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 111 學年度碩士班考試入學試題

系所班組別：生命科學院
乙組(化學與生醫工程組)

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. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，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 111 學年度碩士班考試入學試題

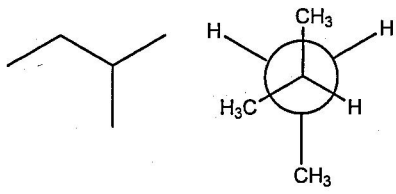
系所班組別：生命科學院乙組、丁組

考試科目（代碼）：有機化學(0502、0706)

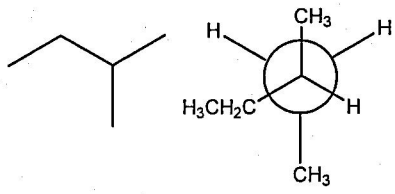
Part 1 簡答題 (70%)

1. Does each of the following pairs of structures show the same molecule or different molecules? (6%)

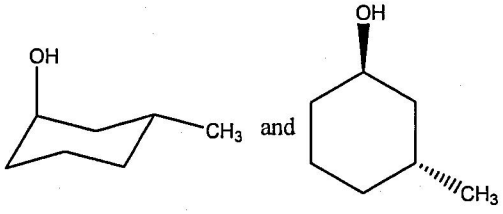
(a)



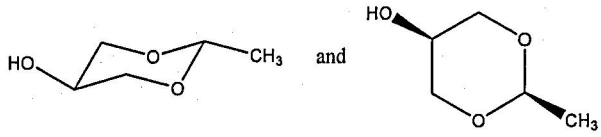
(b)



(c)



(d)

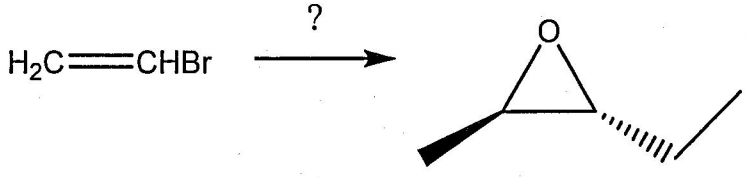


2. Draw the most stable conformation of each of the *cis* and *trans* isomers of the following: (6%)

(a) 3-phenylcyclohexanol　　(b) 1-bromo-4-chlorocyclohexane

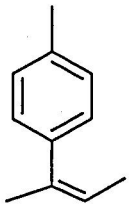
(c) 1-*t*-butyl-3-methylcyclohexane (d) 1-isopropyl-2-methylcyclohexane

3. 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. (6%)



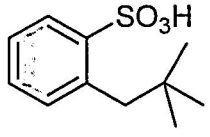
4. Starting with benzene, outline a synthesis of each of the following: (12%)

a.

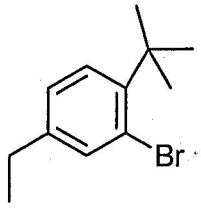


b.

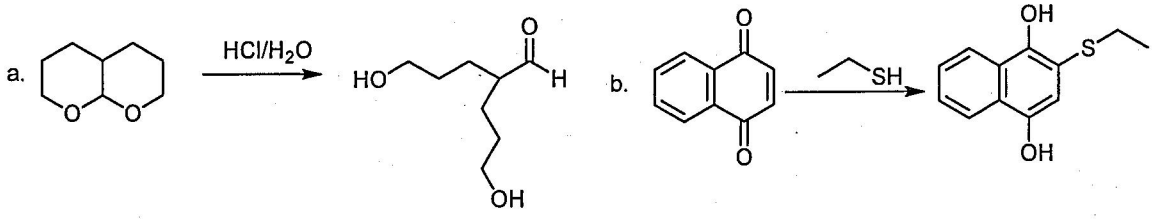
c.



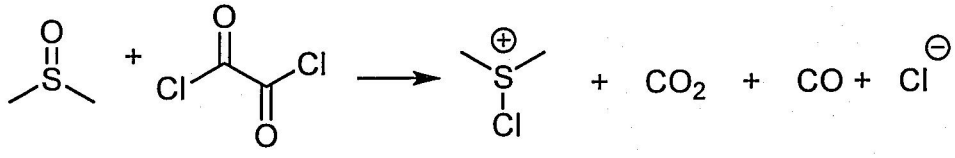
d.



