

國立嘉義大學九十七學年度

應用化學系碩士班(甲組)招生考試試題

科目：綜合化學 II

Part I: 物理化學

說明：1. 請標明題號並依序作答。

- 簡答題的答案必須寫在答卷上；計算題必須寫出計算過程，只寫答案不給分。
- $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$, $h = 6.626 \times 10^{-34} \text{ Js}$, $c \approx 3.0 \times 10^8 \text{ ms}^{-1}$, $e \approx 1.6 \times 10^{-19} \text{ C}$

一、計算題及問答題

- The heat of vaporization of water at 100°C is 40.66 KJ/mol . Find (a) ΔS , (b) ΔG , and (c) ΔA when 1.0 mole of water condensed to liquid at 100°C and 1.0 atm. (9%)
- Find the Maxwell relation from the Gibbs equation: $dA = -SdT - pdV$. (6%)
- $A \xrightarrow{k_1} B$, $A \xrightarrow{k_2} C$ and $A \xrightarrow{k_3} D$ are three parallel first-order processes. (a) Find the concentration of each species, $[A]$, $[B]$, $[C]$ and $[D]$ at time t . Assume that the initial concentrations, at time $t = 0$, are $[A]_0 = a$, $[B]_0 = 0$, $[C]_0 = 0$ and $[D]_0 = 0$. (b) Find $\frac{[B]}{[C]}$ at any time. (c) Find $[D]$ at $t \rightarrow \infty$. (9%)
- Cheng-Ming Wang used to throw a 0.2 Kg baseball in a very high speed of 156 Km/hr. What is the wavelength of the matter wave of the ball? (6%)

二、簡答題

- The porphyrin molecule can be treated as a model of two-dimensional square box with the approximate side of 1000 pm. The porphyrin molecule has 18 π electrons. (a) What are the quantum numbers of the highest occupied molecular orbital(s)? (b) What are the quantum number corresponding to the lowest unoccupied molecular orbital(s)? (c) Is it an allowed transition from HOMO to LUMO according to the selection rule? (d) What is the spin multiplicity of the ground state? (e) What is the predicted longest wavelength allowed absorption of the porphyrin molecule? (10%)
- The ionization energy of hydrogen atom is 13.6 eV. (a) What is the second ionization energy of He atom (in the unit of eV)? (b) If the first ionization energy of He is 24.6 eV, what is the ground state energy of He (in the unit of eV)? (c) What is the wavelength (in the unit of nm) of the photon emitted when an electron goes from $n = 2$ to $n = 1$? (d) What is the wavelength (in the unit of nm) of the photon emitted when an electron goes from $n = 3$ to $n = 1$? (e) Which range of the radiation do these two emissions belong to? You can select one of the following choices: (a) x-ray, (b) VUV, (c) UV, (d) visible, (e) IR, or (f) microwave? (10%)

Part II: Analytical chemistry (50 points)

- Describe the mechanisms of
 - producing a laser beam. (5 points)
 - photomultiplier tube as a photon transducer. (5 points)
 - quadrupole as a mass analyzer. (5 points)
- Differentiate the following terms:
 - sensitivity and selectivity (4 points)
 - coulometry and voltammetry (4 points)
 - protecting agent and releasing agent (for AAS) (4 points)
 - partition chromatography and adsorption chromatography (4 points)
- Calculate the pH of
 - $1.20 \times 10^{-2} \text{ M ClCH}_2\text{COOH}$ ($K_a = 1.36 \times 10^{-3}$)
 - $1.20 \times 10^{-2} \text{ M ClCH}_2\text{COOK}$ (8 points)
- An ore sample containing magnetite, Fe_3O_4 , was analyzed by dissolving a 0.8615-g sample in HCl, the iron was brought into the +2 oxidation state by Jones's reductor, and the solution was diluted to 100.0 mL. Titration of a 25.00-mL aliquot to diphenylamine sulfonic acid end point required 14.37 mL of 0.01012M $\text{K}_2\text{Cr}_2\text{O}_7$. Express the result as %w/w Fe_3O_4 in the ore sample. (Fe_3O_4 : 231.55) (5 points)
- Salicylic acid in extract of cucumber leaves was determined by gas chromatography with ortho-anisic acid as internal standard. A solution containing 1 mL of $1.00 \times 10^{-4} \text{ M}$ ortho-anisic acid and 1 mL of $1.20 \times 10^{-4} \text{ M}$ salicylic acid was esterified, and diluted to 5.00 mL (Soln 1). A second solution containing 1 mL of $1.00 \times 10^{-4} \text{ M}$ ortho-anisic acid and 1 mL of extract was also esterified, and diluted to 5.00 mL (Soln 2). The chromatographic data for these two solutions were as followed (injection volume: 1 microliter).

compound	Soln 1			Soln 2
	Retention time (min)	Peak width (min)	Peak area	Peak area
ortho-anisic acid	4.78	0.32	38650	41332
salicylic acid	5.95	0.41	23548	39740

Calculate

- resolution of the two compounds. (2 points)
- molar concentration of salicylic acid in the original extract. (4 points)