

# 國立中山大學 111 學年度

## 碩士班暨碩士在職專班招生考試試題

科目名稱：有機化學及無機化學【化學系碩士班】

### — 作答注意事項 —

考試時間：100 分鐘

- 考試開始鈴響前不得翻閱試題，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，請斟酌作答(不得另攜帶紙張)。
- 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，後果由考生自負。
- 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。

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題號：422001

※本科目依簡章規定「不可以」使用計算機(混合題)

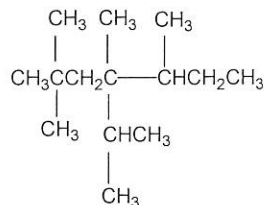
共 8 頁第 1 頁

一、單選題 (72%，不倒扣)

第 1~16 題，每題 3 分

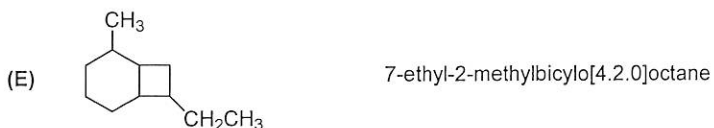
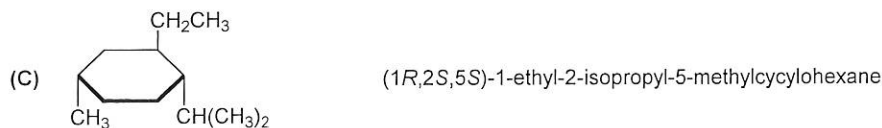
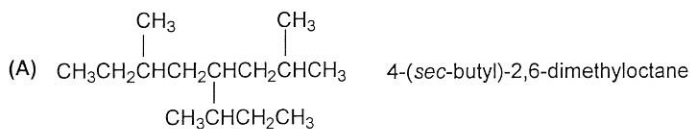
第 17~28 題，每題 2 分

1. Which of the following statements is correct? Refer to the structure shown below:

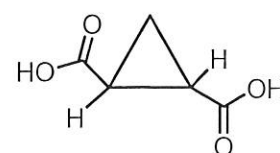
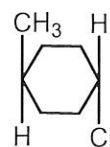
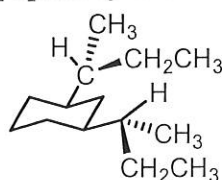
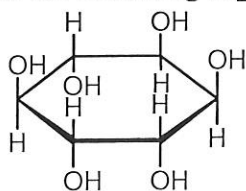


- (A) nine 1° carbons, two 2° carbons, two 3° carbons, and two 4° carbons  
 (B) eight 1° carbons, two 2° carbons, three 3° carbons, and two 4° carbons  
 (C) eight 1° carbons, two 2° carbons, one 3° carbons, and two 4° carbons  
 (D) eight 1° carbons, two 2° carbons, two 3° carbons, and two 4° carbons  
 (E) eight 1° carbons, two 2° carbons, two 3° carbons, and one 4° carbons

2. Which of the following has an **INCORRECT** IUPAC name?



3. Which of the following is **NOT** optically active?



國立中山大學 111 學年度碩士班暨碩士在職專班招生考試試題

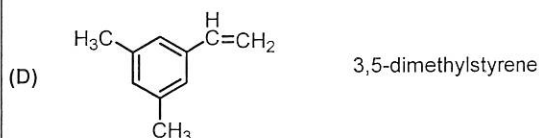
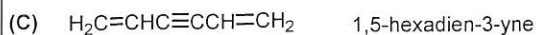
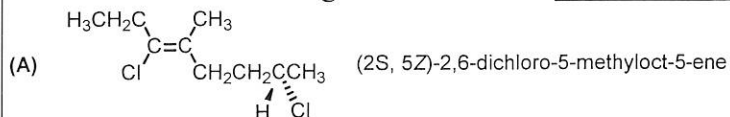
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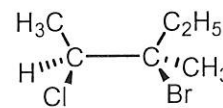
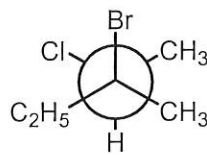
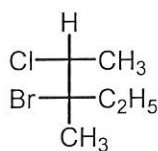
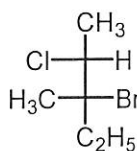
※本科目依簡章規定「不可以」使用計算機(混合題)

