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 109 學年度碩士班考試入學試題

系所班組別：生命科學院
乙組

科目代碼：0502

考試科目：有機化學

—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。

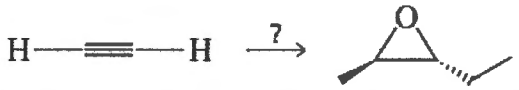
國立清華大學 109 學年度碩士班考試入學試題

系所班組別：生命科學院乙組、丁組

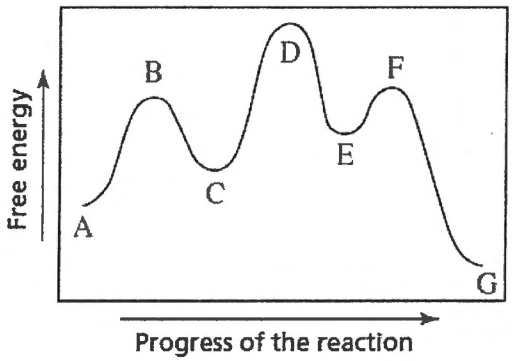
考試科目（代碼）：有機化學(0502、0706)

Part 1 簡答題 (70%)

1. Show how the following compound can be prepared from the given starting material. Draw the structure of the compound that is formed in each step of the synthesis. **(5%)**



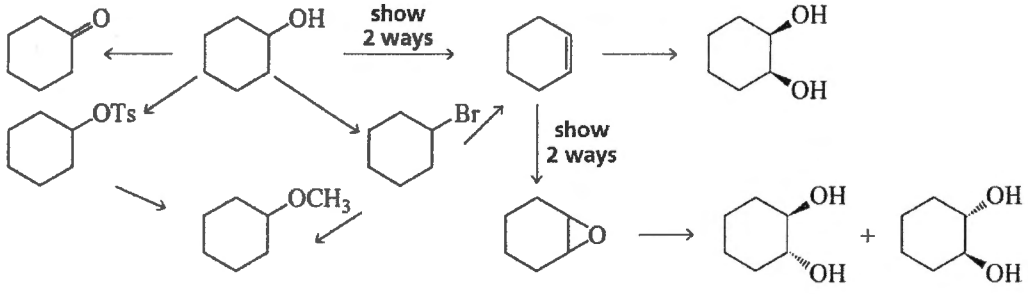
2. Given the reaction coordinate diagram for the reaction of **A** to form **G**, answer the following questions: **(11%)**



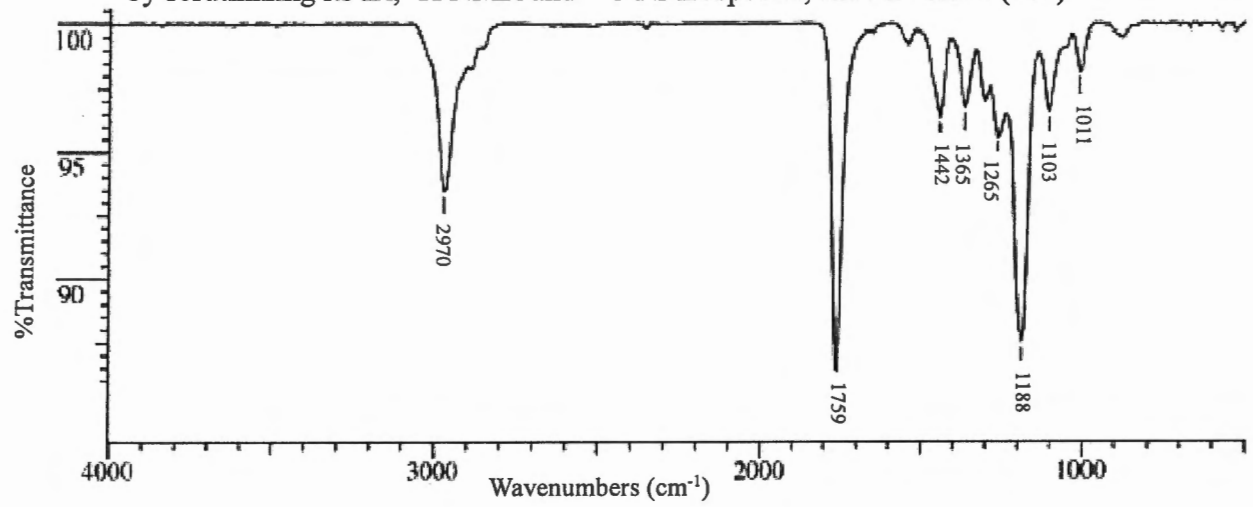
a. How many intermediates are formed in the reaction?
b. Which letters represent transition states?
c. What is the fastest step in the reaction?
d. Which is more stable: **A** or **G**?
e. Does **A** or **E** form faster from **C**?
f. Which is the more stable intermediate?
g. What is the reactant of the rate-determining step?
h. Is the first step of the reaction exergonic or endergonic?
i. Is the overall reaction exergonic or endergonic?
j. Which step in the forward direction has the largest rate constant?
k. Which step in the reverse direction has the smallest rate constant?

