


注意：考試開始鈴響前，不得翻閱試題，
並不得書寫、畫記、作答。

國立清華大學 108 學年度碩士班考試入學試題

系所班組別：生命科學院 乙組

考試科目(代碼)：有機化學(0502)

— 作答注意事項 —

1. 請核對答案卷(卡)上之准考證號、科目名稱是否正確。
2. 作答中如有發現試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清(含未依範例畫記)致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「國立清華大學試場規則及違規處理辦法」，無法因本試題封面作答注意事項中未列明而稱未知悉。

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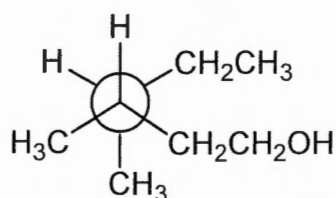
系所班組別：生命科學院乙組、丁組

考試科目（代碼）：有機化學(0502、0706)

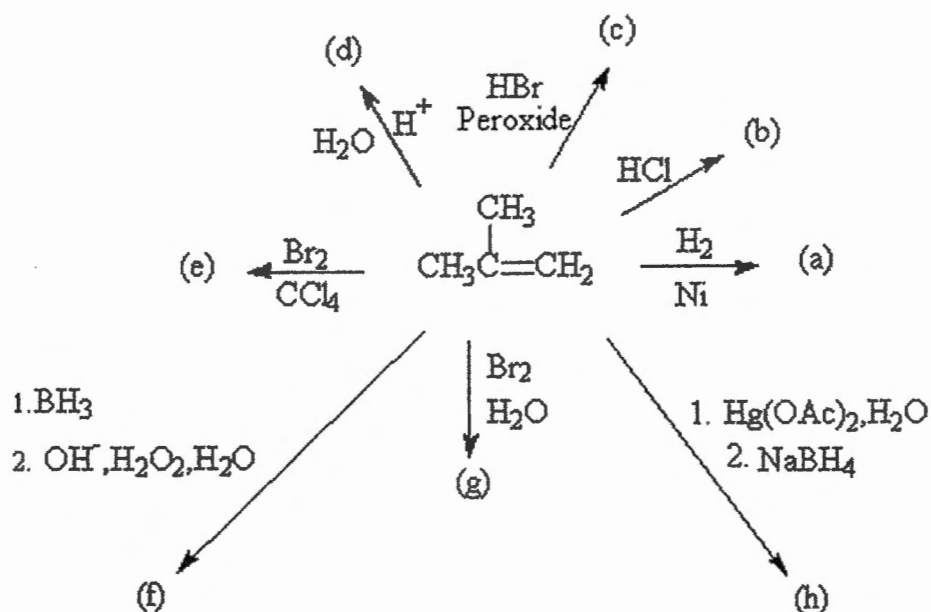
共 8 頁，第 1 頁 *請在【答案卷】作答

Part 1 簡答題 (76%)

1. Draw dash-wedge structures for all stereoisomers of 1-bromo-3-isopropylcyclohexane, giving stereochemical details for each structure. (6%)
2. What is the complete IUPAC name of the following substance? (Remember to give stereochemical details, as relevant.) (4%)



3. Provide the structures and specify the configurations (R, S) of the products obtained from epoxidation of cis-2-pentene (with CH_3COOOH). (4%) Which of the following terms best describes the reaction: stereoselective, stereospecific or both? (2%)
4. Complete the following tree of reactions by giving the major products: (8%)



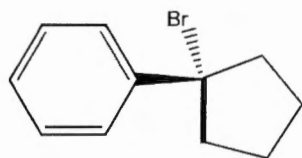
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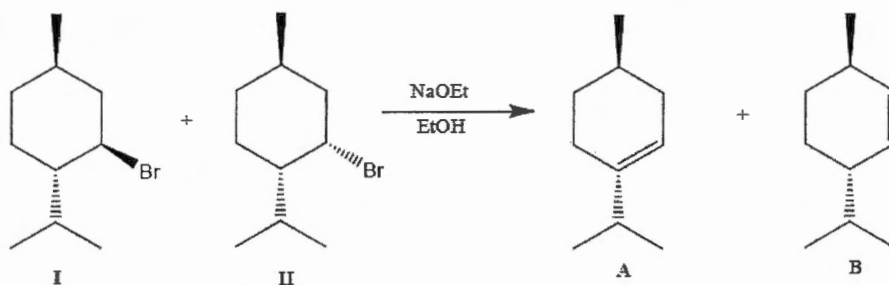
考試科目（代碼）：有機化學(0502、0706)