共 8 頁第 2 頁

4. Which of the following nomenclature is **INCORRECT**?



5. Which of the following statements is correct?



(i)

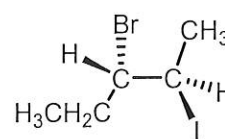
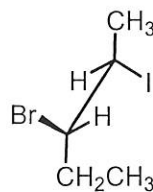
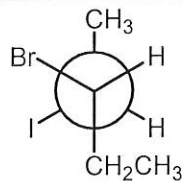
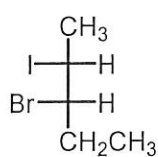
(ii)

(iii)

(iv)

- (A) (i) and (iv) are identical  
 (B) (i) and (ii) are enantiomers  
 (C) (i) and (iii) are enantiomers  
 (D) (ii) and (iv) are diastereomers

6. Which of the following is an **INCORRECT** representation of (2R,3S)-3-Bromo-2-iodopentane?



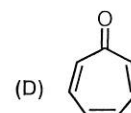
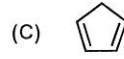
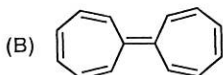
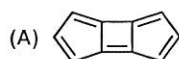
(A)

(B)

(C)

(D)

7. Which of the following is an aromatic compound?



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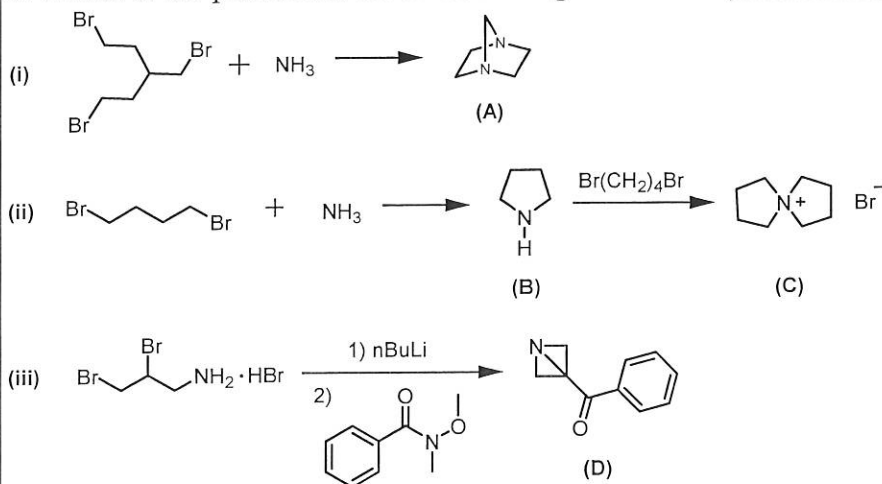
科目名稱：有機化學及無機化學【化學系碩士班】

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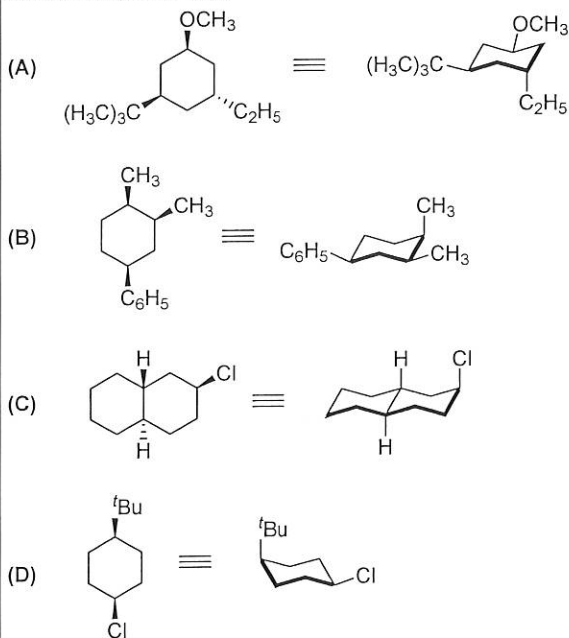
※本科目依簡章規定「不可以」使用計算機(混合題)