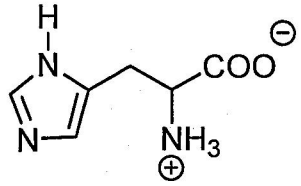
5. Propose a mechanism for each of the following reactions: (6%)



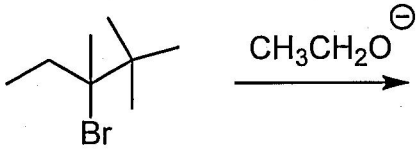
6. Propose a mechanism to explain how dimethyl sulfoxide and oxalyl chloride react to form the dimethylchlorosulfonium ion used as the oxidizing agent in the Swern oxidation. (5%)



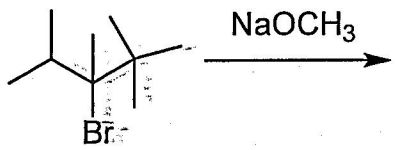
7. Histidine is a heterocyclic compound with three nitrogen atoms. (a) Which nitrogen is most apt to be protonated? (b) Which nitrogen is least apt to be protonated? (2% each).



8. Predict the products formed from the following reaction in terms of (a) regioselectivity and (b) stereochemistry. (4%)



(c) How about the stereochemical outcome for the following example? (2%)

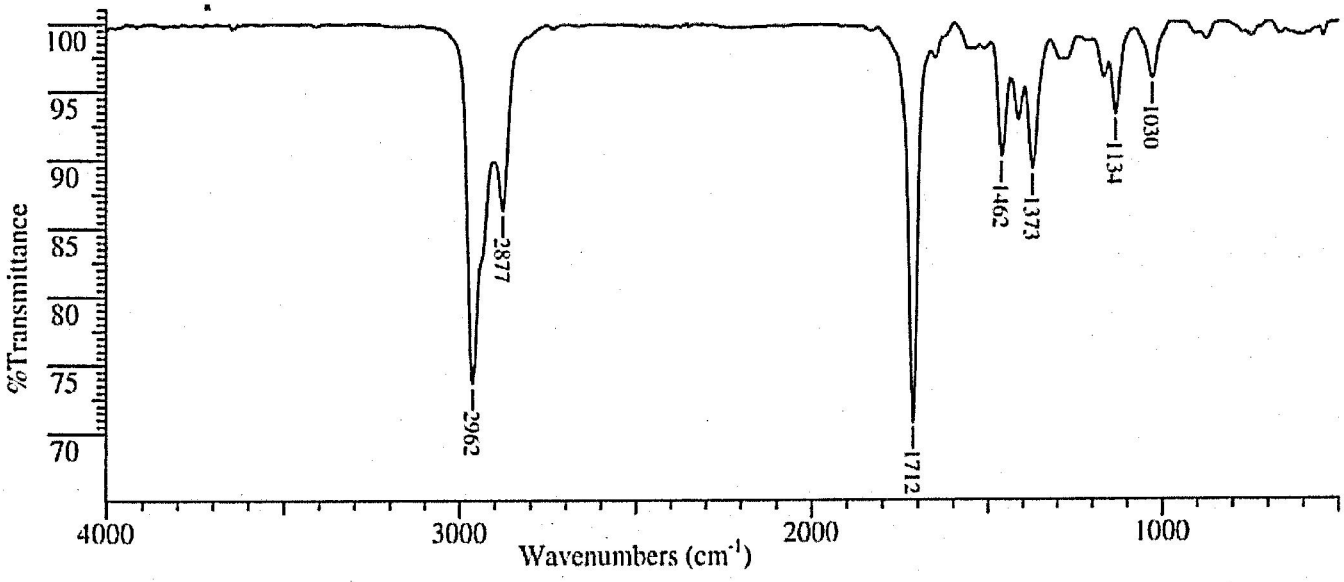


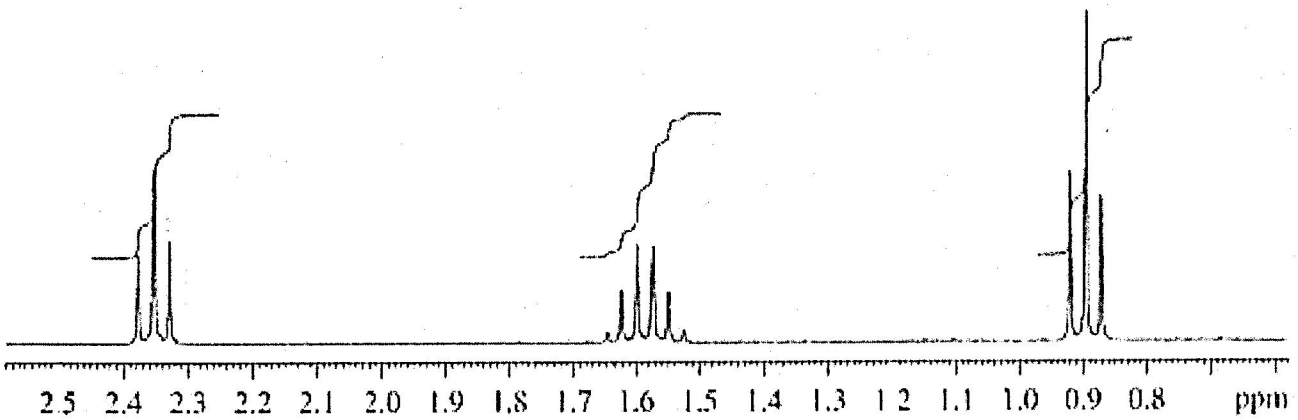
9. Phosgene ($COCl_2$) was used as a poison gas in World War I. What product would be formed from the reaction of phosgene with each of the following reagents? (6%)

