

國立清華大學 105 學年度碩士班考試入學試題

系所班組別：生命科學院乙組、醫學生物科技學程

考試科目（代碼）：有機化學(0502、0706)

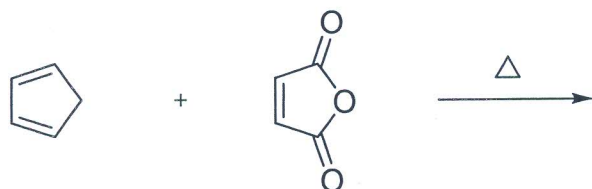
共 8 頁，第 1 頁

*請在【答案卷】作答

Part 1 簡答題

1. Please predict the product of the following reaction.

(6%)

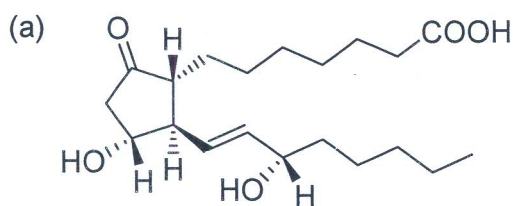


A endo-adduct

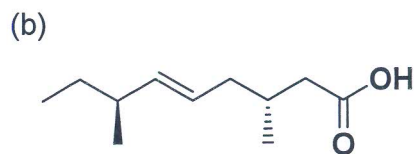
B exo-adduct

2. Please label each stereocenter with * and its R or S configuration.

(6%)

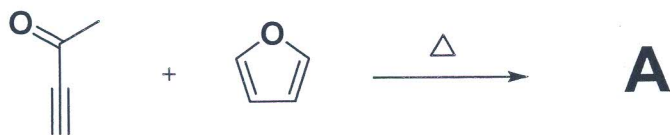


Prostaglandin E₁



3. Please predict the product of the following reaction.

(3 % each)



A



B



C



D

國立清華大學 105 學年度碩士班考試入學試題

系所班組別：生命科學院乙組、醫學生物科技學程

考試科目（代碼）：有機化學(0502、0706)

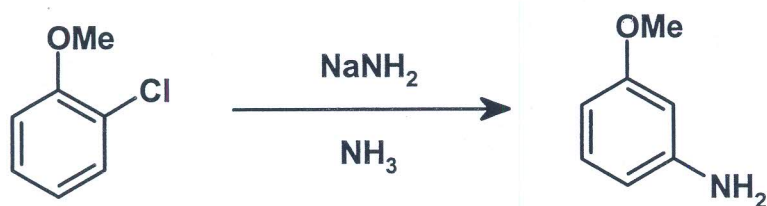
共 8 頁，第 2 頁

*請在【答案卷】作答

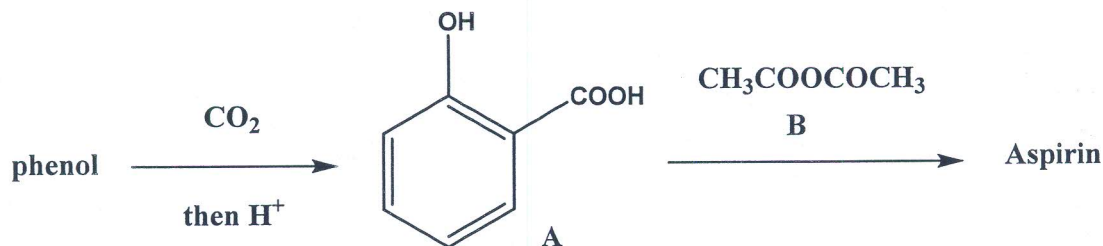
4. Cyclopentanone reacts with ethane-1,2-diol ($\text{HOCH}_2\text{CH}_2\text{OH}$) in the presence of acid to form a compound A, $\text{C}_7\text{H}_{12}\text{O}_2$. (9 %)

- (a) Give a structure for A.
- (b) Explain the role of the acid.
- (c) Provide a mechanism for the reaction.

5. Please provide the product and mechanism of the following reaction. (5%)



6. The following questions relate to the synthesis of aspirin, which is shown below. (15 %)



- (a) Draw the skeletal structure of phenol.
- (b) Give the IUPAC name for compound A.
- (c) Draw the skeletal structure for compound B.
- (d) Given that the IUPAC name of aspirin is 2-ethanoyloxybenzoic acid, draw the skeletal structure of aspirin.
- (e) Draw the skeletal structure of *p*-ethanoyloxybenzoic acid.