共 8 頁第 3 頁

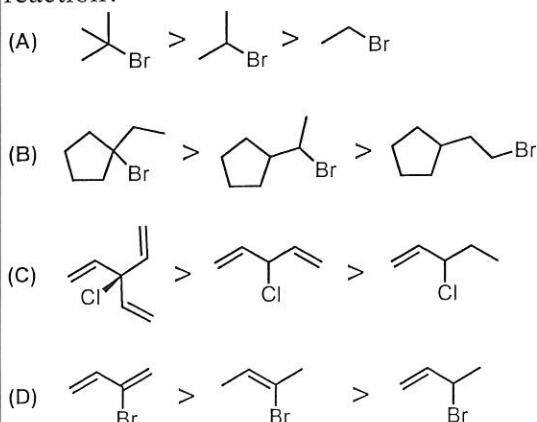
8. Which of the products from the following reactions is **INCORRECT**?



9. Which of the following choices does **NOT** describe the most stable chair conformation for the structures shown?



10. Which of the following choices does **NOT** depict the correct order of reactivity towards  $S_N1$  reaction?



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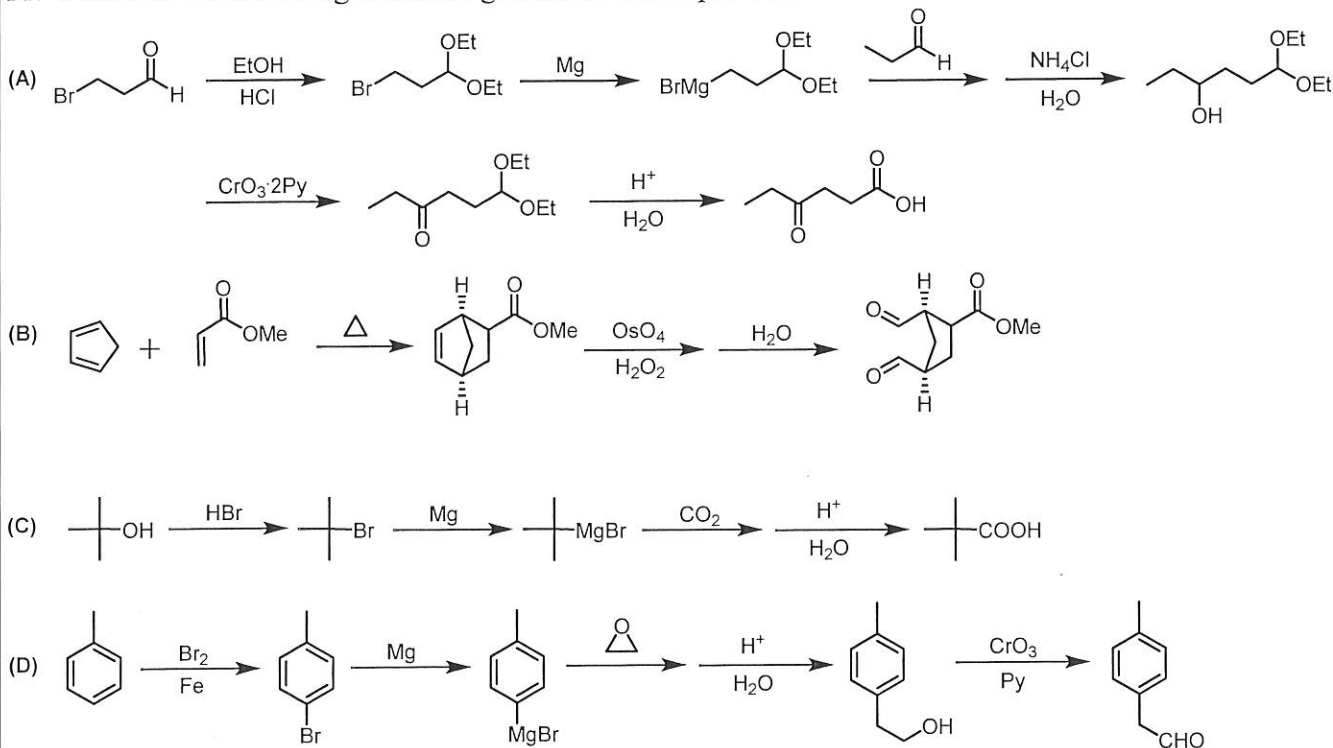
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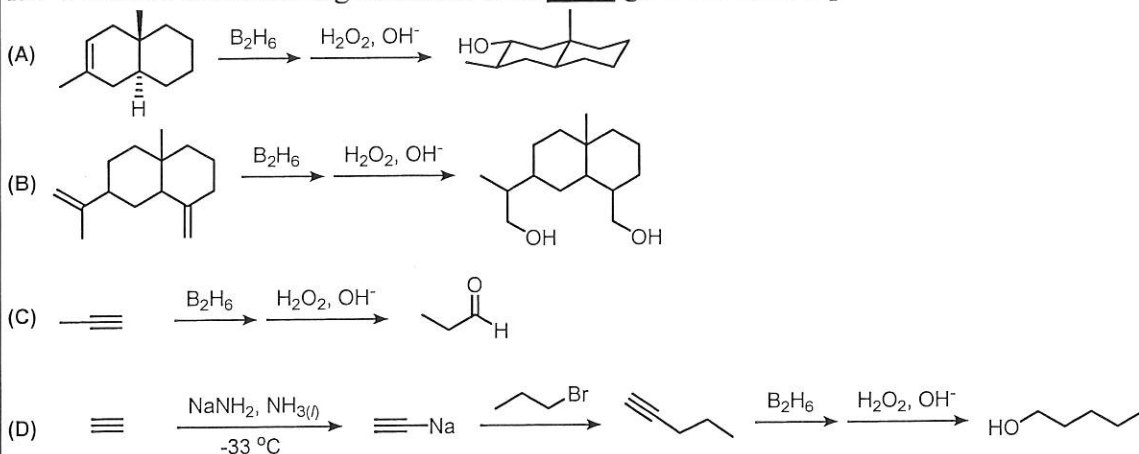
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共 8 頁第 4 頁