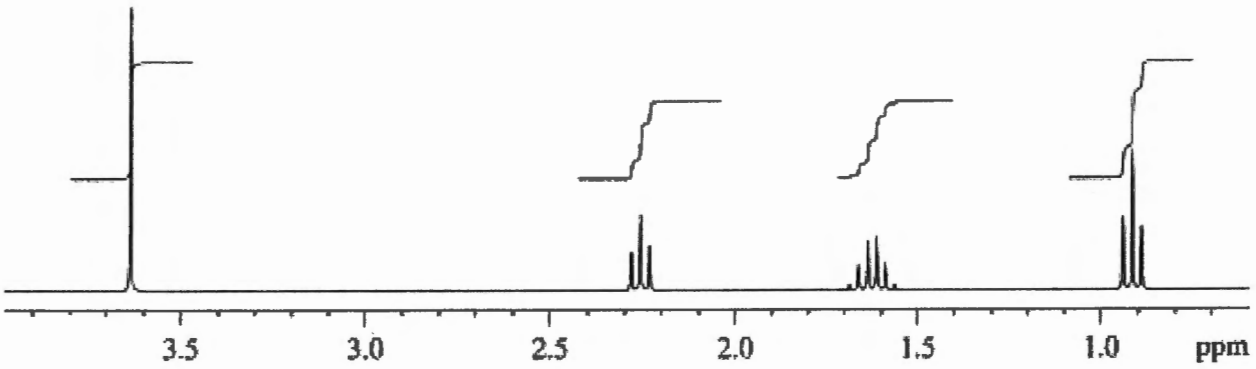
3. Explain why 2,3-pentadiene is chiral. **(4%)**

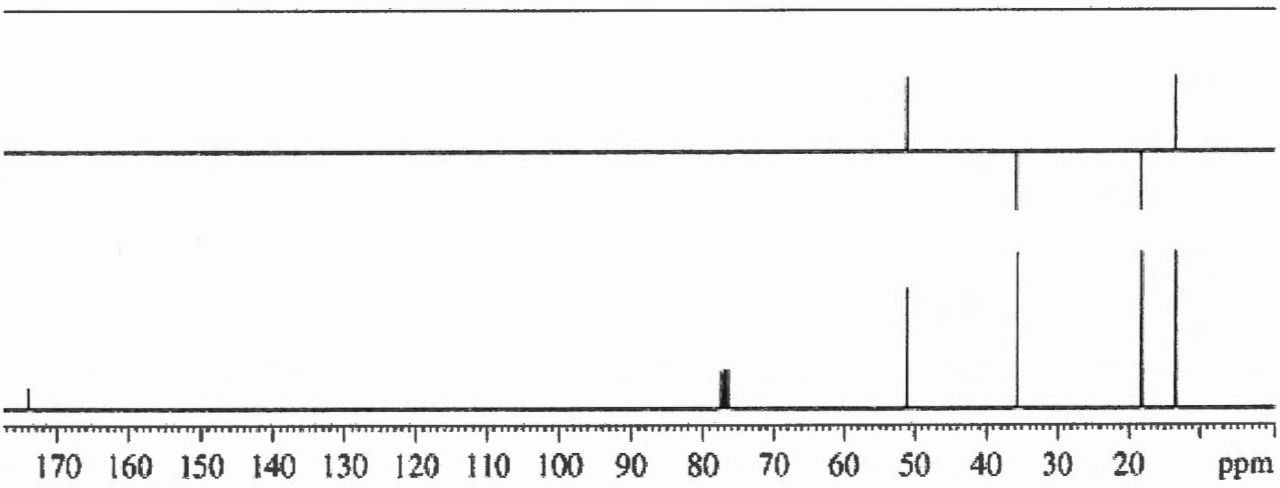
4. Write the appropriate reagent over each arrow. **(12%)**



