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 114 學年度碩士班考試入學試題

系所班組別：生命科學暨醫學院
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。

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考試科目（代碼）：有機化學(0502、0706)

　　*請在【答案卷】作答

Part 1 簡答題 (70%)

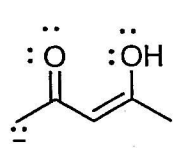
1. Deduce the identity of the compound from the data provided. **(4%)**

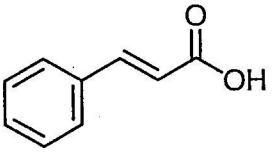
   C_3H_6O: IR (cm^{-1}): 3050, 2820, 2720, 1750 (deep)

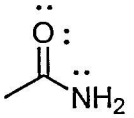
   ^1H NMR(δ): 1.3 (t, 3H), 2.0 (m, 2H), 2.8 (broad s, 1H),10.0 (t, 1H)

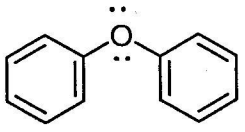
2. How would you use mass spectrometry to quickly distinguish between the benzyl bromide and 2-chloromethyl benzene carboxylic acid that have the same molecular mass? **(6%)**

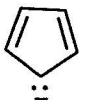
3. Draw the resonance contributors for the following: **(10%)**

a. 

c. 

e. 

b. 

d. 

4. Are the following pairs identical, enantiomers, diastereomers, or constitutional isomers? **(12%, 1.5% each)**

國立清華大學 114 學年度碩士班考試入學試題

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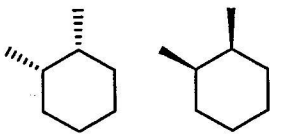
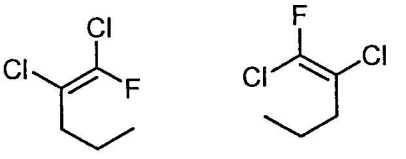
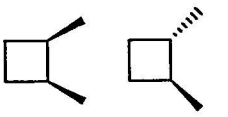
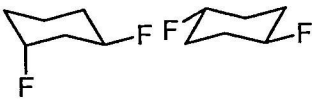
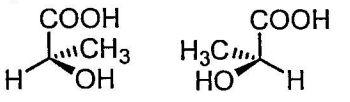
考試科目（代碼）：有機化學(0502、0706)

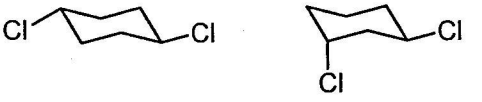
A) 

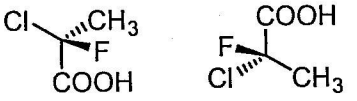
B) 

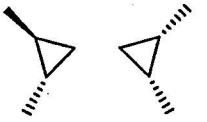
C) 

D) 

E) 

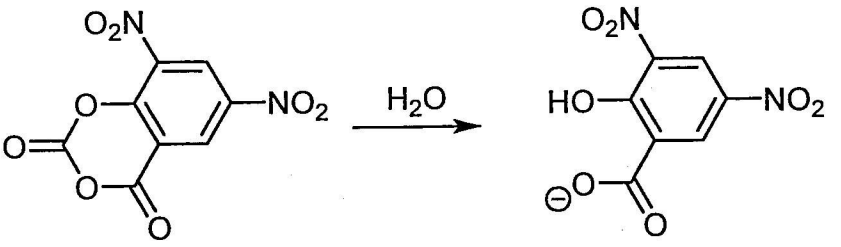
F) 

G) 

H) 

5. Predict the number of signals expected, their splitting, and their relative area in the ^{1}H NMR spectrum of $CH_3CClHCH_3$. **(2%)**

6. Provide the mechanism for the reaction shown below. **(6%)**



國立清華大學 114 學年度碩士班考試入學試題

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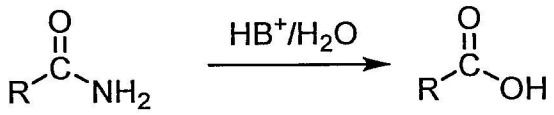
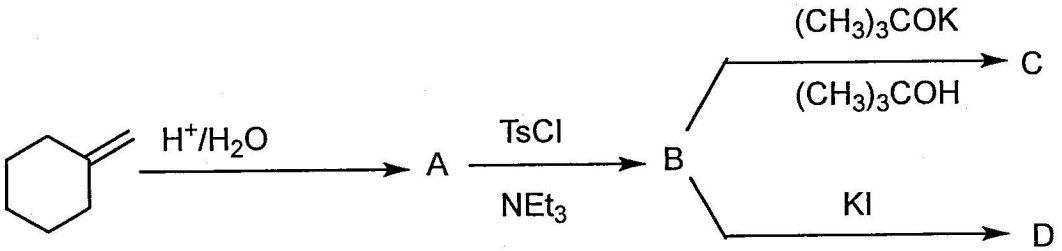
考試科目（代碼）：有機化學(0502、0706)

