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 115 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系
丙組(應用化學組)

科目代碼：2901

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. 提早交卷者不可攜出試題，請將試題連同答案卷(卡)交予監考人員，攜出將以違規論處。當節考試結束後試題將置於講台，可自行取回，本試場不負保管責任。
7. 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。

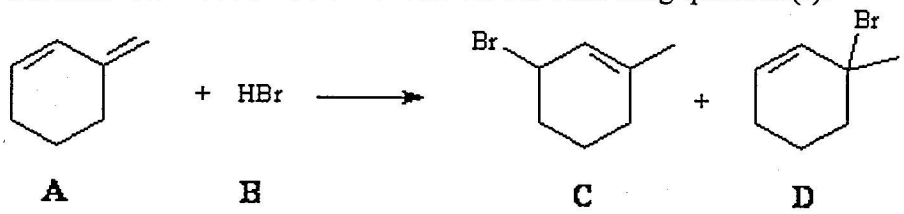
國立清華大學 115 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系碩士班 丙組(應用化學組)

考試科目（代碼）：有機化學 (2901)

Part 1 簡答題 (78%)

1. Consider the reaction below to answer the following question(s):



(a) The nucleophile in this reaction is ____. (1%)

(b) The electrophile in this reaction is ____. (1%)

(c) The kinetically controlled product in this reaction is _____. (1%)

(d) The product that results from 1,4-addition is _____. (1%)

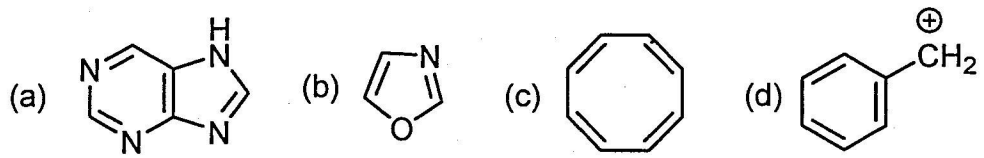
(e) Write a stepwise mechanism that accounts for both of the products shown. Show all intermediate structures and electron flow with arrows. (6%)

2. Draw the mechanism of the bromination of 2-ethyl-1,3-pentadiene. (6%)

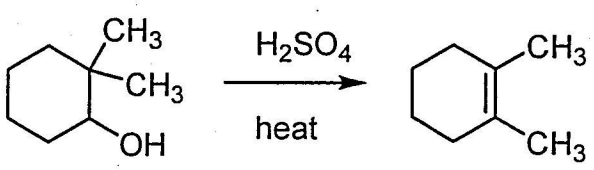
3. Draw resonance contributors for the following species, showing all the lone pairs:. (9%)

(a) CH_2N_2　　(b) N_2O　　(c) $NO2^-$

4. Discuss possible aromaticity in each of the following. (6%)

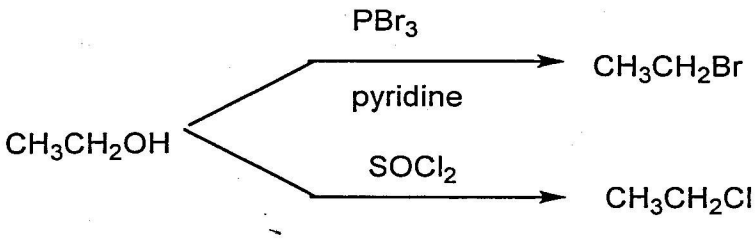


5. Propose a detailed, step-by-step mechanism for the reaction pathway shown below. (6%)



6. Provide a reasonable synthetic strategy for the synthesis of a racemic mixture of (1*R*,2*R*) and (1*S*,2*S*)-2-bromo-1-methylcyclopentanol from methylcyclopentane: (6%)

