)
7. An equilibrium constant K_c is increased by a factor of 3 when the temperature is raised from 25.0 °C to 40.0 °C. Calculate the standard enthalpy change. (10%)
8. (a) Derive the van't Hoff's equation for osmotic pressure $\pi = cRT$. (5%)
 - (b) Calculate the osmotic pressure developed if 6.00 g of urea, (NH₂)₂CO, is dissolved in 1.00 dm³ of solution at 27°C. (5%)
9. (a) Derive the half-life of a first-order reaction is $t_{1/2} = \frac{\ln 2}{k}$. (5%)
 - (b) The isotope ⁹⁰Sr emits radiation by a first-order process and has a half-life of 28.1 years. If 1 μg of ⁹⁰Sr is absorbed by human at birth, how much of this isotope remains after 50 years? (5%)