

國 立 宜 蘭 大 學

1 0 8 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 10 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: (15%)
 - (a) Compression factor
 - (b) Joule-Thomson coefficient
 - (c) Le Chatelier principle
 - (d) Colligative properties
 - (e) Rate-controlling step.
2. What are the molar fractions and partial pressures of each gas in a 2.50 L container into which 100.0 g of nitrogen and 100.0 g of carbon dioxide are added at 25 °C? What is the total pressure? (10%)
3. (a) At 25 °C 1 mol of an ideal gas is expanded isothermally from 2 to 20 dm³. Calculate ΔU , ΔH , ΔS , ΔA , and ΔG . (10%)
 - (b) Do the values depend on whether the process is reversible or irreversible? (5%)
4. (a) Derive the van't Hoff equation $\frac{d \ln K_p^\circ}{d(\frac{1}{T})} = -\frac{\Delta H^\circ}{R}$ from Gibbs-Helmholtz equation. (10%)
 - (b) An equilibrium constant K_c is increased by a factor of 3 when the temperature is raised from 25 °C to 40 °C. Calculate the standard enthalpy change. (5%)
5. Derive the phase rule. (10%)
6. (a) Derive the Clausius-Clapeyron equation $\ln \frac{P_2}{P_1} = \frac{\Delta_{vap}H}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$. (10%)
 - (b) The normal boiling point of ethylene glycol (C₂H₆O₂) is 197 °C; its enthalpy of vaporization is 49708 J/mol. Estimate the temperature at which ethylene glycol will boil in a vacuum distillation if the system were maintained at 50 Torr. (5%)
7. When 3.78 g of a nonvolatile solute is dissolved in 300.0 g of water, the freezing point depression is 0.646 °C. Calculate the molar mass of the compound. $K_f = 1.856 \text{ K kg mol}^{-1}$. (5%)
8. Toluene (molar mass = 92.15 g/mol) and water are immiscible. If boiled together under an atmospheric pressure of 755 Torr and 83 °C, what is the ratio of toluene to water in the distillate? The vapor pressure of pure toluene and water at 83 °C are 322 Torr and 400.6 Torr, respectively. (5%)
9. Describe how to determine the rate constant of a first-order reaction. (5%)
10. The rate constant for a reaction at 30 °C is found to be exactly twice the value at 20 °C. Calculate the activation energy. (5%)