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 丁組

考試科目(代碼)：有機化學(0706)

—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。

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、丁組

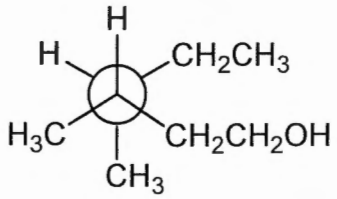
考試科目（代碼）：有機化學(0502、0706)

 *請在【答案卷】作答

Part 1 簡答題 (76%)

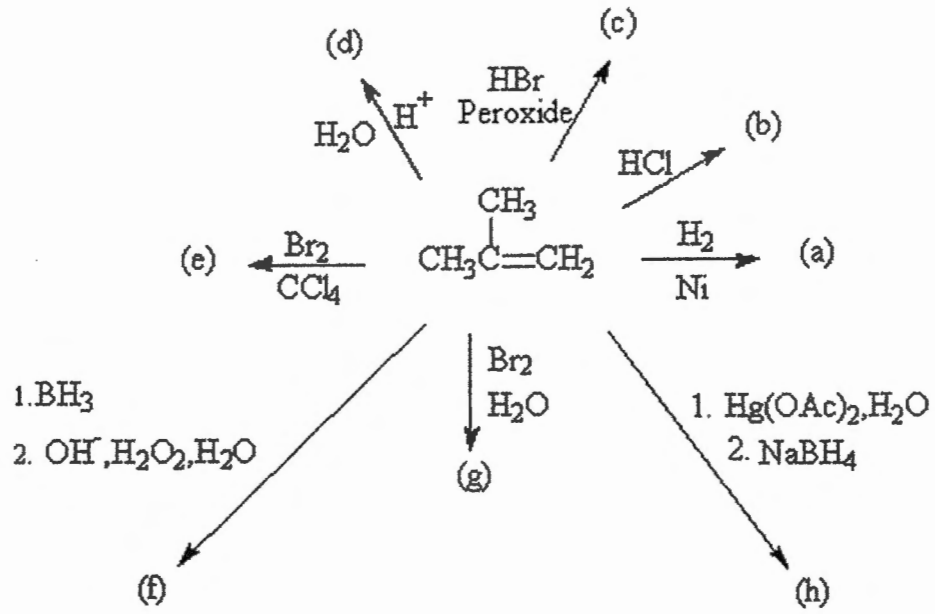
1. Draw dash-wedge structures for all stereoisomers of 1-bromo-3-isopropylcyclohexane, giving stereochemical details for each structure. **(6%)**

2. What is the complete IUPAC name of the following substance? (Remember to give stereochemical details, as relevant.) **(4%)**



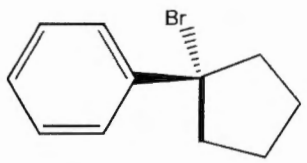
3. Provide the structures and specify the configurations (R, S) of the products obtained from epoxidation of cis-2-pentene (with CH_3COOOH). **(4%)** Which of the following terms best describes the reaction: stereoselective, stereospecific or both? **(2%)**

4. Complete the following tree of reactions by giving the major products: **(8%)**

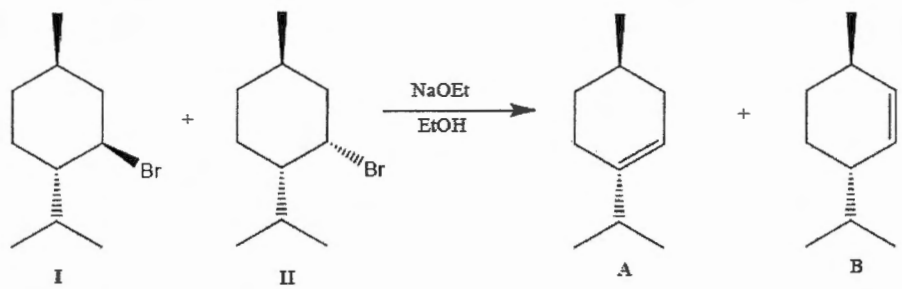


5. Draw the potential energy diagram that represents an exothermic reaction between a tertiary alkyl halide and methanol. Briefly explain your rationale. **(4%)**