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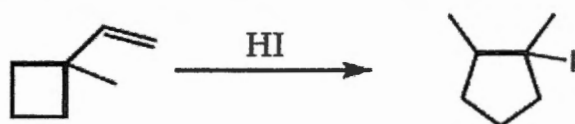
5. Draw the potential energy diagram that represents an exothermic reaction between a tertiary alkyl halide and methanol. Briefly explain your rationale. (4%)
6. A student has isolated a chiral alkyl halide (shown below) with a specific rotation of $[\alpha] = +22.1^\circ$. The student decided to store the compound in the solvent MeOH overnight. However, reanalysis of the alkyl halide showed a new chemical formula of $C_{12}H_{16}O$ with a specific rotation of $[\alpha] = 0^\circ$. Suggest a mechanism to justify these results. (5%)



7. When diastereomers **I** and **II** undergo an E2 elimination on treatment with sodium ethoxide in ethanol, one of the isomers react 500 times faster than the other one. Also, one isomer gives only **A** as a product and the other isomer gives a mixture of **A** and **B** as products. Determine the products of each isomer and explain your reasoning. (5%)



8. Give a mechanistic explanation for the formation of the following product in significant yield. What other product(s) might also be obtained? Explain clearly. (5%)



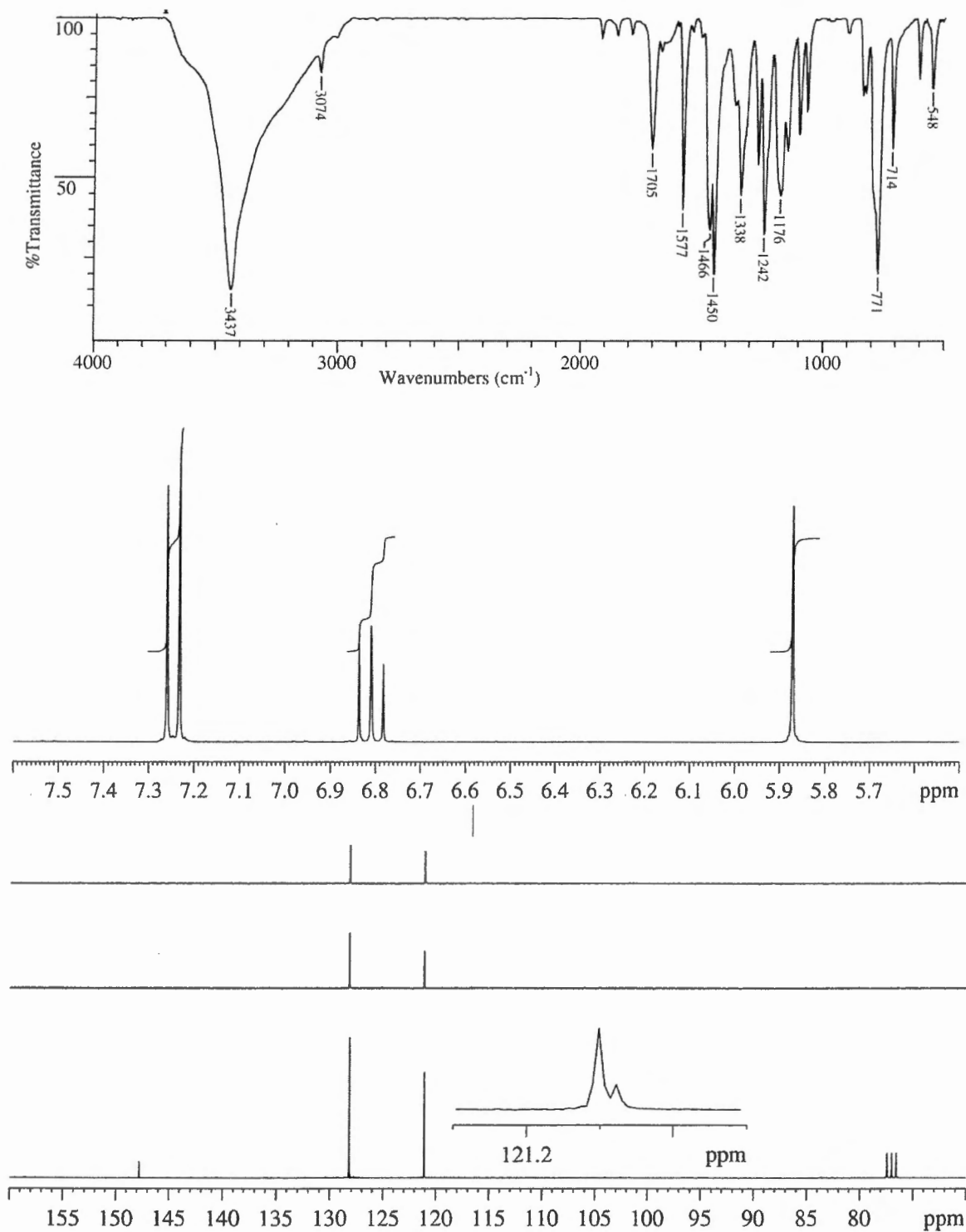
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共 8 頁，第 3 頁 *請在【答案卷】作答

