國立清華大學 106 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(0602、0806)

　　*請在【答案卷】作答

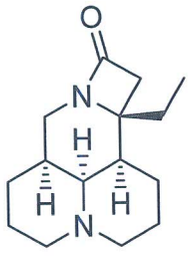
Part 1 簡答題 **(70%)**

1. Please rank the following acyl derivatives from low to high base on their reactivity as electrophiles toward hydroxide ion. **(4%)**

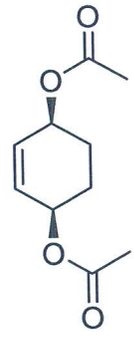
A　　**B**　　**C**　　**D**

2. Please label each stereocenter with * and its ***R*** or ***S*** configuration. **(4% each)**

(a)



(b)



3. Please predict the product of the following reaction. **(6%)**

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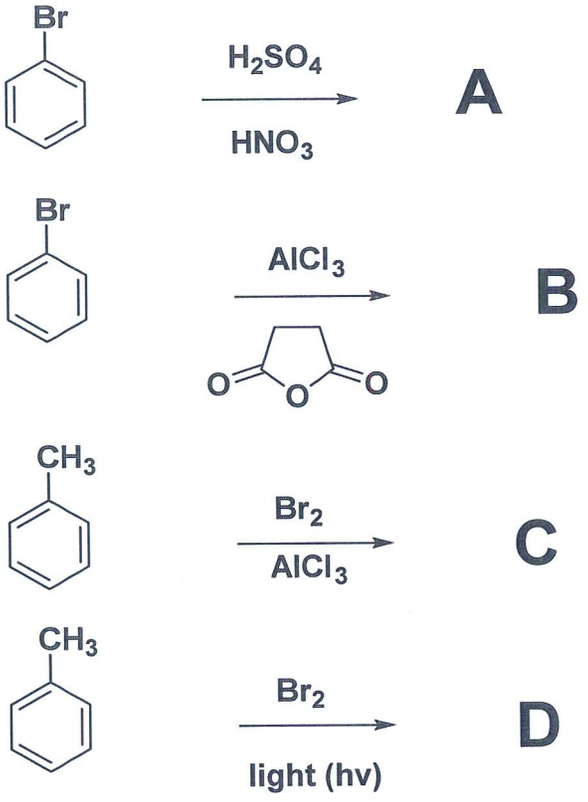
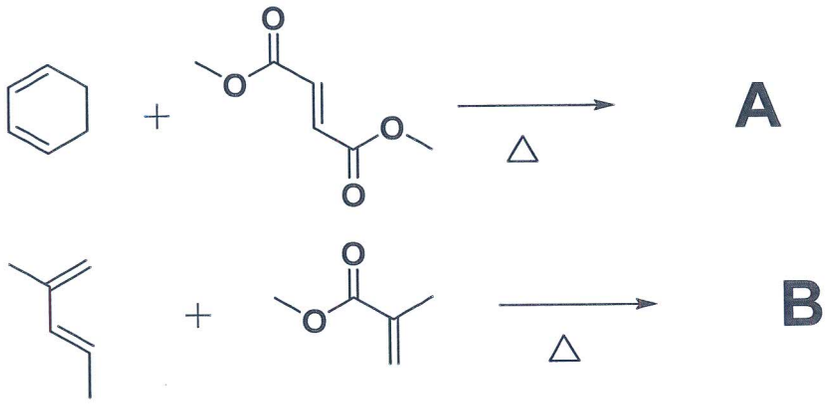
4. Please predict the product of the following reaction. **(3% each)**



5. Please draw the structure of the major product of the reaction. **(4% each)**



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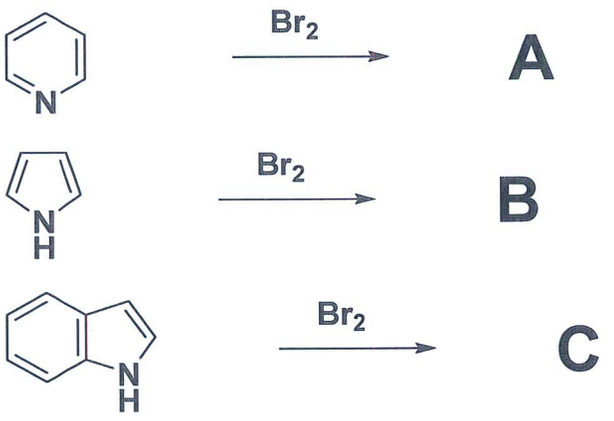
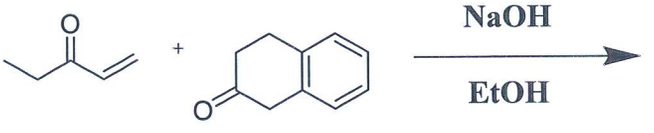
6. Please draw the structure of the major product of each reaction. **(3% each)**



