

# 國立宜蘭大學

## 103 學年度研究所碩士班考試入學

### 物理化學試題

(化學工程與材料工程學系碩士班)

准考證號碼：

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#### 《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.考試中禁止使用大哥大或其他通信設備。
- 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: (a) First law of thermodynamics (b) Ideal gas (c) Raoult's law (d) Le Chatelier's principle (e) Phase rule (20%)
2. An ideal gas occupies a volume of  $0.300 \text{ dm}^3$  at a pressure of  $1.80 \times 10^5 \text{ Pa}$ . What is the new volume of the gas maintained at the same temperature if the pressure is reduced to  $1.15 \times 10^5 \text{ Pa}$ ? (10%)
3. With the temperature maintained at  $0^\circ\text{C}$ , 2 mol of an ideal gas are allowed to expand reversibly and isothermally from the initial pressure of 10bar to the final pressure of 2bar. (a) How much work is done by the gas? (b) What is the change in the internal energy and the enthalpy of the gas? (c) How much heat is absorbed by the gas? (10%)
4. At  $25^\circ\text{C}$  1 mol of ideal gas is expanded isothermally from 1 to  $10 \text{ dm}^3$ . Calculate  $\Delta U$ ,  $\Delta H$ ,  $\Delta S$ ,  $\Delta A$ , and  $\Delta G$ . (10%)
5. (a) Derive the entropy change per mol of mixture gas is  $\Delta S = -R(x_1 \ln x_1 + x_2 \ln x_2)$ . (5%)  
(b) Calculate the entropy change of mixing per mol of air, taking the composition by volume to be 79%  $\text{N}_2$ , 20%  $\text{O}_2$ , and 1% Ar. (5%)
6. The equilibrium constant for the reaction listed below in benzene solution at  $10^\circ\text{C}$  is  $2.19 \times 10^{-3} \text{ mol dm}^{-3}$ .  
$$(\text{C}_6\text{H}_5\text{COOH})_2 \rightleftharpoons 2\text{C}_6\text{H}_5\text{COOH}$$
  
(a) Calculate  $\Delta G^\circ$  for the dissociation of the dimer. (5%)  
(b) If 0.1 mol of benzoic acid is present in  $1 \text{ dm}^3$  of benzene at  $10^\circ\text{C}$ , what are the concentrations of the monomer and of the dimer? (5%)
7. (a) Derive the Clausius-Clapeyron equation  $\ln \frac{P_2}{P_1} = \frac{\Delta_{\text{vap}}H_m}{R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right)$ . (5%)  
(b) Benzene has a normal boiling point at 760 Torr of 353.25K and  $\Delta_{\text{vap}}H_m = 30.76 \text{ kJ mol}^{-1}$ . If benzene is to be boiled at  $30.00^\circ\text{C}$  in a vacuum distillation, to what value of P must the pressure be lowered? (5%)
8. Toluene and water are immiscible. If boiled together under an atmospheric pressure of 755 Torr at  $83^\circ\text{C}$ , what is the ratio of toluene to water in the distillate? The vapor pressure of pure toluene and water at  $83^\circ\text{C}$  are 322 Torr and 400.6 Torr, respectively. The molar mass of pure toluene and water are  $92.15$  and  $18.02 \text{ g mol}^{-1}$ , respectively. (10 %)
9. (a) Derive the half-life of a first-order reaction is  $t_{1/2} = \frac{\ln 2}{k}$ . (5%)  
(b) The isotope  $^{32}\text{P}$  emits radiation and has a half-life of 14.3 days. What percentage of the initial activity remains after 100 days? (5%)