9. An unknown compound, U, has the formula $C_6H_4Cl_2O$. Elucidate the structure of U by scrutinizing its IR, 1H NMR and ^{13}C NMR spectra, shown below. (6%)



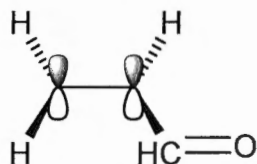
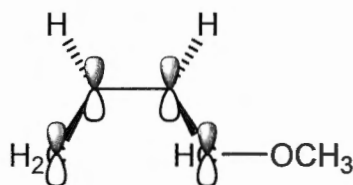
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共 8 頁，第 4 頁 *請在【答案卷】作答

10. Complete the following reaction sequence: indicate regiochemical/stereochemical details as relevant. (5%) The reaction starts from methylcyclopentane via (i) Br_2 , $h\nu$, (ii) $\text{C}_2\text{H}_5\text{Na}/\text{C}_2\text{H}_5\text{OH}$, heat, (iii) B_2H_6 , THF, (iv) H_2O_2 , NaOH.
11. Provide a reasonable synthetic strategy for the synthesis of trans-1,2-cyclohexanediol from bromocyclohexane (6%)
12. Complete the following reaction sequence, giving structural details of all key intermediates. 1-hexene \rightarrow i), ii), iii), iv) (6%)
i) HBr/ROOR
ii) Li
iii) $(\text{CH}_3\text{CH}_2)_2\text{C}=\text{O}$
iv) $\text{C}_2\text{H}_5\text{I}$
13. Diels-Alder reaction between the conjugated diene and the dienophile as shown below can proceed at elevated temperature. Is this reaction regioselective? (1%) How? (2%) How many chiral center (s) is (are) created? (1%) Draw all the isomers. (6%)



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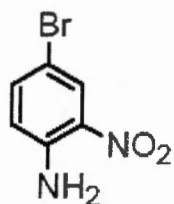
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共 8 頁，第 5 頁

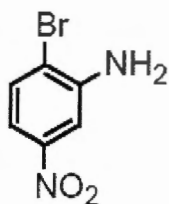
*請在【答案卷】作答

Part 2 單選題 (24%, 1.5% each)

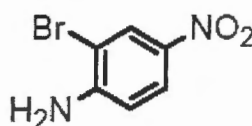
1. 2-Bromo-4-nitroaniline is:



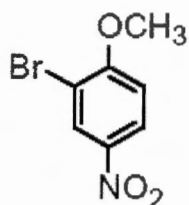
I



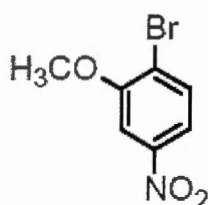
II



III



IV

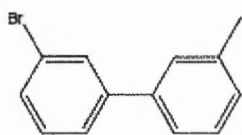
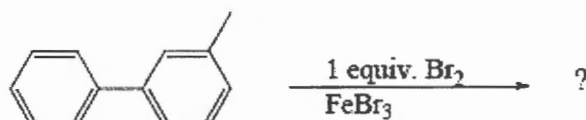


V

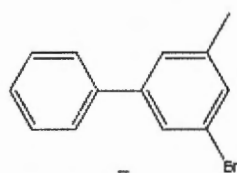
2. Which of these is the rate-determining step in the sulfonation of benzene?