國立清華大學 105 學年度碩士班考試入學試題

系所班組別：生命科學院乙組、醫學生物科技學程

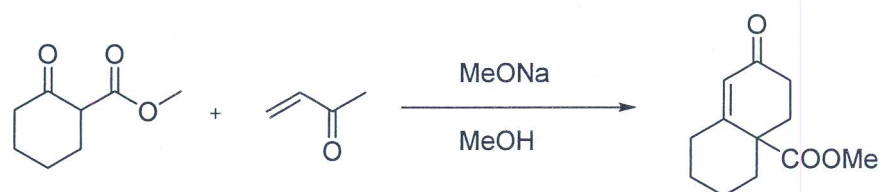
考試科目（代碼）：有機化學(0502、0706)

共 8 頁，第 3 頁

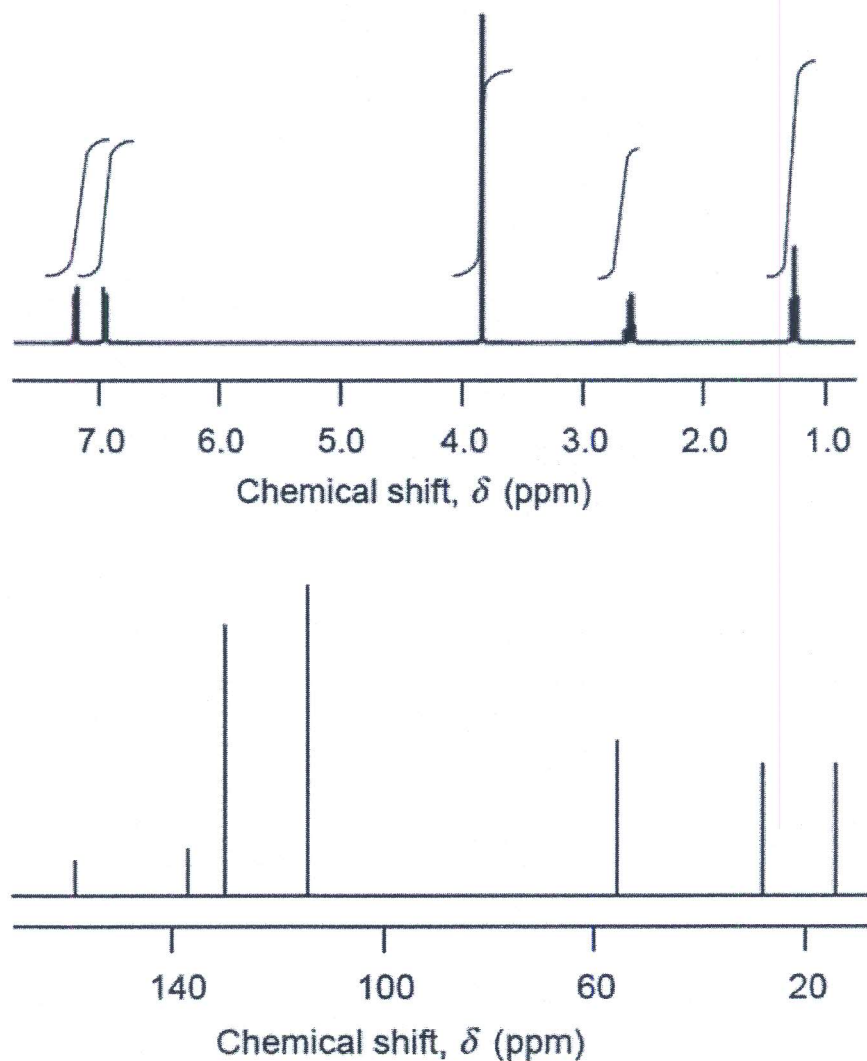
*請在【答案卷】作答

7. Please propose a mechanism of the following reaction.

(5 %)



8. The ^1H and ^{13}C NMR spectra of a compound with the molecular formula $\text{C}_9\text{H}_{12}\text{O}$ are shown below. Use the spectra to propose a structure for this compound: (6 %)