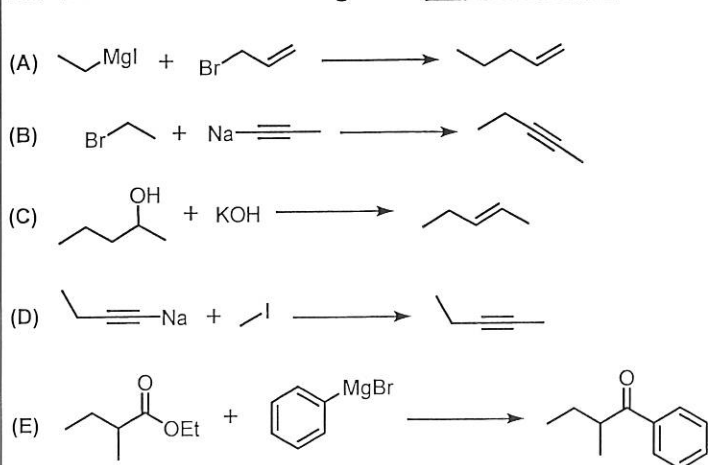
11. Which of the following reactions gives the correct product?



12. Which of the following reactions does NOT give the correct product?



13. Which of the following is an INCORRECT reaction?



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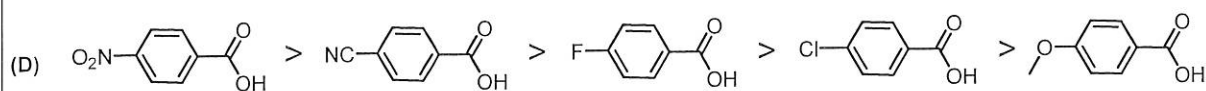
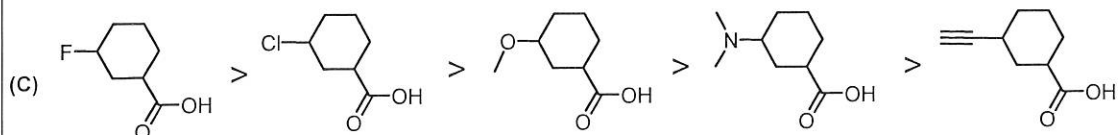
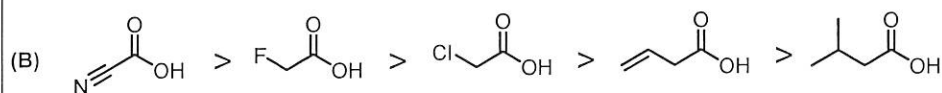
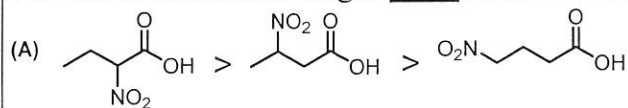
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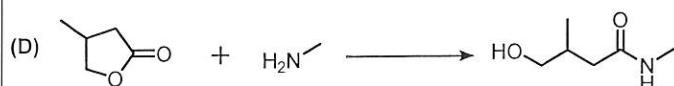
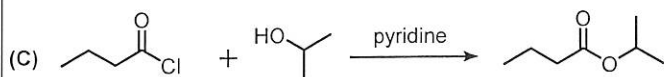
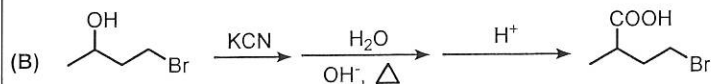
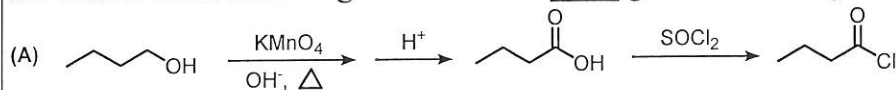
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共 8 頁第 5 頁

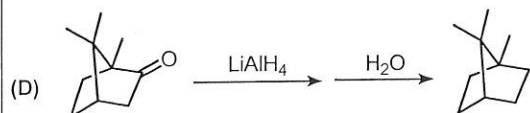
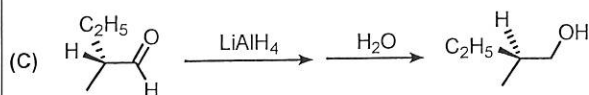
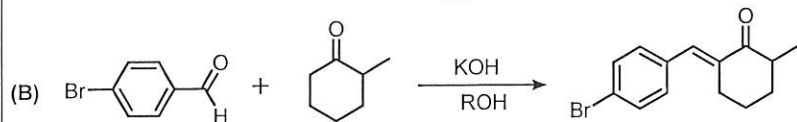
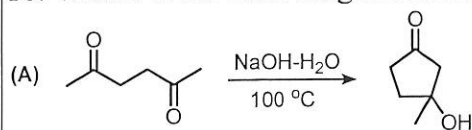
14. Which of the following is **NOT** in the correct order in terms of acidity?