7. Identify the structures of the main products of the following reactions by giving curly arrow mechanisms. (6%)

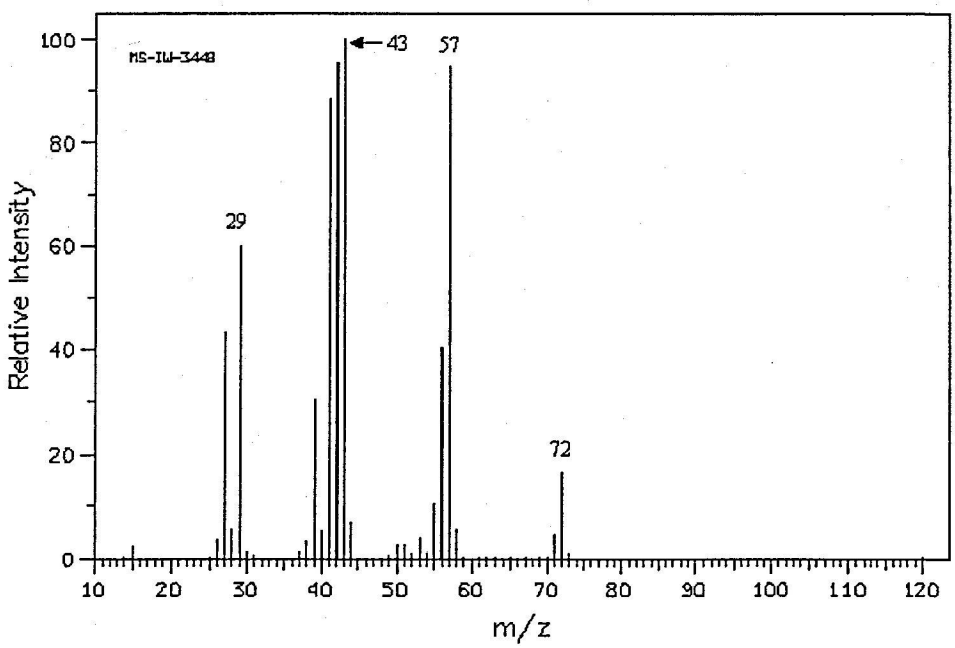


8. Draw the mechanism of the Diels–Alder reaction between propenal and 2-methyl-1,3-butadiene. (5%)

9. Draw the MO energy diagram for the cycloheptatrienyl anion and classify the anion as aromatic or antiaromatic. (6%)

10. How would you convert 1-butene to 1-hexanol?. (4%)

11. Refer to the mass spectrum of 2-methylbutane shown below to answer the following question (s). (6%)



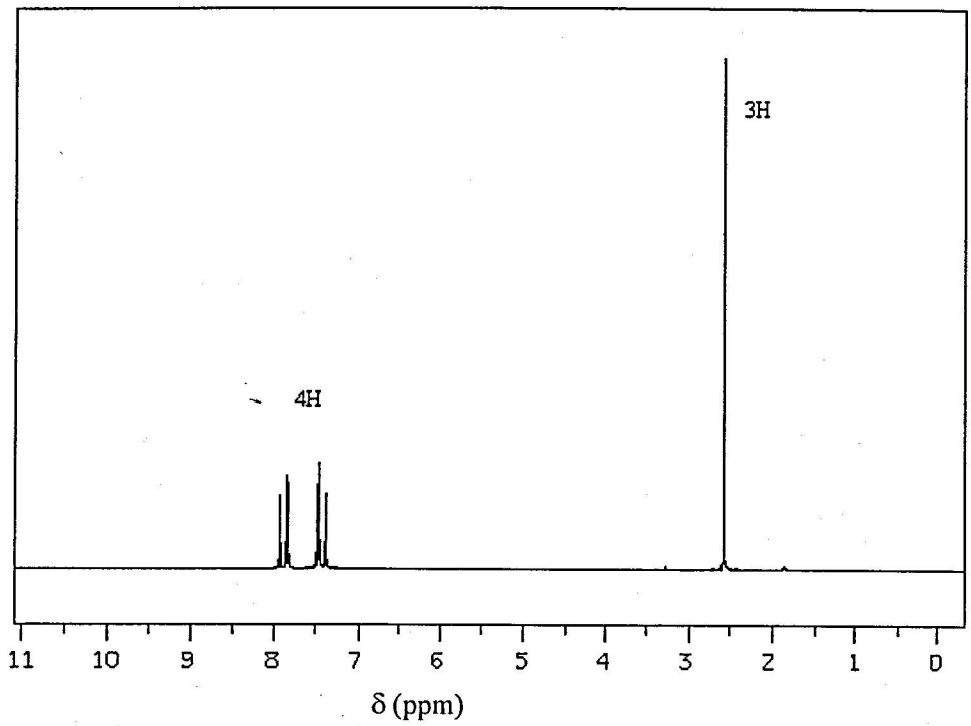
(a)

(a)What peak represents M^+?