國立清華大學 105 學年度碩士班考試入學試題

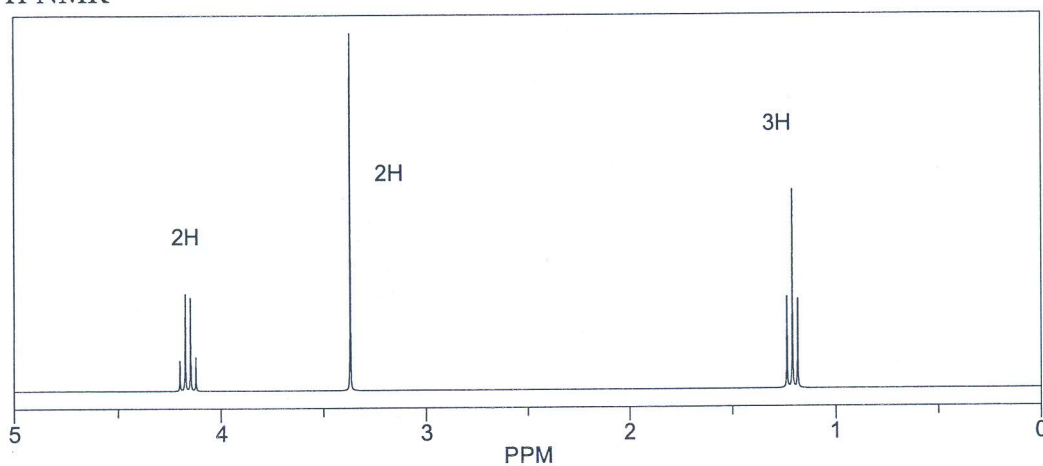
系所班組別：生命科學院乙組、醫學生物科技學程

考試科目（代碼）：有機化學(0502、0706)

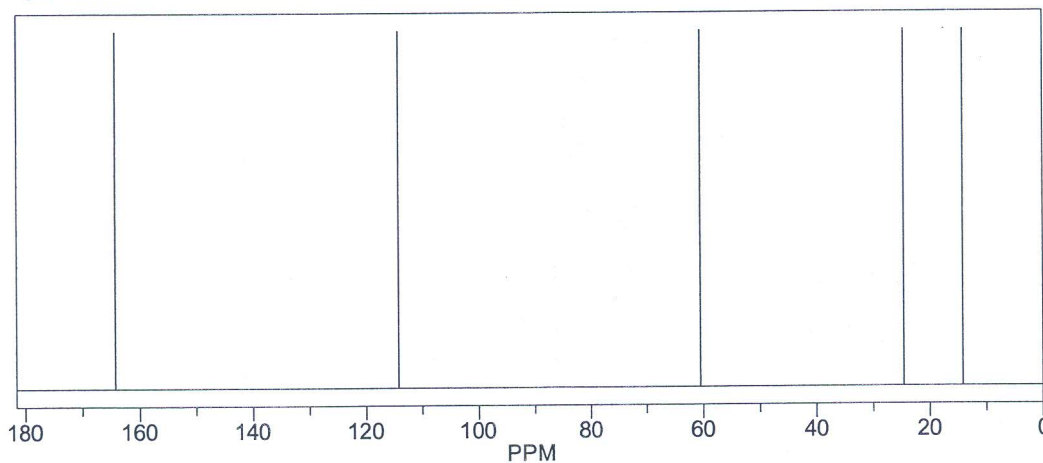
共 8 頁，第 4 頁 *請在【答案卷】作答

9. This compound has the molecular formula $C_5H_7NO_2$. Following are the 1H NMR, ^{13}C NMR and IR spectra. (6%)

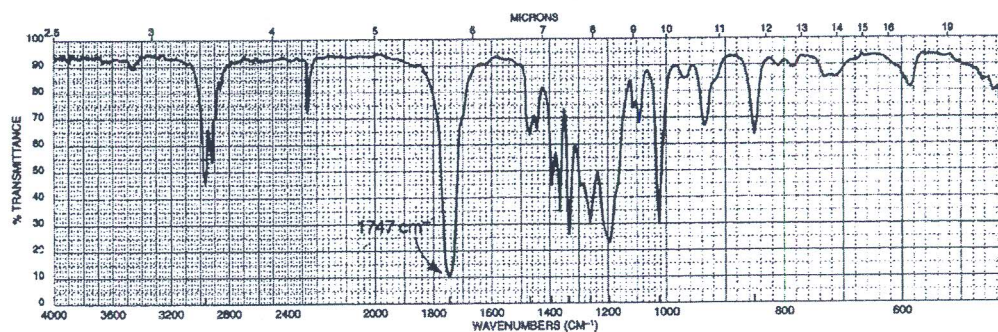
1H NMR



^{13}C NMR



IR



國立清華大學 105 學年度碩士班考試入學試題

系所班組別：生命科學院乙組、醫學生物科技學程

考試科目（代碼）：有機化學(0502、0706)