15. Which of the following reactions does **NOT** give the correct product?



16. Which of the following reactions gives the correct product?



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共 8 頁第 6 頁

17. The description “The anions form a face-centered cubic packing, and the cations occupy half of the tetrahedral holes formed by the anions.” fits to which of the following crystal structures?  
(A) NaCl structure (B) Anti fluorite structure (C) CsCl structure (D) Wurtzite structure  
(E) Zinblende structure
18. Which of the following molecules has the highest boiling point?  
(A) HF (B) HCl (C) H<sub>2</sub>O (D) NH<sub>3</sub> (E) CH<sub>4</sub>
19. Find the molecule that does not belong to the same point group as the others.  
(A) I<sub>3</sub><sup>+</sup> (B) H<sub>2</sub>O (C) I<sub>3</sub><sup>-</sup> (D) O<sub>3</sub> (E) All molecules belong to the same point group.
20. Which of the following coordination compounds shows the least intense color?  
(A) [Cu(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> (B) [Ni(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> (C) [Mn(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> (D) [Fe(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup> (E) [Cr(H<sub>2</sub>O)<sub>6</sub>]<sup>2+</sup>
21. The presence of Fe<sup>3+</sup> ions can be proven with the formation of an iron thiocyanate coordination compound. When adding an aqueous potassium thiocyanate solution to a solution containing Fe<sup>3+</sup> ions, one sees an intense...  
(A) blue color (B) red color (C) green color (D) violet color (E) yellow color
22. AgX (with X = F, Cl, Br, I) differ in their solubility in water. Which of the compounds has the smallest solubility product in water?  
(A) AgF (B) AgCl (C) AgBr (D) AgI
23. Which of the following ligands is the “strongest”?  
(A) Chloro ligand (B) Cyano ligand (C) Aqua ligand (D) Oxo ligand (E) Iodo ligand
24. B<sub>10</sub>H<sub>14</sub> is a ... borane structure.  
(A) closo (B) nido (C) arachno (D) hypo (E) clado
25. Na<sup>+</sup> ions lead to a very distinct flame coloring. The color is mainly a result of the emission of photons with a wavelength of about...  
(A) 380 nm (B) 450 nm (C) 590 nm (D) 730 nm (E) 810 nm
26. In a hexagonal-closed packed structure, the (010) surface and the (001) surface form an angle of...  
(A) 45° (B) 60° (C) 90° (D) 120° (E) The two surfaces are parallel.
27. The metal *d*-orbitals of an octahedral coordination compound splits into two different energy levels. Into how many energy levels do the metal *d*-orbitals of a trigonal-bipyramidal coordination compound split?  
(A) 1 (B) 2 (C) 3 (D) 4 (E) 5
28. Which of the following half-reactions occurs at the cathode of a Zn|ZnSO<sub>4</sub>(1M)||CuSO<sub>4</sub>(0.1M)|Cu voltaic cell?  
(A) Zn<sup>2+</sup> + 2e<sup>-</sup> → Zn (B) Zn → Zn<sup>2+</sup> + 2e<sup>-</sup> (C) Cu → Cu<sup>2+</sup> + 2e<sup>-</sup> (D) Cu<sup>2+</sup> + 2e<sup>-</sup> → Cu  
(E) None of the above.

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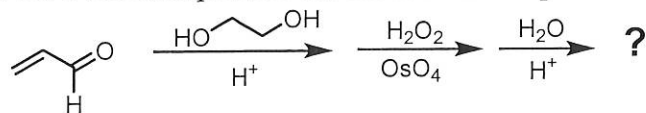
共 8 頁第 7 頁

## 二、問答題 (28%)

第 29~37 題，每題 2 分

第 38 題，10 分

29. Give the final product for the reaction sequence shown below.



30. If atoms of the same element occupy both the anion sites and the cation sites of the zincblende structure, one gets which crystal structure?

31. Instantaneous dipoles are responsible for what kind of intermolecular interactions?

32. How many microstates are associated with the ground-state electron configuration of an isolated V atom?

33. When boric acid is dissolved in water, the solution becomes acidic. Write down a reaction equation to show how boric acid reacts with water!

34. An isolated F atom has the electron configuration  $1s^2 2s^2 2p^5$ . Write down all term symbols associated this electron configuration.

35. If  $[\text{Pt}(\text{NH}_3)_4]^{2+}$  undergoes ligand substitution reaction with two equivalents of  $\text{Cl}^-$ , what is the expected main product? Draw the structure of the product and name the product.

36. Draw the structure of ferrocene, and count the number of valence electrons.

37. The d-orbitals of neighboring transition metal atoms can form different types of MOs. Draw each an example for a  $\sigma$ -,  $\pi$ -,  $\delta$ -orbital formed by two metal d-orbitals.

