

# 國立臺北科技大學九十七學年度碩士班招生考試

系所組別：3520 化學工程研究所乙組

## 第一節 物理化學 試題

填准考證號碼

第一頁 共一頁

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### 注意事項：

1. 本試題共 7 題，配分共 100 分。第 1 題 16 分，第 2~7 題各 14 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. Determine the number of degree of freedom for the following systems: (每小題 4 分)
  - a. A solution of potassium chloride in water at the equilibrium pressure.
  - b. A solution of potassium chloride and sodium chloride at 25°C and 1 atm pressure.
  - c. Ice in a solution of water and alcohol.
  - d. A system of CaCO<sub>3</sub>-CaO-CO<sub>2</sub> at 25°C
2. A sample of hydrogen gas, which may be assumed to be ideal, is initially at 5.0 bar pressure and a temperature of 25°C, and has a volume of 1.2 L. It is expanded reversibly and adiabatically until the volume is 6.0 L. The heat capacity C<sub>p</sub> of H<sub>2</sub> is 28.80 J/mol·K and may be assumed to be independent of temperature.
  - a. Calculate the final pressure and temperature after the expansion.
  - b. Calculate ΔU and ΔH for the process.
3. Calculate the enthalpy and entropy change in the system and in the surroundings when 2 moles of ice at -10°C is placed in a room at a temperature of 25°C. Take the heat capacities of water and ice to be constant at 75.3 and 37.7 J/mol·K, respectively, and the latent heat of fusion of ice as 6.02 kJ/mol.

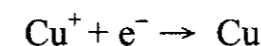
4. Suppose that a gas obeys the modified van der Waals equation

$$P(V_m - b) = RT$$

And that  $b = 0.0211$  L/mol. If 0.500 mol of the gas is reversibly compressed from an initial volume of 3.00 L to a final volume of 0.600 L at 25°C.

- a. How much work is done on the system? How much work would have been done if the gas were ideal? Account for the difference between the two values.
- b. Calculate the fugacity of gas at 25°C and 1 bar pressure.
- c. At what pressure is the fugacity equal to 1 bar?

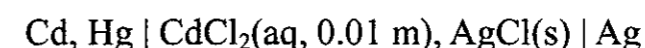
5. Calculate the standard electrode potential for the reaction at 298 K:



where  $\text{Cu}^{2+} + e^- \rightarrow \text{Cu}^+$ ,  $E^\circ = 0.153$  V,

and  $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$ ,  $E^\circ = 0.337$  V.

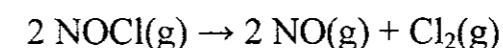
6. At 298 K the emf of the cell



is 0.7585 V. The standard emf of the cell is 0.5732 V.

- a. Calculate the mean activity coefficient for the Cd<sup>2+</sup> and Cl<sup>-</sup> ions.
- b. Compare the value with that estimated from the Debye-Hückel limiting law, and comment on any difference.

7. Measuring the total pressure is a convenient way to monitor the gas phase reaction



However, the rate depends on the concentration of the reactant, which is proportional to the partial pressure of the reactant. Derive an expression relating the rate of this reaction to the initial pressure, P<sub>0</sub>, and the total pressure, P<sub>t</sub>, at time t. Assume that the reaction follows second-order kinetics.