共__8__頁，第__5__頁 *請在【答案卷】作答

Part 2 單選題： Please select 1 answer from each of the following questions (30%, 1.5% each)

- Which of the following substances has a Lewis structure containing non-neutral atoms with charges?
(A) Acetamide (B) Cyclopropane (C) Ethylene oxide (D) Nitromethane
- Aspirin is known to be composed of 60.0% carbon, 4.4% hydrogen, and 35.6% oxygen with a molecular weight of 180. What is its molecular formula?
(A) $C_6H_{12}O_6$ (B) $C_7H_{16}O_5$ (C) $C_8H_4O_5$ (D) $C_9H_{10}O_4$
- 11.64 g compound **J** is burned in the presence of oxygen to give 34.2 g carbon dioxide and 21 g water. What is empirical formula for compound **J**?
(A) CH_4 (B) C_2H_6 (C) C_3H_8 (D) C_4H_{10}
- Based on NMR data, which of the following compounds has *t*-butyl group in structure?
(A) $C_3H_3Cl_5$ triplet, δ 4.52, 1H; doublet δ 6.07, 2H
(B) $C_{10}H_{14}$ singlet, δ 1.30, 9H; singlet, δ 7.28, 5H
(C) $C_{10}H_{13}Cl$ singlet, δ 1.57, 6H; singlet, δ 3.02; singlet, δ 7.27, 5H
(D) $C_3H_5Cl_3$ singlet, δ 2.20, 3H; singlet, δ 4.02, 2H
- How many pairs of eclipsed hydrogens are present in planar cyclobutane?
(A) 4 (B) 6 (C) 8 (D) 10
- Among 1-chloropentane, 1-chloro-2-methylpentane, 2-chloropentane, and 2-chloro-2-methylpentane how many structures have a chiral center?
(A) 1 (B) 2 (C) 3 (D) 4
- The blood of lobsters contains a blue copper porphyrin complex. The structure of Cu^{2+} pigment of octamethylporphyrin contains 2 primary amines. What charge does the complex have?
(A) 0 (B) 1 (C) 2 (D) 3

國立清華大學 105 學年度碩士班考試入學試題

系所班組別：生命科學院乙組、醫學生物科技學程

考試科目（代碼）：有機化學(0502、0706)

共 8 頁，第 6 頁

*請在【答案卷】作答

8. An unknown compound **K** rapidly decolorized a solution of bromine in CCl_4 . When **K** is subjected to ozonolysis, the products are butanone and propanol. What might be the structure of **K**?
- I. *cis*-2-methyl-3-hexene II. *cis*-3-methyl-3-hexene
III. *trans*-2-methyl-3-hexene IV. *trans*-3-methyl-3-hexene
- (A) I, II (B) I, III (C) II, IV (D) III, IV
9. Acetylene has an acid ionization constant (K_A) of $\sim 10^{-22}$. Calculate the concentration of acetylide ion expected to be present in a 14 M solution of potassium hydroxide that is 0.01 M in acetylene.
- (A) 1.4×10^{-7} (B) 1.4×10^{-8} (C) 1.4×10^{-9} (D) 1.4×10^{-10}
10. Arrange the following in increasing order of reactivity toward ring nitration.
- I. benzene II. toluene III. *p*-xylene IV. *m*-xylene
- (A) I, II, III, IV (B) I, II, IV, III (C) II, III, IV, I (D) III, IV, II, I
11. Which of the following chemical pairs may be distinguished by chromic anhydride test?
- (A) benzene and toluene
(B) bromobenzene and bromocyclohexane
(C) bromobenzene and 3-bromo-1-hexene
(D) ethylbenzene and benzyl alcohol
12. Ethyl chloride (0.1 M) reacts with potassium iodide (0.1 M) in acetone solution at 60 °C to give ethyl iodide and potassium chloride at a rate of 5.44×10^{-7} mole/liter/sec. If the reaction proceeds by an $\text{S}_{\text{N}}2$ mechanism, what is the rate of the reaction at 0.01 M of both reactants?
- (A) 5.44×10^{-7} (B) 5.44×10^{-8} (C) 5.44×10^{-9} (D) 5.44×10^{-10}

