國立中山大學109學年度
碩士暨碩士專班招生考試試題

科目名稱：物理化學及分析化學【化學系碩士班】

—作答注意事項—

考試時間：100分鐘

- **考試開始響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，不得另攜帶紙張，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，其後果由考生自行負擔。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶具有通訊、記憶或收發等功能或其他有礙試場安寧、考試公平之各類器材、物品（如鬧鈴、行動電話、電子字典等）入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

國立中山大學109學年度碩士暨碩士專班招生考試試題

科目名稱：物理化學及分析化學【化學系碩士班】　　題號：422002

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

物理化學 (50%)

$R = 8.3145\ J\ K^{-1}\ mol^{-1}$
1 amu $= 1.660539040 \times 10^{-27}$ kg
$h = 6.626 \times 10^{-34}$ J s

問答題

1. (14%) The $v = 0 \rightarrow 1$ vibrational band of ICl occurs at 382 cm^{-1}. Approximating this molecular vibration as a harmonic oscillator, answer following questions: (Atomic weights of I and Cl are 126.9 amu and 35.5 amu, respectively.)
(a) Calculate the zero point vibrational energy. (4%)
(b) Calculate the force constant of ICl. (4%)
(c) Calculate the ratio of the $v = 0$ and $v = 2$ populations at 200°C. (4%)
(d) Is the rotational constant, B, of ICl at $v = 1$ the same as that at $v = 0$? And explain why? ($B = \hbar^2/(2I)$, where I is moment inertia) (2%)

2. (15%) A reactant molecule S can be converted into its product P by an enzyme molecule E,

$$E + S \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} ES \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} P + E$$

where k_1, k_{-1}, k_2 and k_{-2} are rate coefficients. The initial concentrations of E and S are $[E]_0$ and $[S]_0$, respectively. The initial concentrations of P and ES are zero.
(a) Write the rate expressions for [S], [E], [ES] and [P]. (Example: $d[S]/dt = ?$) (4%)
(b) Prove $[E] + [ES] = [E]_0$. (4%)
(c) Assuming the steady-state approximation for ES, express [ES] in terms of [S], [P], $[E]_0$ and above rate coefficients. (4%)
(d) Continued from (c), prove that $d[S]/dt$ and $d[P]/dt$ is proportional to $[E]_0$. (3%)

3. (15%) Consider the dissociation reaction $H_2O(g) \rightarrow H_2(g) + 0.5O_2(g)$, the values of its standard reaction Gibbs energy ($\Delta_r G°$) are +135 kJ/mol at 2000 K and +118 kJ/mol at 2300K. Please answer following questions:
(a) Calculate the equilibrium constants at 2000 K and 2300 K. (5%)
(b) Calculate the reaction enthalpy of this reaction. (5%)
(c) Calculate the mole fraction of H_2, after the dissociation reaction of H_2O at 2300 K and 1 bar finishes. (5%)

4. (6%) Light incident on the surface of a metal causes electrons to be ejected. Answer following questions:
(a) Does the kinetic energy of ejected electrons depend on the frequency or intensity of light? And explain why? (2%)
(b) Does the number of electrons depend on the frequency or intensity of light? And explain why? (2%)
(c) The minimal energy required to remove an electron from a material is called work function. For elements Be, Mg and Ca, which one has the smallest work function? And which one has the largest work function? (2%)

分析化學(50%)

5. (11%) (a) Define: Buffer solution, describe its feature, significance and also possible application. (3%)
(b) Define buffer capacity, use one equation to express the term and explain the meaning for each parameter. (3%)
(c) Describe how you can prepare a buffer solution (1L) with a pH value of 4.5 from 0.9 M of acetic acid with sodium acetate. The K_a of the acetic acid is 1.75×10^{-5}. (5%)

6. (9%) Define the 3 different quantification methods in Analytical Chemistry that is listed below. Describe their principles in details and also give example of applications for how to use these quantification methods? Please also compare their advantages and limitations?
(a) External standard method (3%)
(b) Internal standard method (3%)
(c) Standard addition method (3%)

7. (10%) Calculate the molar solubility of $Ba(IO_3)_2$ in an aqueous solution while it is in the presence of 0.03 M of $Ba(NO_3)_2$ in the solution. $K_{sp} = 1.57 \times 10^{-9}$.

8. (10%) To date, there are many types of mass spectrometric instruments (mass analyzers) that have been developed. Please define the listed mass spectrometers below and also draw their instrumental designs, describe their working principles and also discuss their advantages and limitations for each type.
(a) Ion trap (2%)
(b) Time of flight (2%)
(c) Quadrupole (2%)
(d) Sector (2%)
(e) FTMS (Fourier Transform Mass Spectrometer) (2%)

9. (10%) In Analytical Chemistry, there are many terms that are significant. Please define all the following terms and also give detailed explanation for how to use these terms? Also, their significance must be explained.
(a) LOD (Limit of detection) (2%)
(b) Resolution (2%)
(c) Standard Deviation (please also write down the equation for this term and give meaning for each parameter in the equation (2%)
(d) Linear dynamic range (2%)
(e) CV(coefficient of variation) (2%)