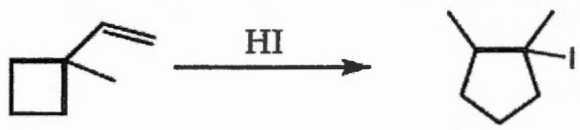
6. A student has isolated a chiral alkyl halide (shown below) with a specific rotation of $[\alpha] = +22.1°$. The student decided to store the compound in the solvent MeOH overnight. However, reanalysis of the alkyl halide showed a new chemical formula of $C_{12}H_{16}O$ with a specific rotation of $[\alpha] = 0°$. Suggest a mechanism to justify these results. **(5%)**



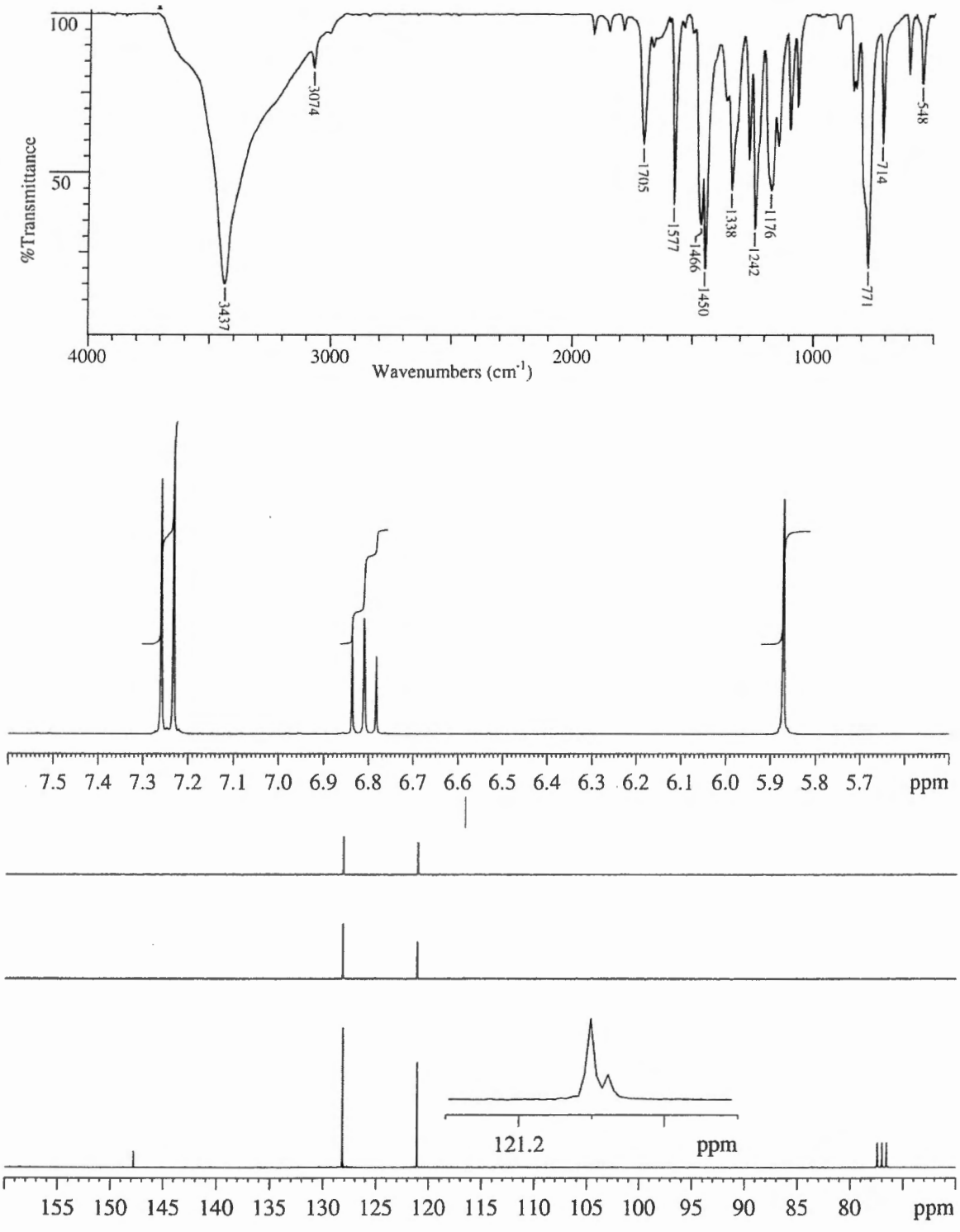
7. When diastereomers **I** and **II** undergo an E2 elimination on treatment with sodium ethoxide in ethanol, one of the isomers react 500 times faster than the other one. Also, one isomer gives only A as a product and the other isomer gives a mixture of A and B as products. Determine the products of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