國立清華大學 105 學年度碩士班考試入學試題

系所班組別：生命科學院乙組、醫學生物科技學程

考試科目（代碼）：有機化學(0502、0706)

共 8 頁，第 7 頁

*請在【答案卷】作答

13. Optically pure 2-bromooctane has a specific rotation of -34.6° and optically pure 2-octanol has a specific rotation of -9.9° . Under S_N1 conditions 2-bromo octane of specific rotation -20.8° is found to yield 2-octanol of specific rotation $+3.96^\circ$. What is the percentage of racemization accompanying the reaction?
(A) 1/2 (B) 1/3 (C) 2/3 (D) 1/4
14. HCN has $pK_a = 9.21$; acetic acid has $pK_a = 4.76$. $\Delta G^\circ = -2.3 RT \log K_a$ (in which $2.3 RT = 1.36$) What is ΔG° for the following reaction (Kcal/mole)?
$$\text{HCN} + \text{CH}_3\text{CO}_2^- \rightarrow \text{CN}^- + \text{CH}_3\text{CO}_2\text{H}$$

(A) 1.36 (B) 4.45 (C) 4.60 (D) 6.05
15. Arrange in increasing order of reactivity of the following halides with aqueous alcoholic silver nitrates.
I. $\text{C}_6\text{H}_5\text{CH}_2\text{Br}$ II. $\text{CH}_3\text{C}_6\text{H}_4\text{Br}$ III. CH_3Br IV. $(\text{C}_6\text{H}_5)_2\text{CHBr}$
(A) II, III, I, IV (B) IV, II, I, III (C) II, I, IV, II (D) IV, III, II, I
16. An aromatic dibromide $\text{C}_7\text{H}_6\text{Br}_2$ reacts with aqueous sodium hydroxide. Only 1 bromo group is lost to give the product $\text{C}_7\text{H}_7\text{BrO}$. When the dibromide is converted to a Grignard reagent and then hydrolyzed, the product is toluene. What is the relationship between 2 substituents containing Br?
(A) *ortho* (B) *meta* (C) *para* (D) all of above
17. Compound **L**, C_5H_{10} , decolors a solution of Br_2 in carbon tetrachloride. When **L** is dissolved in cold, concentrated sulfuric acid and then heated with water, **M**, $\text{C}_5\text{H}_{12}\text{O}$ is formed. **M** reacts with chromic acid $\text{H}_2\text{Cr}_2\text{O}_7$ to give **N**, $\text{C}_5\text{H}_{10}\text{O}$. Both **M** and **N** give positive iodoform tests. The reaction mixture of the iodoform test also produces isobutyric acid $(\text{CH}_3)_2\text{CHCOOH}$. What is the structure of **N**?
(A) $\text{CH}_3(\text{CH}_2)_3\text{CHO}$ (B) $(\text{CH}_3)_2\text{CHCOCH}_3$
(C) $(\text{CH}_3\text{CH}_2)_2\text{CO}$ (D) $(\text{CH}_3)_3\text{CCHO}$

國立清華大學 105 學年度碩士班考試入學試題

系所班組別：生命科學院乙組、醫學生物科技學程

考試科目（代碼）：有機化學(0502、0706)

共__8__頁，第__8__頁

*請在【答案卷】作答

18. Arrange the following compounds in increasing order of basicity.

I. ethylamine

II. 2-aminoethanol

III. 3-amino-1-propanol

(A) I, II, III

(B) I, III, II

(C) II, III, I

(D) III, I, II

19. How many stereoisomers do you expect in methylethyl-*s*-butylsulfonium bromides?

(A) 1

(B) 2

(C) 3

(D) 4

20. Which of the following phenol derivatives has the strongest acidity?

(A) 2,4-dichloro

(B) 2,5-dichloro

(C) 2,6-dichloro

(D) 3,5-dichloro