7. Please predict the final product and provide detailed reaction mechanism. **(6%)**



8. Please propose a mechanism of the following reaction. **(5%)**

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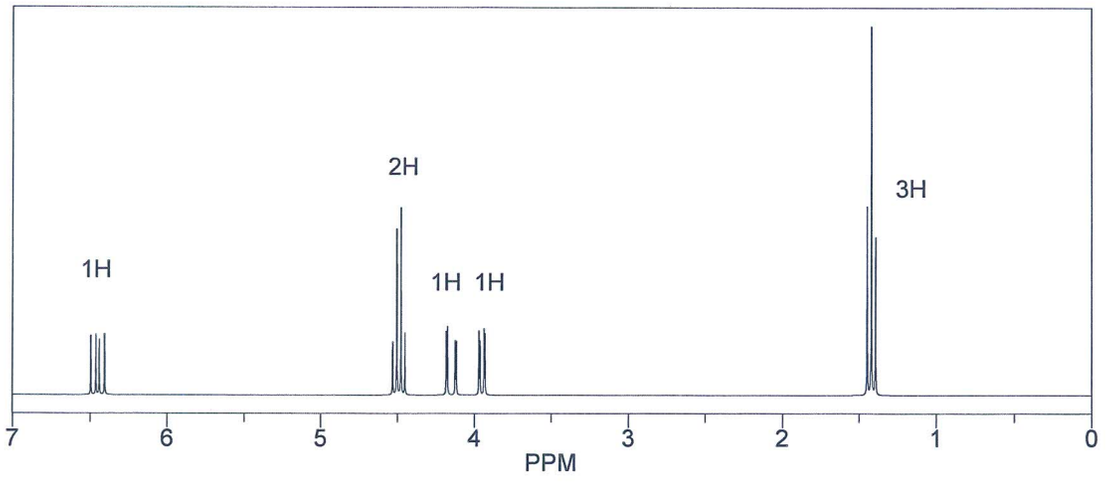
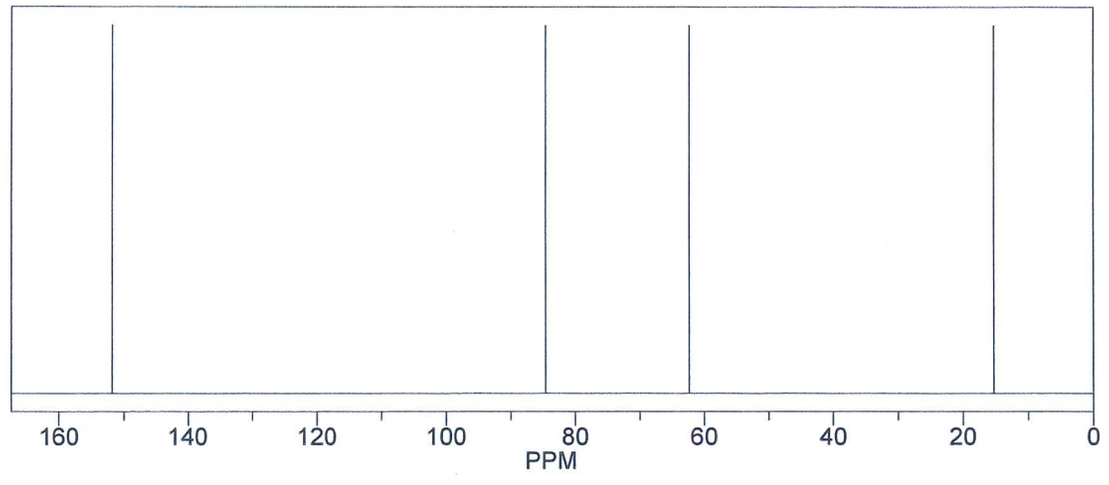
9. The ^{1}H and ^{13}C NMR spectra of a compound with the molecular formula C_4H_8O are shown below. Use the spectra to propose a structure for this compound with explanation in detail. **(6%)**