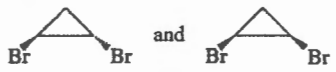
5. An unknown compound, L, has the formula $C_5H_{10}O_2$. Elucidate the structure of L by scrutinizing its IR, ^1H NMR and ^{13}C NMR spectra, shown below. **(6%)**

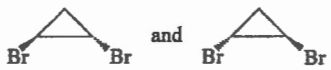


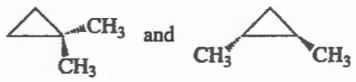


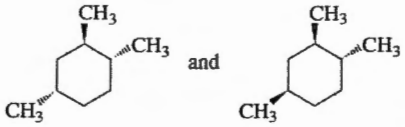


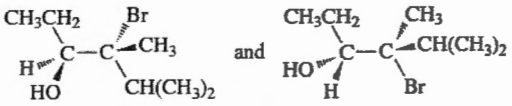
6. Are the following pairs identical, enantiomers, diastereomers, or constitutional isomers? **(12%)**

a. 

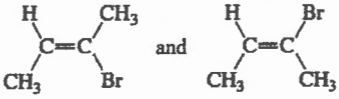
b. 

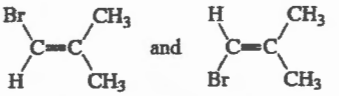
c. 

d. 

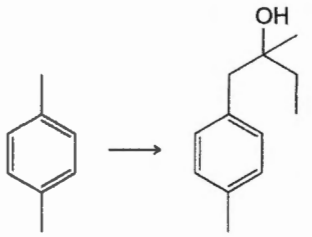
e. 

f. 

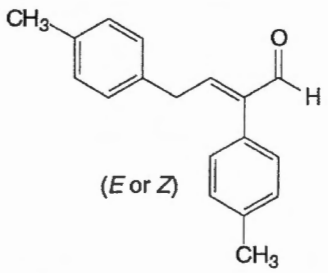
g. 

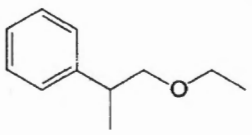
h. 

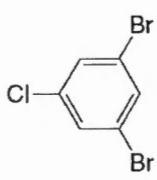
7. Indicate the reagents needed for the following multistep transformation. **(5%)**

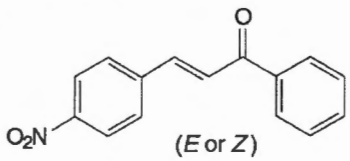


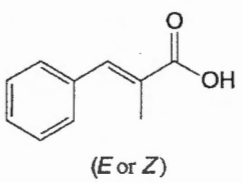
8. Starting with benzene, toluene, or aniline and any other required reagents, outline a synthesis of each of the following: **(15%)**

(a) 

(b) 

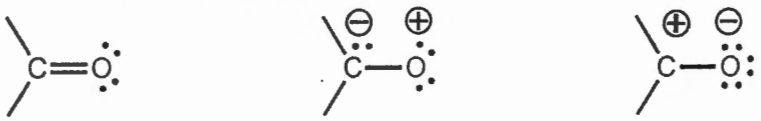
(c) 

(d) 

(e) 

Part 2 單選題 (30%, 1.5% each)

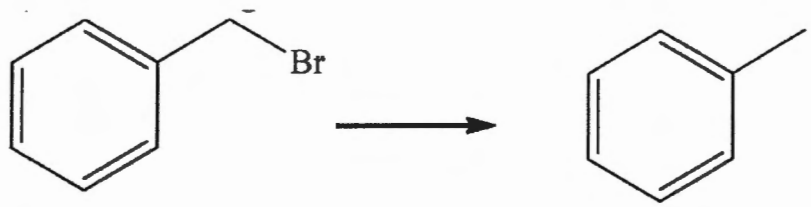
1. Which of the following resonance structures is not a significant contributor to the hybrid for the carbonyl group?



I　　II　　III

a) I
b) II
c) III
d) Neither II nor III is important.
e) All are significant contributors.

