# 國立清華大學 107 學年度碩士班考試入學試題

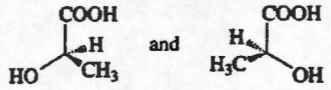
系所班組別：生命科學院乙組、丁組

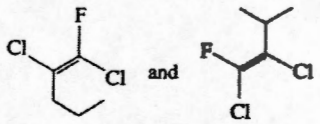
考試科目（代碼）：有機化學(0502、0706)

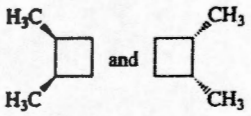


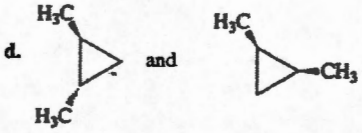
**Part 1 簡答題 (70%)**

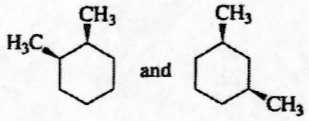
1. Are the following pairs identical, enantiomers, diastereomers, or constitutional isomers? **(1% each)**

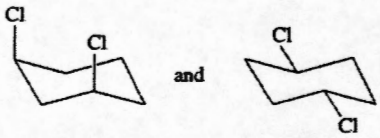
a. 

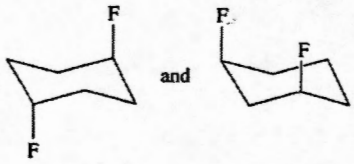
b. 

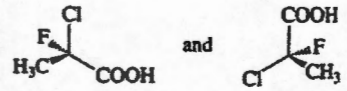
c. 

d. 

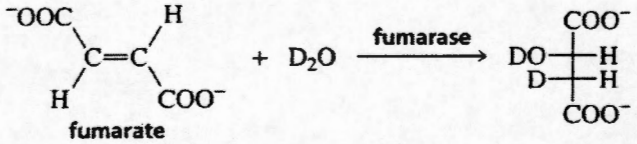
e. 

f. 

g. 

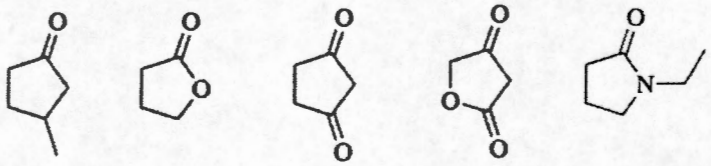
h. 

2. When fumarate reacts with $D_2O$ in the presence of the enzyme fumarase, only one isomer of the product is formed, as shown here. Is the enzyme catalyzing a syn or an anti addition of $D_2O$? **(4%)**




fumarate

3. Number the following compounds in order of increasing p$K_a$ value. (Number the most acidic compound 1.) **(4%)**



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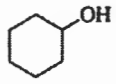
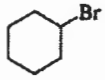
考試科目（代碼）：有機化學(0502、0706))

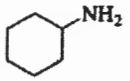


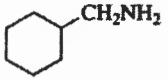
4. Using cyclohexanone as the starting material, describe how each of the following compounds can be synthesized: **(2% each)**

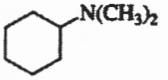
a. 

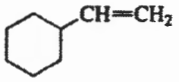

b. 

c. 


d. 


e. 


f. 