(b) What peak represents the base peak?

(c) Propose structures for fragment ions at *m/z* = 57, 43, and 29.

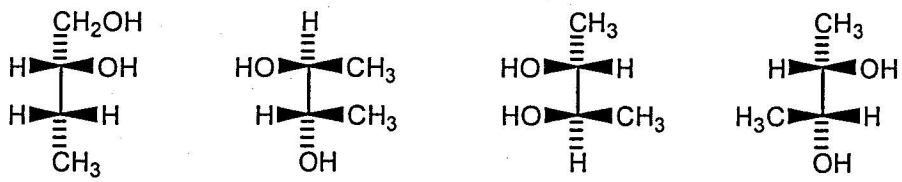
12. Referring to the following NMR spectrum for C_8H_7ClO, answer the questions. (8%)



(a) Calculate the degree of unsaturation in this compound.
(b) Describe the signals that occur between 7 and 8 δ in terms of integration, splitting and chemical shift.
(c) Describe the signal at 2.6 δ in terms of integration, splitting and chemical shift.
(d) Propose a structure for this compound.

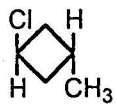
Part 2 單選題 (22%, **2% each**)

1) Which compound (I-IV) is (2*R*,3*R*)-2,3-butanediol?



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

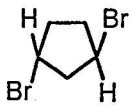
2) Which of the following substances is/are achiral?



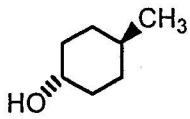
I



II



III



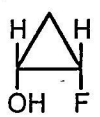
IV

a) I
b) II
c) III
d) IV
e) More than one of these choices.

3) Which of the following molecules is achiral?

a) (2*R*,3*R*)-2,3-Dichloropentane
b) (2*R*,3*S*)-2,3-Dichloropentane
c) (2*S*,4*S*)-2,4-Dichloropentane
d) (2*S*,4*R*)-2,4-Dichloropentane
e) Two of these choices.

4) Which molecule is a meso compound?



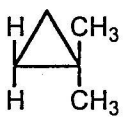
I



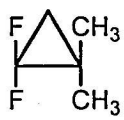
II



III



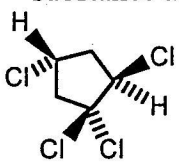
IV



V

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

5) The Cahn-Ingold-Prelog stereochemical designations used for the following substance are:



a) 2*R*,4*S*
b) 2*S*,4*R*
c) 2*R*,4*R*
d) 2*S*,4*S*
e) The "*R*,*S*" terminology doesn't apply in this case.

6) The atomic number of boron is 5. The correct electronic configuration of boron is

a) $1s^2\ 2s^3$.

b) $1s^2\ 2p^3$.

c) $1s^2\ 2s^2\ 2p^1$.

d) $2s^2\ 2p^3$.

e) $1s^2\ 2s^2\ 3s^1$.

7) Identify the compound with the highest pK_a.

a) CH_3NH_2

b) CH_3OH

c) CH_3COOH

d) H_2O

e) $CH_3NH_3^+$

8) The K_{eq} for the interconversion for the two chair forms of methylcyclohexane at 25 °C is 18. What % of the chair conformers feature an axial methyl group?

a) 95

b) 75

c) 50

d) 25

e) 5

9) Identify the compound where the groups are axial and equatorial.

a) *trans*-1,4-dibromocyclohexane

b) *cis*-1,4-dibromocyclohexane

c) *cis*-1,3-dibromocyclohexane

d) *trans*-1,2-dibromocyclohexane

e) none of the above

10) An increase in which of the following will occur if the reaction temperature is increased?

I. Energy of activation

II. Collision frequency

III. Fraction of collisions with sufficient energy

a) I and II

b) I and III

c) II and III

d) I, II, and III

e) I

11) What is the major product from the acid-catalyzed hydration of 2-methyl-2-pentene?

a) 2-methylpentane

b) 2-methyl-1-pentanol

c) 2-methyl-2-pentanol

d) 2-methyl-3-pentanol

e) 1-methoxypentane