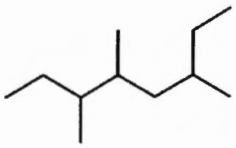
2. The following transformation would be considered a(n)?



a) Reduction
b) Oxidation
c) Addition
d) Elimination
e) Rearrangement

3. Which of these molecules is not expected to arise as a product of the high temperature chlorination of methane?

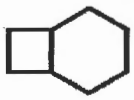
a) CCl_4
b) $HCCl_3$
c) CH_2Cl_2
d) CH_3CH_3
e) $CH_2{=}CH_2$



4. The IUPAC name for
   is:

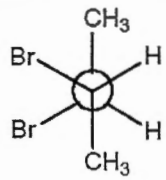
a) 6-Ethyl-3,4-dimethylheptane
b) 2-Ethyl-4,5-dimethylheptane
c) 3,4,6-Trimethyloctane
d) 3,5,6-Trimethyloctane
e) 2-(1-Methylpropyl)-4-methylhexane

5. What is the name of this compound?

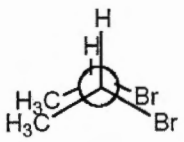


a) Bicyclo[2.2.2]octane
b) Bicyclo[3.2.1]octane
c) Bicyclo[4.1.1]octane
d) Bicyclo[4.2.0]octane
e) Bicyclo[3.3.0]octane

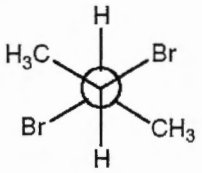
6. The most stable conformation of 2,3-dibromobutane, viewed through the C-2—C-3 bond :



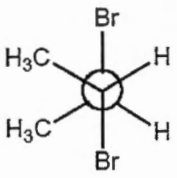
I



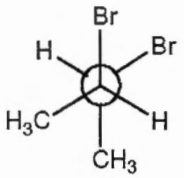
II



III



IV



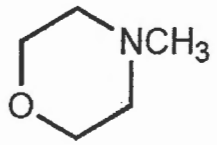
V

a) I　b) II　c) III　d) IV　e) V.

7. Which of the following compounds contains polar covalent bonds?

a) CS_2
b) LiF
c) F_2
d) CH_3F
e) None of these choices.

8. What functional group(s) is/are present in the following compound?

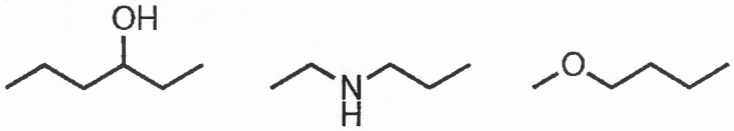


a) ether and 2° amine
b) ester and 3° amine
c) 3° amine
d) 3° amine and ether
e) None of these choices.

9. Which compound would have the highest boiling point?

a) $CH_3CH_2CH_2CH_2CH_2CH_3$
b) $CH_3CH_2OCH_2CH_2CH_3$
c) $CH_3CH_2CH_2CH_2CH_2OH$
d) $CH_3CH_2OCH(CH_3)_2$
e) $CH_3OCH_2CH_2CH_2CH_3$

10. The IR spectrum of which of the following substances is likely to show a small, but sharp peak at 2200 cm^{-1}?



I　　II　　III

IV　　V

a) I　b) II　c) III　d) IV　e) V.

11. What is the conjugate base of ethanol?

a) $CH_3CH_2O^-$

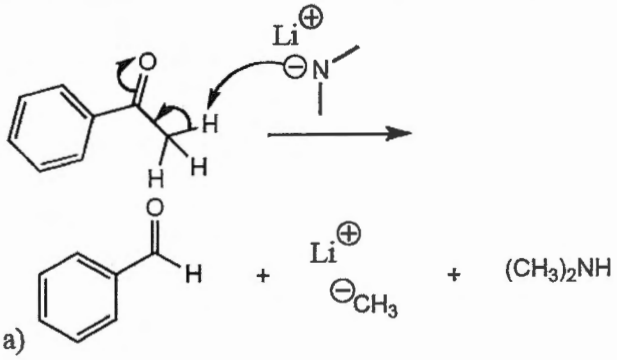
b) $CH_3CH_2^-$

c) $CH_3CH_2OH_2^+$

d) CH_3CH_3

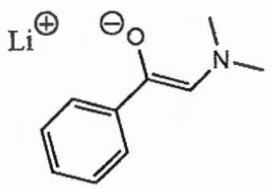
e) CH_3OCH_3

12. What is/are the product(s) of the following acid-base mechanism?

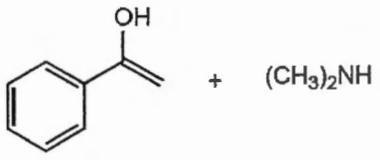


a)

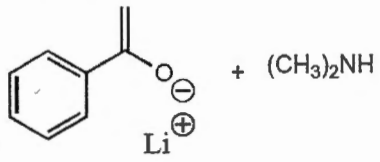
b)



c)



d)

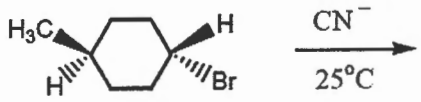


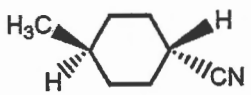
e) None of these choices.