^{1}H NMR



^{13}C NMR



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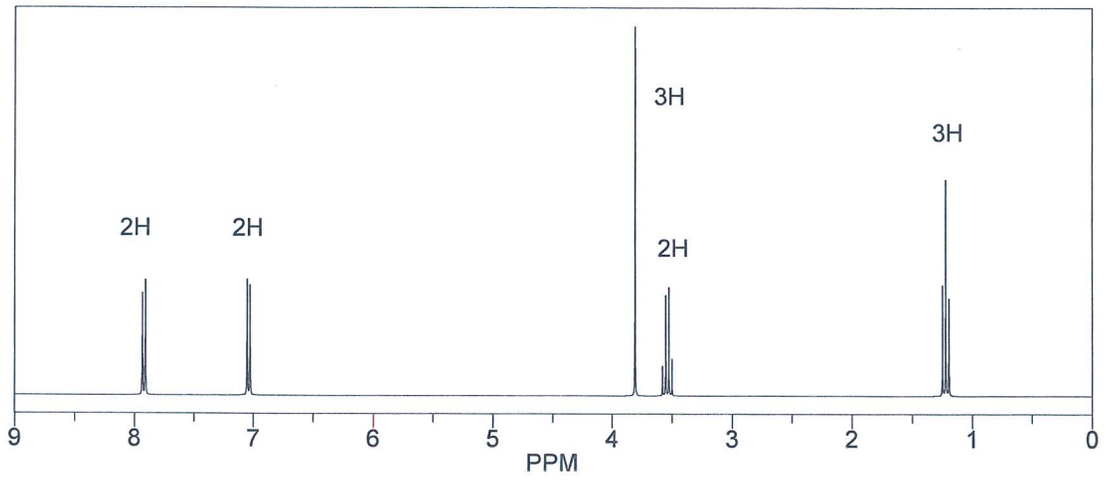
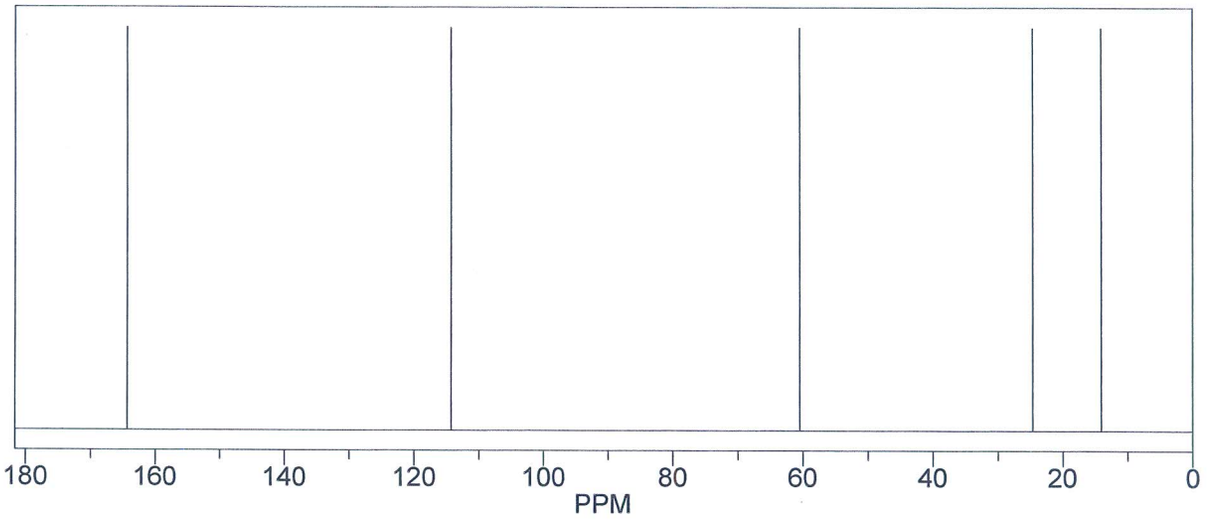
10. This compound has the molecular formula $C_{10}H_{12}O_2$. Following are the ^1H NMR and ^{13}C NMR spectra. Use the spectra to propose a structure for this compound with explanation in detail. **(6%)**

^1H NMR



^{13}C NMR



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Part 2 單選題 **(30%, 1.5% each)**

1. Which of the following terms describes backbone structure of DNA?
   (A) Sugar glycosides
   (B) Pairs of complementary bases
   (C) Polyphosphate esters of 1,3-glycols
   (D) Pyrophosphates

2. What is the mechanism of RNA backbone hydrolysis?
   (A) E_1
   (B) E_2
   (C) SN_1
   (D) SN_2

3. Which of the following chemicals are suitable *N*-protected glycines useful in peptide synthesis?
   I. $C_6H_5(C{=}O)NHCH_2COOH$
   II. $C_6H_5O(C{=}O)NHCH_2COOH$
   III. $(CH_3)_3C(C{=}O)NHCH_2COOH$
   IV. $(CH_3)_3CO(C{=}O)NHCH_2COOH$
   (A) I, II
   (B) I, III
   (C) II, III
   (D) II, IV

4. Arrange the following compounds according to <u>increasing order</u> of acidity of indicated carboxyl groups underlined.
   I. $CH_3\underline{C}OOH$
   II. $CH_3(C{=}O)NHCH_2\underline{C}OOH$
   III. $H_2NCH_2\underline{C}OOH$
   (A) I, II, III
   (B) II, III, I
   (C) III, II, I
   (D) I, III, II

5. How many triglycerides (including stereoisomers) are possible that have 2 different acyl groups?
   (A) 2
   (B) 3
   (C) 4
   (D) 5

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6. Which of the following reactions will proceed under normal condition?