7. Provide the 6-step hydrolysis mechanism for the hydrolysis of amide. **(6%)**



8. Draw newman projections for all stereoisomers of 1-fluoro-3-isopropylcyclohexane, giving stereochemical details for each structure. **(6%)**

9. Complete the following reaction sequence, giving structures for compounds A, B, C and D: **(6%)**



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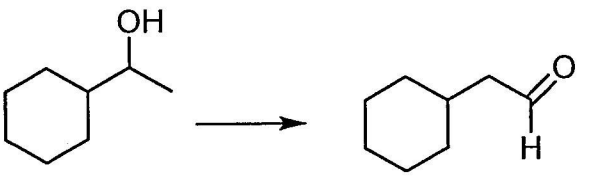
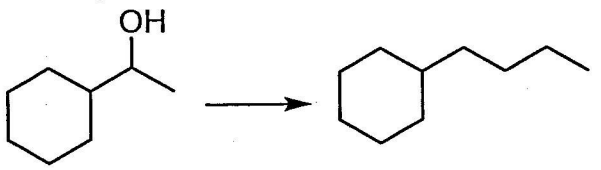
10. For each of the following target molecules, design a multistep synthesis to show how it can be prepared from the given starting material: **(6%)**

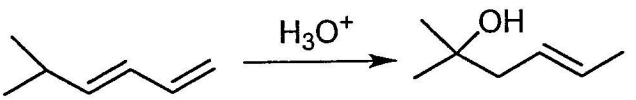
a)



b)



11. Propose a mechanism for the following transformation: **(6%)**



Part 2 單選題 (30%, 1.5% each)

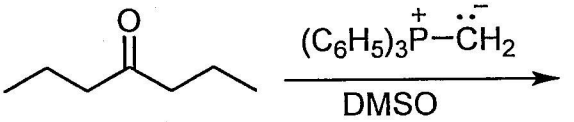
1. Which of the following correctly lists the compounds in order of decreasing basicity?

A) H2O > HC≡CH > NH3 > CH3CH3
B) HC≡CH > H2O > NH3 > CH3CH3
C) CH3CH3 > NH3 > HC≡CH > H2O
D) CH_3CH_3 > HC≡CH > H_2O > NH_3

2. Which alkane is predicted to have the lowest melting point of those shown?

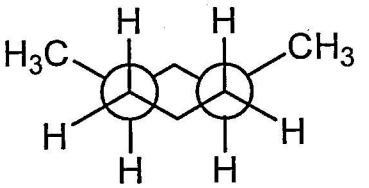
A) *n*-butane
B) isobutane
C) *n*-pentane
D) isopentane

3. What is the product of the reaction below?



A) 2-propyl-1-heptene　　C) 2-propyl-1-pentene
B) 2-methyl-2-pentyloxirane　　D) 4-heptene

4. The IUPAC name of the following compound is



A) *cis*-1,2-dimethylcyclohexane. B) *trans*-1,2-dimethylcyclohexane.
C) 1,1-dimethylcyclohexane. D) *cis*-1,3-dimethylcyclohexane.

5. The bond dissociation enthalpies ($-\Delta H^{\circ}$) of C-H of methane and ethane are 105.0 and 101.1 kcal/mol, respectively. Which statement is true?
   (A) If ignoring C-C bond effects, C-H of methane is 6.0 kcal/mol more stable than that of ethane.
   (B) If ignoring C-C bond effects, C-H of ethane is 6.0 kcal/mol more stable than that of methane.
   (C) Stabilities can be compared since they have different enthalpies.
   (D) Stabilities cannot be compared since they give different combustion products.

