

國立成功大學
110學年度碩士班招生考試試題

編 號： 79

系 所： 化學工程學系

科 目： 物理化學

日 期： 0203

節 次： 第 3 節

備 註： 可使用計算機

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第1頁，共2頁

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Useful constants:

$$F=96485 \text{ C mol}^{-1}$$

$$R= 8.315 \text{ J K}^{-1} \text{ mol}^{-1}$$

1. Answer the following questions: (20%)
 - a. A nonideal gas undergoes adiabatic expansion through a throttling valve. Is ΔH of this process equal to zero? (4%)
 - b. Provide the rationale to decide the rate-determining step in a chemical reaction. (4%)
 - c. Briefly describe the Langmuir adsorption isotherm and provide its assumptions. (4%)
 - d. Trouton's rule suggests the entropy of vaporization of normal liquid is $88 \text{ J K}^{-1} \text{ mol}^{-1}$. This rule may provide a good estimation for the enthalpy of vaporization of some liquids. Please give a potential molecular interpretation of Trouton's rule. Also, name some liquids that do not follow Trouton's rule and explain why such deviation occurs. (4%)
 - e. For a system containing ice in a solution of water and alcohol, determine the degree of freedom. (4%)
2. A process first maintains water vapor at 100°C , 1.8 atm , and then condense the vapor into liquid at the same condition. The $\Delta_{\text{vap}}H$ of water is 40.6 kJ/mol . We can assume the vapor behaves ideally and the liquid water is incompressible. (20%)
 - a. Calculate ΔH , ΔS , and ΔG of this process. (15%)
 - b. Is this process spontaneous? (5%)
3. Derive the following relationships: (15%)
 - a. The entropy of a perfect gas depends on the volume, $S \propto R \ln(V)$ (7%)
 - b.
$$\left(\frac{\partial C_p}{\partial P}\right)_T = -T \left(\frac{\partial^2 V}{\partial T^2}\right)_P$$
 (8%)
4. One mole of a gas at 300 K is compressed isothermally from an initial pressure of 1 bar to a final pressure of 50 bar . Calculate ΔH of this process for (15%)
 - a. Ideal gas (5%)
 - b. Van der Waals gas (10%)

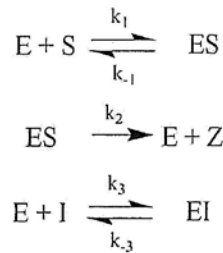
Equation of state: $\left(P + \frac{a}{V_m^2}\right)(V_m - b) = RT$

 $a=0.0248 \text{ Pa m}^6 \text{ mol}^{-2}$ and $b=0.0266 \times 10^{-3} \text{ m}^3 \text{ mol}^{-1}$

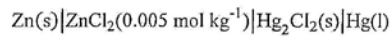
Also, for Van der Waals gas, the Joule-Thomson coefficient can be expressed as:

$$\mu = \frac{\frac{2a}{RT} - b}{C_p}$$

5. An inhibitor, I, decreases the rate of product formation from the substrate by binding to the enzyme. Derive a modified Michaelis-Menten rate equation by considering the effect of the inhibitor. You may assume the complex EI is at steady-state. (10%)



6. Consider the following cell: (20%)



The cell reaction is $\text{Hg}_2\text{Cl}_2(\text{s}) + \text{Zn(s)} \rightarrow 2\text{Hg(l)} + 2\text{Cl}^-(\text{aq}) + \text{Zn}^{2+}(\text{aq})$

$$E^\circ(\text{Zn}^{2+}, \text{Zn}) = -0.7628 \text{ V}$$

$$E^\circ(\text{Hg}_2\text{Cl}_2, \text{Hg}) = +0.2676 \text{ V}$$

- Calculate the electromotive force of this cell, neglecting the correction of activity coefficient. (5%)
- Write the Nernst equation that includes activity coefficients for the cell reaction. (5%)
- Assuming that the Debye-Hückel limiting law holds at this concentration, calculate the electromotive force again. (5%)
- Calculate ΔG of this cell, using the electromotive force from part c. (5%)