I. $CH_3NH_2 + H_2O \rightarrow CH_3N^+H_3 + {}^-OH$

II. $CH_3NH_2 + CH_3COOH \rightarrow CH_3N^+H_3 + CH_3COO^-$

III. $CH_3NH_2 + (CH_3)_3N \rightarrow CH_3N^-H + (CH_3)_3N^+H$

IV. $CH_3NH_2 + C_6H_5N^-H \rightarrow CH_3N^-H + C_6H_5NH$

(A) I, II　　(B) I, III

(C) II, IV　　(D) III, IV

7. Arrange the following compounds with <u>decreasing order</u> of boiling point.

I. $C_6H_5(C{=}O)CH_3$　　**II.** $C_6H_5C(CH_3)HOH$

III. $C_6H_5CO_2H$　　**IV.** $C_6H_5CO_2^-Na^+$

(A) I, II, III, IV　　(B) II, III, IV, I

(C) III, IV, II, I　　(D) IV, III, II, I

8. Compound **X** has a strong sharp peak at 1,700 cm^{-1} and a week band at 2,700 cm^{-1}. Its proton NMR spectrum has signals at 7.0 ppm and 9.5 ppm in addition to other signals. What is the most like structure of X?

(A) $(C_6H_5)_2C{=}O$　　(B) CH_3CH_2CHO

(C) C_6H_5CHO　　(D) $CH_3CH_2(C{=}O)CH{=}CH_2$

9. How many carbon resonance are there in ^{13}C NMR spectrum of *p*-$HO(C_6H_4)CH_3$?

(A) 6　　(B) 5

(C) 4　　(D) 3

10. What is index of hydrogen deficiency for a compound having a molecular formula of $C_6H_6N_2O$?

(A) 3　　(B) 4

(C) 5　　(D) 6

11. What is the base peak in mass spectrum expected for methylcyclopentane?

(A) 28　　(B) 43

(C) 57　　(D) 84

12. Which of the following statements characterize the reaction of *R*-3-chlorocyclopentene with sodium iodide in acetone?

I. The reaction involves a carbocation intermediate

II. The reaction involves inversion of configuration

III. The reaction involves retention of configuration

IV. The reaction gives predominately a racemic product

(A) I　　(B) II

(C) I, IV　　(D) I, III

13. How many stereoisomers can be formed from acid-catalyzed hydration of 4-methyl cyclohexene?

(A) 2　　(B) 4

(C) 6　　(D) 8

14. The specific rotation of dextrorotatory compound **Z** is +12.7 degrees. A mixture of dextrorotatory and levorotatory compound **Z** has a specific rotation of +6.35 degrees. What is optical purity of the mixture?

(A) 25%　　(B) 33.3%

(C) 50%　　(D) 75%

15. Which of the following compounds contain stereocenters?

I. Chlorocyclohexane　　**II.** 2-methylpentane

III. 2-hydroxypropanoic acid　　**IV.** 3-methyl-2-butanol

(A) I, II　　(B) III, IV

(C) I, III　　(D) II, IV

16. What is the bonding of the carbon-carbon bonds in 1,3-butadiene?

(A) s-s, p　　(B) sp^3-sp3, p-p

(C) s-p, sp^2-sp^2　　(D) sp^2-sp^2, π

17. Which of the following react with alkenes by a free radical mechanism?

I. H2
II. HBr/peroxides
III. CCl
IV. $Hg(OAc)_2/H_2O$
(A) I, II
(B) III, IV
(C) I, IV
(D) II, III

18. Which of the following alkenes show *cis-trans* isomerization?

I. 1-chloropropene
II. 3-methylcyclohexene
III. 2,6-dimethyl-2,5-octadiene
IV. 3-ethyl-3-methyl-1-pentene
(A) I, II
(B) II, III
(C) III, IV
(D) I, III

19. What is a reasonable explanation for the following observation?

H_3O^+ is a stronger acid than NH_4^+

I. Electronegativity
II. Resonance
III. Hybridization
(A) I, II
(B) I, III
(C) II
(D) I

20. Which of the following are more stable isomers?

I. *cis* or *trans* 1,4-dibromocyclohexane
II. *cis* or *trans* 1,3-dibromocyclohexane
(A) I *cis* and II *cis*
(B) I *cis* and II *trans*
(C) I *trans* and II cis
(D) I *trans* and II *trans*