

國立中正大學
108 學年度碩士班招生考試
試題

[第 2 節]

系所組別	化學暨生物化學系
科目名稱	物理分析化學

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

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物理化學部分 總分 50 分

第一部份 選擇題 (單選; 每題 3 分, 共 18 分)

- Which of the following is true regarding noncompetitive inhibitors?
 - They do not form covalent bonds with the active site
 - They alter both K_m and v_{max}
 - They alter the shape of the active site

(a) I and III (b) II and III (c) III only (d) I only
- The rate law for the reaction: $2A + 2B \rightarrow 3C + D$ was found to be $v = k[A]^2[B]^2$. What is the unit of k ?

(a) $M^3 s^{-1}$ (b) $L^3 mol^{-3} s^{-1}$ (c) $L^4 mol^{-4} s^{-1}$ (d) $L^{-1} mol^1 s^{-1}$
- The combustion of methanol takes place according to the reaction

$$2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l).$$
 Calculate ΔH for the combustion of 1 mol of methanol under standard conditions. Use the following standard enthalpies of formation:

ΔH°_f for $CH_3OH(l) = -238.5$ kJ/mol
 ΔH°_f for $CO_2(g) = -393.5$ kJ/mol
 ΔH°_f for $H_2O(l) = -285.6$ kJ/mol

(a) -726.2 kJ/mol (b) $+726.2$ kJ/mol (c) -1452.4 kJ/mol (d) $+1452.4$ kJ/mol
- A mixture of hydrogen and chlorine remains unreacted until it is exposed to ultraviolet light from a burning magnesium strip. Then the following reaction occurs very rapidly.

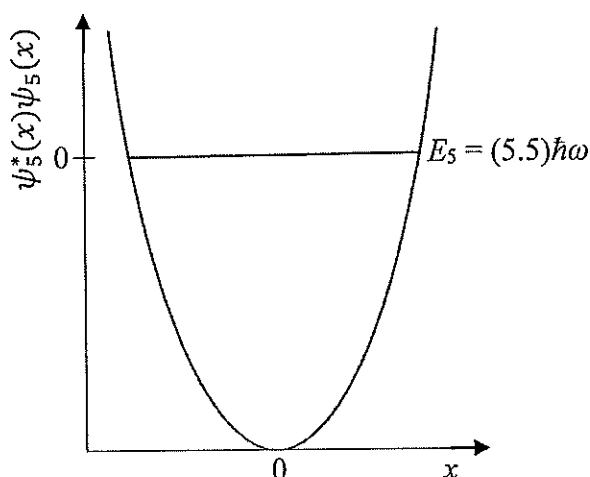
$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

$\Delta G = -45.54$ kJ; $\Delta H = -44.12$ kJ; $\Delta S = -4.76$ J/K

 Select the statement below that best explains this behavior.
 - The reactants are thermodynamically more stable than the products.
 - The reaction has a small equilibrium constant.
 - The ultraviolet light raises the temperature of the system and makes the reaction more favorable.
 - The reaction is spontaneous, but the reactants are kinetically stable.
- Consider the freezing of liquid water at $-10^\circ C$. For this process what are the signs for ΔH , ΔS , and ΔG , respectively?
 - + -
 - + - -
 - - -
 - + 0
- As the vibrational quantum number increases, the energy separation between neighboring vibrational energy levels of a diatomic molecule
 - increases
 - stays the same
 - decreases
 - increases first and then decreases

第二部份 問答題 (題分示於各題題號後，共 32 分)

7. (10 pts) Sketch $\psi_5^*(x)\psi_5(x)$ vs. x , where $\psi_5(x)$ is the $\nu = 5$ wavefunction of a harmonic oscillator. Describe each of the essential qualitative features of this sketch.

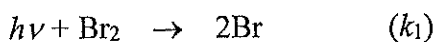


8. (10 pts) Spectrum of a Particle in a 1D Box: The absorption spectrum of a conjugated molecule of length L can be approximated as an electron trapped in a 1D box of the same length. Thus, the electron feels a potential

$$V(x) = \begin{cases} 0 & \text{if } 0 \leq x \leq L \\ \infty & \text{otherwise} \end{cases}$$

In this problem, we will use this model to make a simple picture of the electronic absorption spectrum of a conjugated molecule.

- (a) What are the energy levels available to the electron in this “molecule”?
 (b) How does the wavelength of the lowest energy absorption feature compare to the length of the molecule? Does this make sense?
 9. (12 pts) For the photochemical $\text{H}_2 + \text{Br}_2$ Reaction, its mechanism is known as



I_a is the intensity of light absorbed. Please prove that its rate law is of the following expression:

$$v_{\text{HBr}} = \frac{2k_2(1/k_{-1})^{1/2}[\text{H}_2][\text{Br}_2]I_a^{1/2}}{[\text{Br}_2] + (k_4/k_3)[\text{HBr}]}$$

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分析化學〔每題 10 分；共五題〕

- Briefly answer the following questions about liquid chromatography – mass spectrometry (LC-MS)
 - Why normal phase LC is not suitable to use in LC-MS system?
 - What kind of interference problem will arise when ion exchange LC is used?
- The p-values of carbonic acid (H_2CO_3) dissociation constants are $\text{p}K_1$ 6.5 and $\text{p}K_2$ 10.5, respectively. Please calculate the pH values of the following mixture solutions of carbonic acid and NaOH. (Only two significant figures are required; 兩位有效數字即可)
 - The mixing volume ratio of carbonic acid and NaOH of the same concentration is 2:1.
 - The mixing volume ratio of carbonic acid and NaOH of the same concentration is 1:1.
- To extract phenol in aqueous solution using ethyl acetate solvent, what kind of carbonate buffer is suitable to use, carbonic acid/ sodium bicarbonate buffer or sodium bicarbonate/ sodium carbonate buffer? [Hint: the $\text{p}K_a$ of phenol is 10; the dissociation constants of H_2CO_3 have been given in Q2.]
- When the UV-VIS absorbance values of solution A and solution B are 0.3 and 0.6, respectively, in one cell of 1-cm light path, calculate the absorbance values of the following mixture solutions
 - The mixing volume ratio of A and B is 1:1 (equal volume).
 - The mixing volume ratio of A and B is 2:1 in one cell of which the light path is 2 cm.[Solution A and solution B are assumed NOT to interact with each other.]
- The average value and standard deviation value of four measured replicates of the same sample is 4.0 g and 1.0 g, respectively.
 - Under 95% confidence level, when the confidence interval of the above measured value is from $4.0 - I$ to $4.0 + I$, please specify the value I. (Only two significant figures are required; 兩位有效數字即可)
 - What is the Student's t-value used to specify I?[Hint: the Student's t-values under 95% confidence level are 3.182, 2.776, and 2.571, when the degrees of freedom of the average value are 3, 4, and 5, respectively]