38. Does  $\text{H}_3^+$  show a  $D_{3h}$  symmetry or a  $C_{2v}$  symmetry? Use molecular orbital diagrams to explain your answer.

補充資料

$D_{3h}$	E	$2C_3$	$3C_2'$	$\sigma_h$	$2S_3$	$3\sigma_v$	$h=12$	
$A_1'$	1	1	1	1	1	1		$(x^2+y^2), z^2$
$A_2'$	1	1	-1	1	1	-1	$R_z$	
$E'$	2	-1	0	2	-1	0	$(x, y)$	$(x^2-y^2, xy)$
$A_1''$	1	1	1	-1	-1	-1		
$A_2''$	1	1	-1	-1	-1	1	$z$	
$E''$	2	-1	0	-2	1	0	$(R_x, R_y)$	$(xz, yz)$



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$C_{2v}$	$E$	$C_2$	$\sigma_v(xz)$	$\sigma'_v(yz)$	$h=4$	
$A_1$	1	1	1	1	$z, z^2, x^2, y^2$	
$A_2$	1	1	-1	-1	$xy$	$R_z$
$B_1$	1	-1	1	-1	$x, xz$	$R_y$
$B_2$	1	-1	-1	1	$y, yz$	$R_x$

# 國立中山大學 111 學年度 碩士班暨碩士在職專班招生考試試題

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

- 考試開始鈴響前不得翻閱試題，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，請衡酌作答(不得另攜帶紙張)。
- 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，後果由考生自負。
- 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 111 學年度碩士班暨碩士在職專班招生考試試題