a. one equivalent of methanol **b.** excess methanol **c.** excess propylamine **d.** excess water

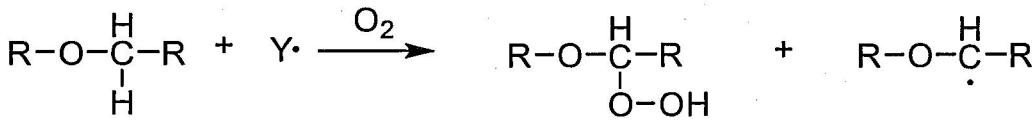
10. Please use the molecular orbital to explain why the back-side attack rather than front-side attack is favored by the S_N2 reaction. (5%)

11. An unknown compound, **A**, has the formula $C_7H_{14}O$. Elucidate the structure of **A** by scrutinizing its IR and ^1H NMR spectra, shown below. (4%)



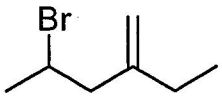


12. Provide the mechanism for the following formation of the explosive peroxide. (4%)



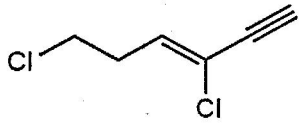
Part 2 單選題 (30%, 1.5% each)

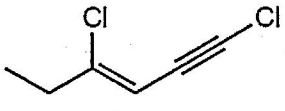
1) The correct IUPAC name for the following compound is:

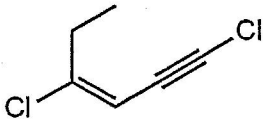


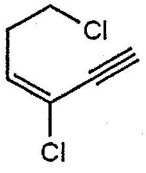
A) 2-Bromo-4-methylenehexane
B) 2-(2-Bromopropyl)-1-butene
C) 4-Bromo-2-ethyl-1-pentene
D) 2-Bromo-4-ethyl-1-pentene
E) 2-Bromo-4-ethyl-4-pentene

2) Which structure represents (*Z*)-1,4-dichlorohex-3-en-1-yne?

A) 

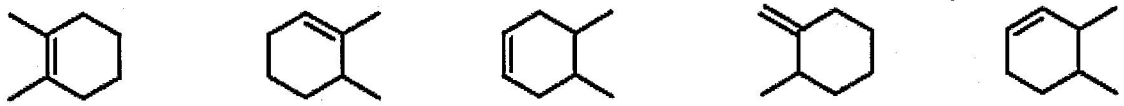
B) 

C) 

D) 

E) None of these choices.

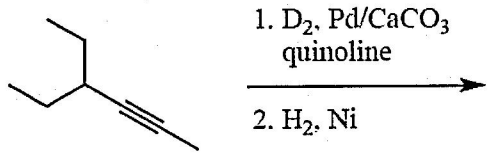
3) Which molecule would have the lowest heat of hydrogenation?

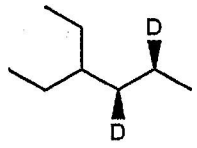


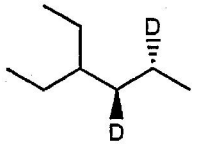
I　　II　　III　　IV　　V

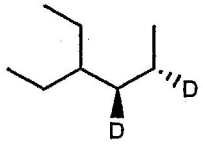
A) I
B) II
C) III
D) IV
E) V

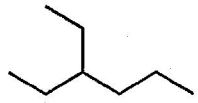
4) Which would be the *major* product of the following reaction sequence?



A) 

B) 

C) 

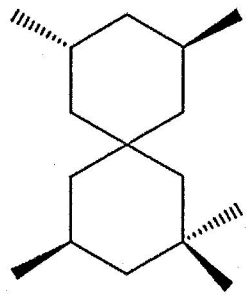
D) 

E) None of these choices.