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%)**

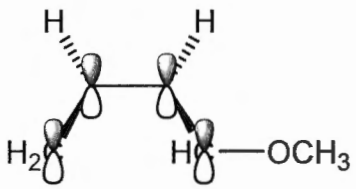


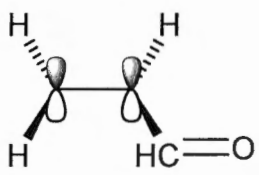
10. Complete the following reaction sequence: indicate regiochemical/stereochemical details as relevant. **(5%)** The reaction starts from methylcyclopentane via (i) Br_2, hν, (ii) C_2H_5Na/C_2H_5OH, heat, (iii) B_2H_6, THF, (iv) H_2O_2, NaOH.

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→ i), ii), iii), iv) **(6%)**
    i) HBr/ROOR
    ii) Li
    iii) $(CH_3CH_2)_2C=O$
    iv) C_2H_5I

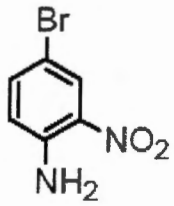
13. Diels-Alder reaction between the conjugated diene and the dienophile as shown below can proceed at elevated temperature. Is this reaction regioselective? **(1%)** How? **(2%)** How many chiral center (s) is (are) created? **(1%)** Draw all the isomers. **(6%)**



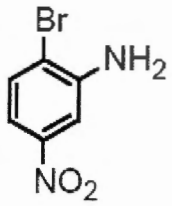


Part 2 單選題 (24%, 1.5% each)

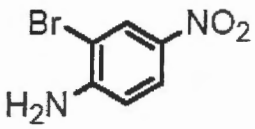
1. 2-Bromo-4-nitroaniline is:



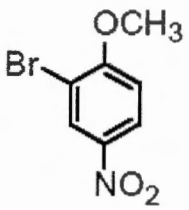
I



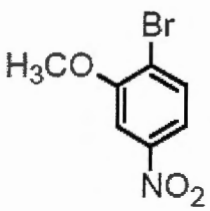
II



III



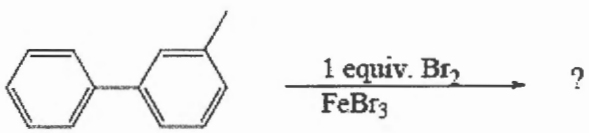
IV

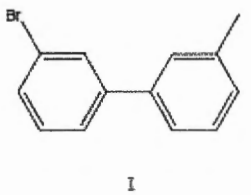


V

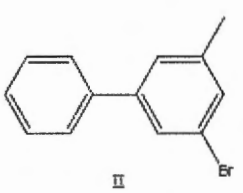
2. Which of these is the rate-determining step in the sulfonation of benzene?
   a) Formation of SO_3 from sulfuric acid
   b) Protonation of SO_3 sulfuric acid
   c) Addition of SO_3H^+ to benzene to form the arenium ion
   d) Loss of a proton from the arenium ion to form benzenesulfonic acide
   e) None of these choices.