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）（混合題）

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一、選擇題（單選，每題 2 分，共計 30 分）

1. Before doing the Joule experiment, which of following statement is NOT correct?  
(A) We need to know  $C_v$  (B) Design a  $dU = 0$  experiment (C) We need to know  $\mu_J$  first (D) Create an adiabatic free expansion process.
2. In an isothermal reversible expansion process for an ideal gas, which of following statement is NOT correct?  
(A)  $\Delta U = 0$  (B)  $\Delta T = 0$  (C)  $dq \neq 0$  (D)  $\left(\frac{\partial U}{\partial V}\right)_T \neq 0$
3. At 300K, which gas has a negative Joule-Thomson coefficient?  
(A) He (B) Ar (C)  $\text{CO}_2$  (D)  $\text{N}_2$
4. What is the correct relationship between  $C_p$  and  $S$ ?  
(A)  $C_p = \left(\frac{\Delta S}{\Delta T}\right)_p$  (B) as  $dP=0$ ,  $dS = \frac{C_p}{T} dT$  (C) as  $dP=0$ ,  $dS = C_p dT$  (D)  $dV=0$ ,  $dS = \frac{C_p}{T} dP$
5. If we mix 0.3 mole of pure benzene with 0.7 mole of pure toluene at temperature T. Assume this mixture is an ideal solution. What is  $\Delta G_{\text{mix}}$ ?  
(A)  $0.7R\ln 0.3 + 0.3R\ln 0.7$  (B)  $0.7RT\ln 0.3 + 0.3RT\ln 0.7$  (C)  $0.3R\ln 0.3 + 0.7R\ln 0.7$  (D)  $0.7RT\ln 0.7 + 0.3RT\ln 0.3$
6. Please estimate the molecular density for 1 mole ideal gas per  $\text{cm}^3$  at 1 torr and 300 K?  
(A)  $\sim 3.2 \times 10^{14}$  (B)  $\sim 3.2 \times 10^{15}$  (C)  $\sim 3.2 \times 10^{16}$  (D)  $\sim 3.2 \times 10^{17}$
7. In terms of energy, 3 GHz is identical to X wavenumber ( $\text{cm}^{-1}$ ), What is X?  
(A) 1 (B) 0.5 (C) 30 (D) 0.1
8. What is the boundary condition for a “particle on a ring” model?  
(A)  $\psi(0) = \psi(2\pi)$  (B)  $\psi(0) = \psi(\pi)$  (C)  $\psi(0) = \psi\left(\frac{\pi}{2}\right)$   
(D)  $\psi(0) = 0, \psi(2\pi) = 0$
9. The lowest eigenvalue for a H atom is  $-13.6 \text{ eV}$ . Calculate the energy uncertainty if the lifetime in the given state is 1.0 nanosecond?  
(A)  $4.74 \mu\text{eV}$  (B)  $38.1 \mu\text{eV}$  (C)  $0.33 \mu\text{eV}$  (D)  $1.35 \mu\text{eV}$
10. The  $Y_2^1(\theta, \phi)$  is an eigenfunction of  $\hat{L}^2$ , so what is the eigenvalue?  
(A)  $2\hbar$  (B)  $2\hbar^2$  (C)  $6\hbar^2$  (D)  $4\hbar^2$
11. What kind of symmetry operation is for determination of the minus sign of  ${}^3\Sigma_g^-$ ?  
(A)  $\sigma_v$  (B)  $C_{\infty v}$  (C)  $S(\varphi)$  (D)  $C_2$