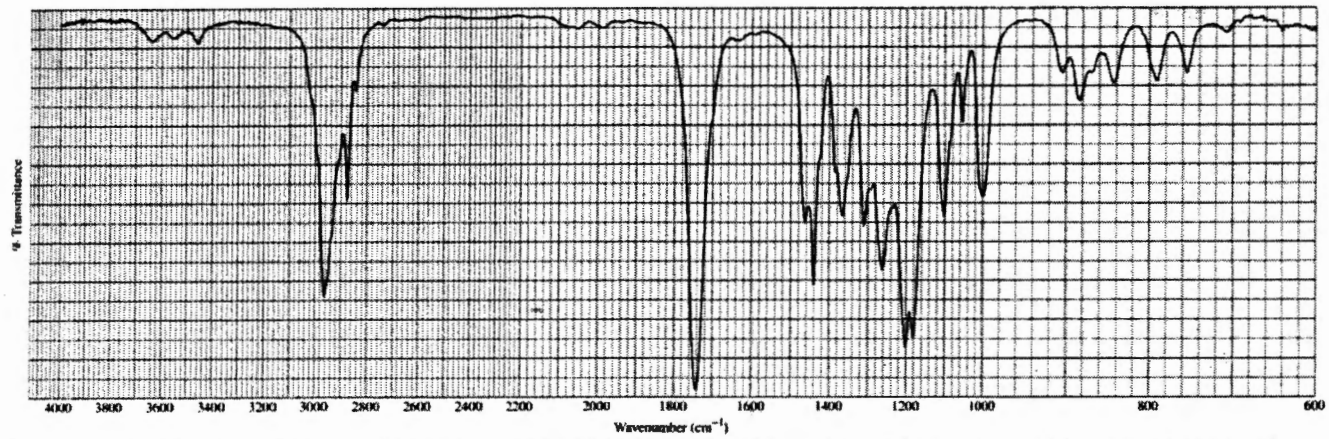

g. 

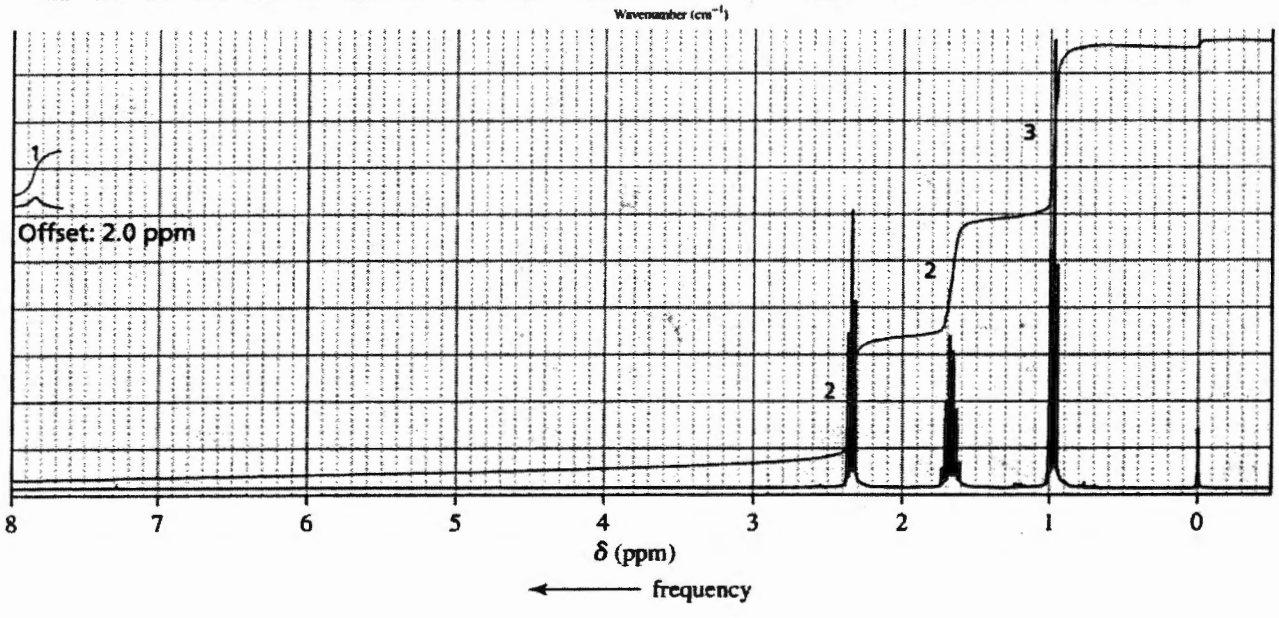

h.  (show two methods)

i. 