6. Which of the following is the electronic configuration of the element Co?

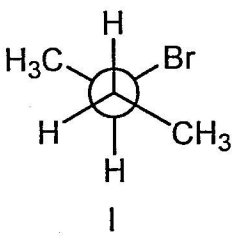
   A) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^6 4p^1$

   B) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 4p^6 3d^1$

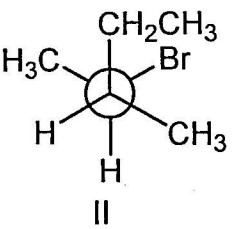
   C) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^6$

   D) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^8\ 4s^1\ 3d^6$

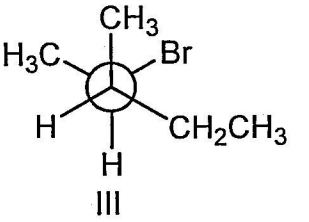
7. In the dehydrohalogenation of 2-bromo alkanes below, which conformation below leads directly to the formation of *trans*-2-alkene



I



II



III

A) only I　　B) only II　　C) only III　　D) I and III.

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8. Identify the least electronegative atom.

   A) O

   B) S

   C) Se

   D) Te

9. A molecule of acetonitrile HNO_3 contains _____ sigma bonds and _____ pi bonds

   A) 2, 2

   B) 5, 2

   C) 4, 3

   D) 4, 2

10. What is the predicted shape, bond angle, and hybridization for $^{-}CH_3$?

   A) trigonal planar, 109.5°, sp^3

   B) trigonal planar, 109.5°, sp^2

   C) trigonal pyramidal, 107°, sp^3

   D) trigonal planar, 120°, sp^2

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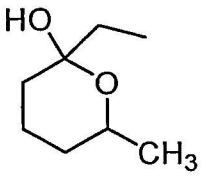
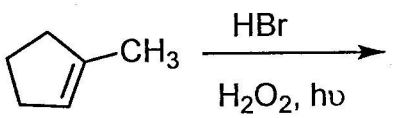
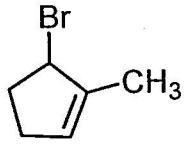
11. The compound shown below is the cyclic hemiacetal of

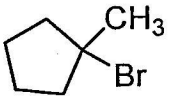


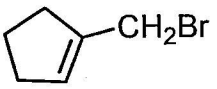
A) 5-hydroxy-2-heptanal.　C) 2-hydroxy-5-heptanone.
B) 7-hydroxy-3-octanone.　D) 6-hydroxyheptanal.

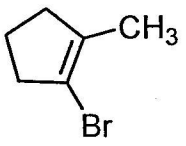
12. What is the major product of the following reaction?



A) 

B) 

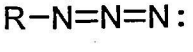
C) 

D) 

13. Which of the following spectroscopic techniques uses the highest energy of the electromagnetic radiation spectrum?

A) UV　B) NMR　C) IR　D) X-ray

14. The formal charges on the two nitrogens from left in the following structures are, respectively



A) +1, -1　B) 0, -1　C) +1, 0　D) 0, +1

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15. In the electromagnetic spectrum, _____ frequencies, _____ wavenumbers, and _____ wavelengths are associated with low energy

A) high, small, short　B) low, small, short,　C) high, large, short　D) high, small, long

16. Esters and amides are most easily made by nucleophilic acyl substitution reactions on

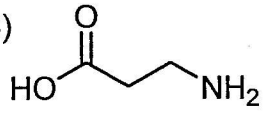
A) alcohols　B) carboxylic acids　C) carboxylates　D) acid sulfonates

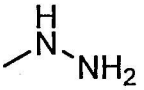
17. A decrease in conjugation is correlated with _____ in the energy of the LUMO, _____ in the energy of the HOMO, and _____ in l_{max}.

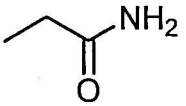
A) a decrease, an increase, an increase　B) a decrease, an increase, a decrease　C) an increase, an increase, a decrease　D) an increase, a decrease, a decrease

18. Which of the following compounds is an amino acid analog?

A) 

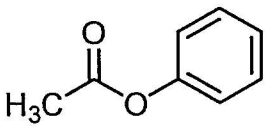
C) 

B) 

D) 

19. Which halogen forms the strongest bond to carbon?
A) F　B) Cl　C) Br　D) I

20. What is the IUPAC name for the following compound?



A) methyl benzoate　B) phenyl acetate　C) methyl phenylacetate　D) benzyl acetate