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

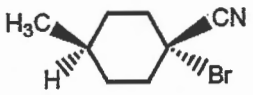
a) 1
b) 2
c) 3
d) 4
e) 0

14. What would be the major product of the following reaction?

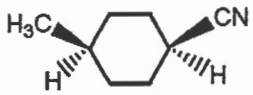




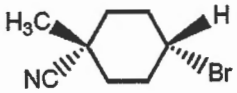
I



II



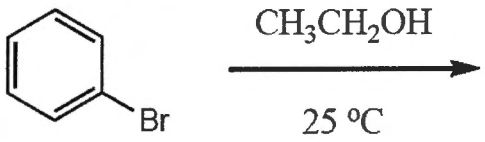
III

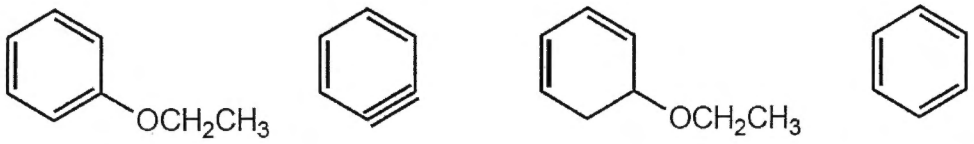


IV

a) I
b) II
c) III
d) IV
e) Equal amounts of I and III.

15. What would be the major product(s) of the following reaction?

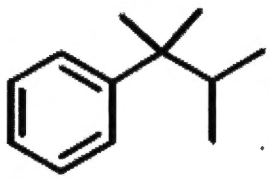




I　　II　　III　　IV

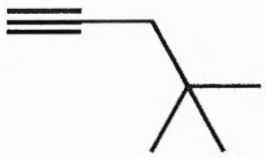
a) I
b) II
c) III
d) IV
e) None of these choices.

16. Predict the splitting pattern you would observe for the proton at C1 of 2,3-dimethyl-2-phenylbutane.



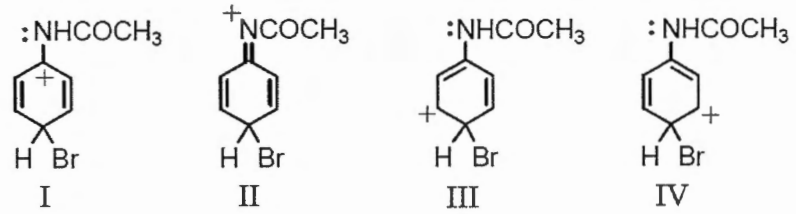
a) Doublet
b) Singlet
c) Quartet
d) Septet
e) Octet

17. For the following compound how many different signals would you see in the proton NMR? (Assume that you can see them all.)



a) 1
b) 2
c) 3
d) 4
e) 5

18. Which of the following structures contribute(s) to the resonance hybrid of the intermediate formed when acetanilide undergoes para-bromination?



a) I
b) II
c) III
d) IV
e) All of these choices.

19. The electrophilic bromination or chlorination of benzene requires, in addition to the halogen:

a) a hydroxide ion.

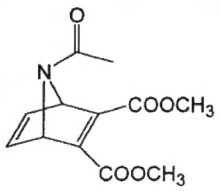
b) a Lewis base.

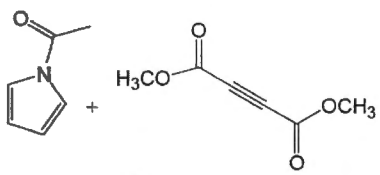
c) a Lewis acid.

d) peroxide.

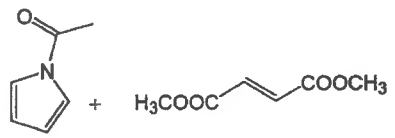
e) ultraviolet light.

20. Which of the following pairs of compounds could be used as the basis for a Diels-Alder synthesis of the compound shown below?

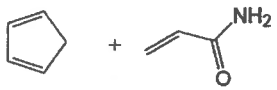




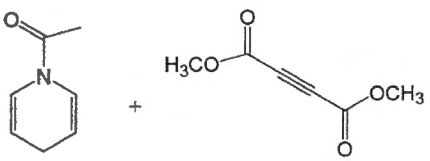
I



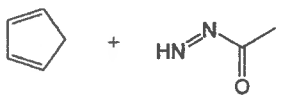
II



III



IV



V

a) I

b) II

c) III

d) IV

e) V