5) Enantiomers are:

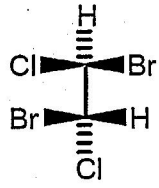
A) molecules that have a mirror image.
B) molecules that have at least one stereogenic center.
C) non-superposable molecules.
D) non-superposable constitutional isomers.
E) non-superposable molecules that are mirror images of each other.

6) How many stereogenic centers are in the following compound:

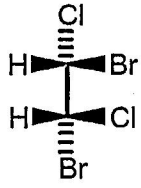


A) 1
B) 3
C) 4
D) 5
E) none of these choice

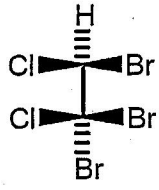
7) Which molecule is achiral?



I



II



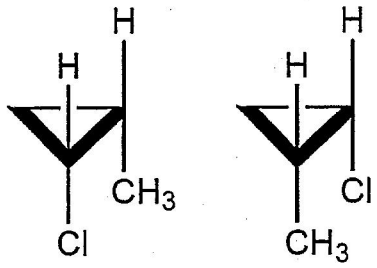
III

A) I
B) II
C) III
D) More than one of these choices.
E) None of these choice

8) What is the percent composition of a mixture of (S) -(+) -2-butanol, $[\alpha]_{25/D}$ = +13.52°, and(R)-(-) -2-butanol, $[\alpha]_{25/D}$ = -13.52°, with a specific rotation $[\alpha]_{25/D}$ = +6.76°?

A) 75%(R) 25%(S)
B) 25%(R) 75%(S)
C) 50%(R) 50%(S)
D) 67%(R) 33%(S)
E) 33%(R) 67%(S)

9) The molecules below are:

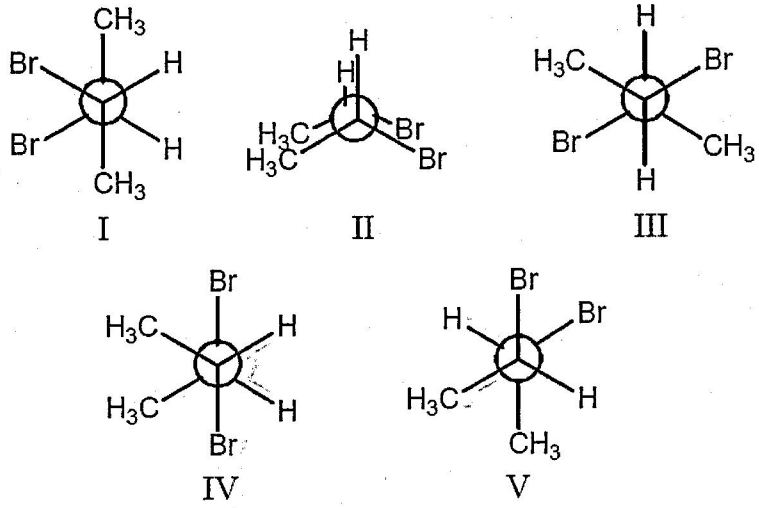


A) constitutional isomers.
B) enantiomers.
C) diastereomers.
D) identical.
E) None of these choice

10) Which is a *meso* compound?

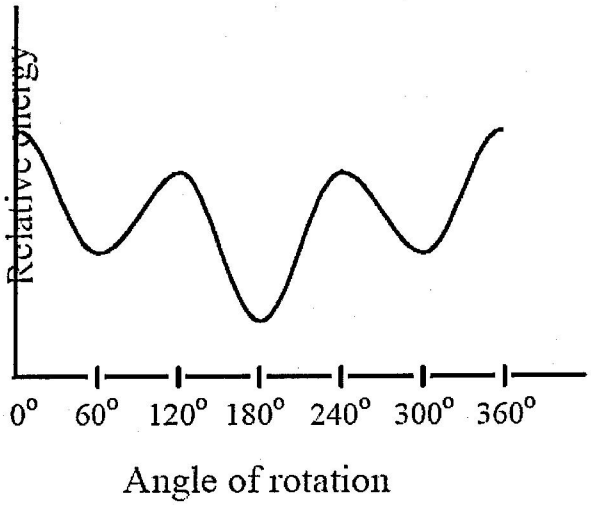
A) (2R,3R) -2,3-Dibromobutane
B) (2R,3S) -2,3-Dibromopentane
C) (2R,4R) -2,4-Dibromopentane
D) (2R,4S) -2,4-Dibromopentane
E) (2R,4S) -2,4-Dibromohexane

11) The most stable conformation of 2,3-dibromobutane, viewed through the C-2-C-3 bond :



A) I B) II C) III D) IV E) V

12) Consider the graph below, which is a plot of the relative energies of the various conformations of hexane, viewed through the C-2-C-3 bond. The conformations corresponding to the 60° and 300° are:



A) eclipsed

B) staggered and *gauche*

C) staggered and *anti*

D) more stable than the conformation at 180°

E) none of these choices

13) What is the index of hydrogen deficiency (or degree of unsaturation) of a compound with the molecular formula of $C_{14}H_{14}Cl_4$?