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

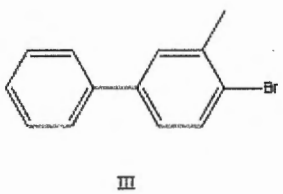




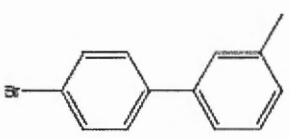
I



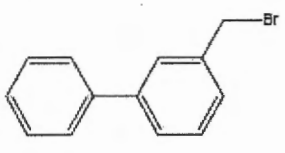
II



III



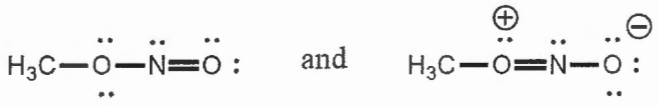
IV



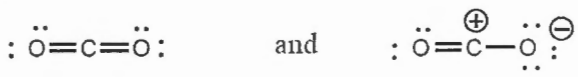
V

4. The greatest degree of ionic character is anticipated for the bond between
   a) H and C.
   b) H and Cl.
   c) C and Cl.
   d) H and Br.
   e) Br and Cl.

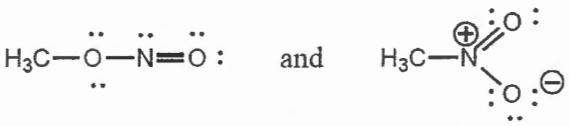
5. Which of the following pairs are NOT resonance structures?
   a)



   b)



   c)

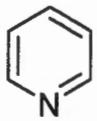


   d) Each of these pairs represents resonance structures.
   e) None of these pairs represents resonance structures.

6. Identify the atomic orbitals in the C-C sigma bond in acetylene (ethyne).
   a) ($2sp^2$, $2sp^2$)
   b) ($2sp^3$, $2sp^3$)
   c) (2sp, 2sp)
   d) (2p, 2p)
   e) (2sp, 1s)

7. Which of the following contains an sp_2-hybridized carbon?
   a) CH_4
   b) $CH_3{:}^-$
   c) CH_3CH_3
   d) CH_3^+

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

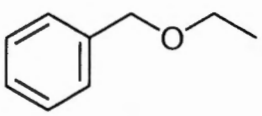


a) s
b) p
c) sp
d) sp^2
e) sp^3

9. Which of the following would have no net dipole moment ($\mu = 0$ D) ?
   a) CBr_4
   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.

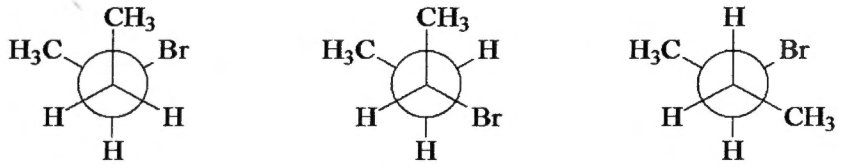
11. What alkyl groups make up the following ether?



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 CH_3CH_2-D?
    a) $CH_3CH_3 + D_2O$
    b) $CH_3CH_2Li + D_2O$
    c) $CH_3CH_2OLi + D_2O$
    d) $CH_3CH_2OH + D_2O$
    e) More than one of these choices.

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

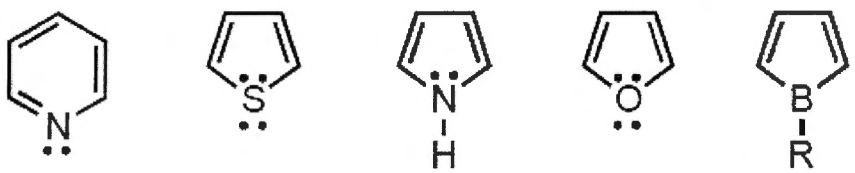


I　　II　　III

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