12. The rate constant for the reaction  $2\text{I} \rightarrow \text{I}_2$  is  $7.0 \times 10^6 \text{ m}^3 \text{ mol}^{-1} \text{ s}^{-1}$  at 296 K and  $7.7 \times 10^6 \text{ m}^3 \text{ mol}^{-1} \text{ s}^{-1}$  at 303 K. What is  $E_a$  (kJ/mol)?  
(A) 16.5 (B) 35.5 (C) 10.2 (D) 185
13. If the population decay channels of the excited state decay include three channels, such as fluorescence channel ( $k_F = 10^9 \text{ s}^{-1}$ ), internal conversion channel ( $k_{IC} = 10^{12} \text{ s}^{-1}$ ), and intersystem crossing channel ( $k_{ISC} = 10^3 \text{ s}^{-1}$ ), what is the observed fluorescence lifetime  $\tau_F$ ?  
(A) 1 psec (B) 1 msec (C) 1 nsec (D) 1  $\mu\text{sec}$
14. If we want to acquire a Raman spectrum with a 785 nm laser for exciting a C–H stretching at  $3000 \text{ cm}^{-1}$ , what Stokes peak in nanometer (nm) will be appeared in the Raman spectrometer?  
(A) 985 (B) 1064 (C) 1027 (D) 633
15. At room temperature, which kind of molecular motion has least contribution to the entropy for  $\text{CH}_4$ ?  
(A) Rotation (B) Vibration (C) Translation (D) Electronic

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## 二、問答與計算(共計 70 分)

1. The equation of state of a van der Waals gas is given as  $(P + \frac{a}{V^2})(V - b) = RT$ , where  $a$ ,  $b$ , and  $R$  are constants. Derive the critical temperature  $T_c$ . (10%)
2. Find  $\langle P_x \rangle$ ,  $\langle P_x^2 \rangle$  for  $n=1$  state of a particle in a 1D box with a length  $L$ . (10%)
3. What is the difference between the *end point* and *equivalence point* in a volumetric titration? (5%)  
How do you correct this “difference” in an acid-base titration? (5%)
4. In the ionic strength range 0–0.1 M, activity coefficients decrease with (a) increasing ionic strength (3%); (b) increasing ionic charge (3%); (c) decreasing hydrated radius (3%). Which statements are true?
5. The concentration of the alkane  $C_{20}H_{42}$  (molecular weight: 282.55) in a particular sample of rainwater is 0.2 ppb. Assume that the density of rainwater is close to 1.00 g/mL and find the molar concentration of  $C_{20}H_{42}$ . (10%)
6. A 0.0450 M solution of benzoic acid has a pH of 2.78. Calculate  $pK_a$  for this acid. (10%)
7. Calculate the pH of  $5.0 \times 10^{-8}$  M  $HClO_4$ . (7%) What fraction of the total  $H^+$  in this solution is derived from the dissociation of water? (4%)