A) 3

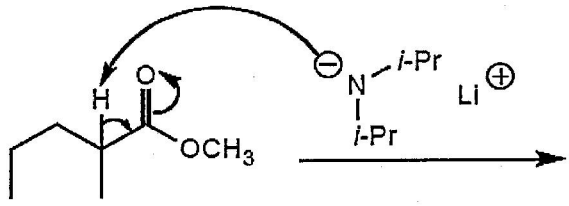
B) 4

C) 5

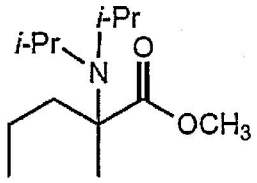
D) 6

E) 7

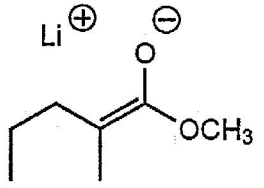
14) What is/are the product(s) of the following acid-base mechanism?



A)

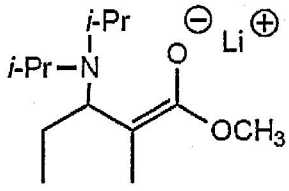


B)

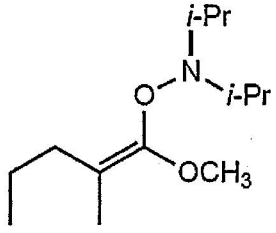


+ $(i\text{-Pr})_2NH$

C)



D)



E) None of these choices.

15) Which of the following correctly lists the compounds in order of decreasing acidity?

A) $H_2O > HC{\equiv}CH > NH_3 > CH_3CH_3$

B) $HC{\equiv}CH > H_2O > NH_3 > CH_3CH_3$

C) $CH_3CH_3 > HC{\equiv}CH > NH_3 > H_2O$

D) $CH_3CH_3 > HC{\equiv}CH > H_2O > NH_3$

E) $H_2O > NH_3 > HC{\equiv}CH > CH_3CH_3$

16) Which base would **not** effectively deprotonate acetylene?

A) $LiOCH_3$

B) CH_3Li

C) CH_3OCH_2MgBr

D) KH

E) $(CH_3)_2NLi$

17) Which alkane is predicted to have the highest melting point of those shown?

A) *n*-butane

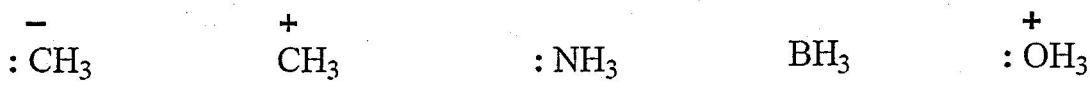
B) isobutane

C) *n*-pentane

D) isopentane

E) *tert*-pentane

18) Which of the following would have a trigonal planar (or triangular) structure?



I　　II　　III　　IV　　V

A) I, II, and IV

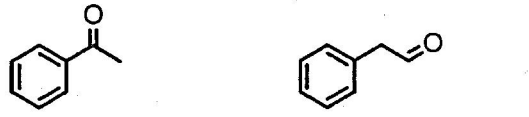
B) II and IV

C) IV

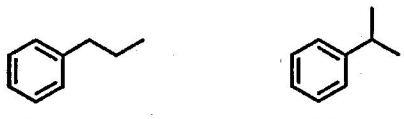
D) II, IV, and V

E) All of these choices.

19) An organic compound absorbs strongly in the IR at 1687 cm^{-1}. Its ^1H NMR spectrum consists of two signals, a singlet at 2.1 ppm and a multiplet centered at 7.1 ppm. Its mass spectrum shows significant peaks at m/z 120, m/z 105 and m/z 77. This information is consistent with which of the following structures?



I　　II　　III



IV　　V

A) I　B) II　C) III　D) IV　E) V

20) An unsaturated product results from the reaction of cyclohexene with which of these?

A) Br_2/CCl_4 at 25°C
B) NBS/CCl_4, ROOR
C) HCl, ROOR
D) HCl, no peroxides
E) More than one of these choices.