- Formation of SO_3 from sulfuric acid
- Protonation of SO_3 sulfuric acid
- Addition of SO_3H^+ to benzene to form the arenium ion
- Loss of a proton from the arenium ion to form benzenesulfonic acid
- None of these choices.

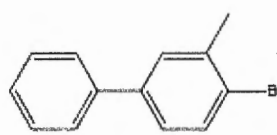
3. What would you expect to be the major product obtained from the following reaction?



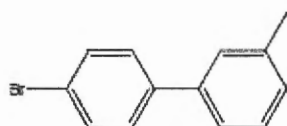
I



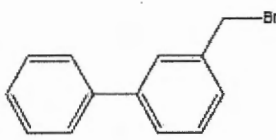
II



III



IV



V

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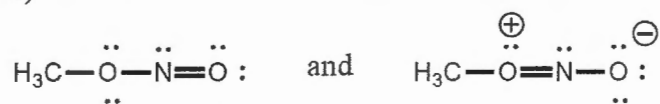
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*請在【答案卷】作答

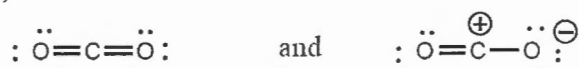
4. The greatest degree of ionic character is anticipated for the bond between
- H and C.
 - H and Cl.
 - C and Cl.
 - H and Br.
 - Br and Cl.

5. Which of the following pairs are NOT resonance structures?

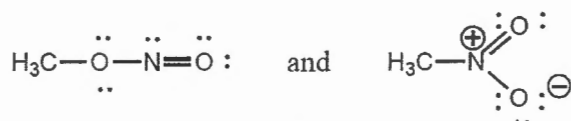
a)



b)



c)



- Each of these pairs represents resonance structures.
- None of these pairs represents resonance structures.

6. Identify the atomic orbitals in the C-C sigma bond in acetylene (ethyne).

- (2sp², 2sp²)
- (2sp³, 2sp³)
- (2sp, 2sp)
- (2p, 2p)
- (2sp, 1s)

7. Which of the following contains an sp²-hybridized carbon?

- CH₄
- CH₃⁻
- CH₃CH₃
- CH₃⁺

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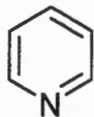
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共 8 頁，第 7 頁

*請在【答案卷】作答

8. What is the hybridization of the N atom in the following molecule?



- a) s
- b) p
- c) sp
- d) sp²
- e) sp³

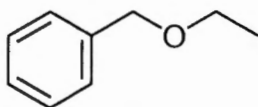
9. Which of the following would have no net dipole moment ($\mu = 0$ D)?

- a) CBr₄
- b) cis-1,2-Dibromoethene
- c) trans-1,2-Dibromoethene
- d) 1,1-Dibromoethene
- e) More than one of these choices.

10. Which halogen forms the weakest bond to carbon?

- a) F
- b) Cl
- c) Br
- d) I

11. What alkyl groups make up the following ether?



- a) ethyl and phenyl
- b) propyl and benzyl
- c) ethyl and benzyl
- d) propyl and phenyl
- e) None of these choices.

12. Which reaction will yield CH₃CH₂-D?

- a) CH₃CH₃ + D₂O
- b) CH₃CH₂Li + D₂O
- c) CH₃CH₂OLi + D₂O
- d) CH₃CH₂OH + D₂O
- e) More than one of these choices.

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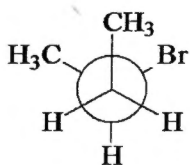
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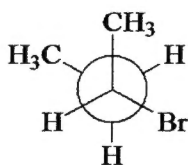
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*請在【答案卷】作答

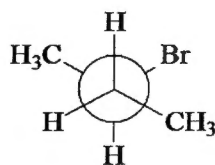
13. In the dehydrohalogenation of 2-bromobutane, which conformation below leads directly to the formation of *cis*-2-butene



I



II



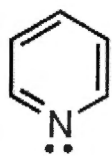
III

- a) only I b) only II c) only III d) I and II.

14. In the molecular orbital model of cyclobutadiene, how many pairs of degenerate π -antibonding molecular orbitals are there?

- a) 1
b) 2
c) 3
d) 4
e) 0

15. Which compound would you NOT expect to be aromatic?



I



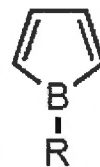
II



III



IV



V

16. How many equivalent resonance structures can be written for the cyclopentadienyl anion?

- a) 3
b) 4
c) 5
d) 6
e) 7