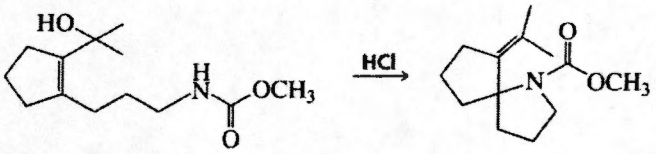
(show two methods)

5. A compound with molecular formula $C_5H_{10}O_2$ gives the following IR spectrum. When it undergoes acid-catalyzed hydrolysis, the compound with the $^1H$ NMR spectrum shown below is formed. Identify the compounds. **(6%)**

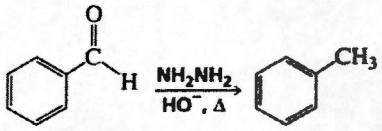


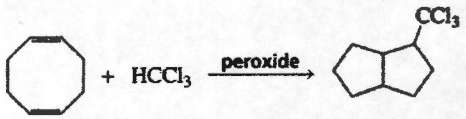
6. Propose a mechanism that accounts for the formation of the product. **(6%)**



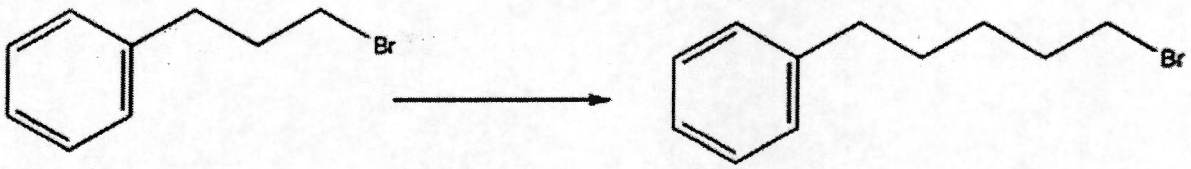

7. **a.** How could you use IR spectroscopy to determine whether the following reaction had occurred? **(3%)**
**b.** After purifying the product, how could you determine whether all the $NH_2NH_2$ had been removed? **(3%)**




8. Propose a mechanism for the following reaction: **(6%)**



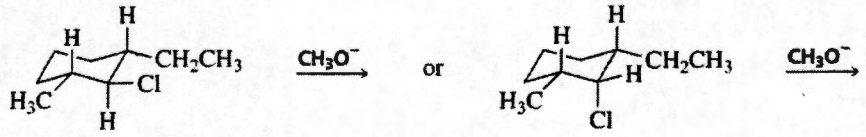

9. What reagents are needed to accomplish the multistep transformation shown below? **(4%)**



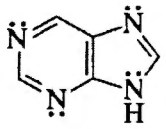

10. Which reactant in each of the following pairs undergoes an elimination reaction more rapidly? Explain your choice. **(2% each)**

**a.** $(CH_3)_3CI \xrightarrow{CH_3O^-}$ or $(CH_3)_3CCl \xrightarrow{CH_3O^-}$

**b.**



11. Purine is a heterocyclic compound with four nitrogen atoms.
**a.** Which nitrogen is most apt to be protonated? **b.** Which nitrogen is least apt to be protonated? **(2% each)**



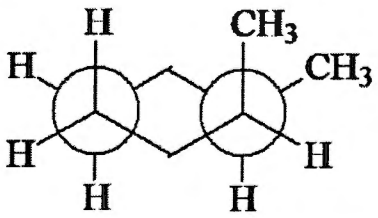
purine

**Part 2 單選題 (30%, 1.5% each)**

1. The heats of combustion ($-\Delta H^{\circ}$) of heptane and 3,3-dimethypentane are 4,817 and 4,809 kJ/mol, respectively. Which statement is true?
(A) Heptane is 8 kJ/mol more stable then 3,3-dimethylpentane.
(B) 3,3-Dimethylpentane is 8 kJ/mol more stable than heptane.
(C) Stabilities cannot be compared since they are not isomers.
(D) Stabilities cannot be compared since they give different combustion products.

2. Which of the following has(have) a higher oxidation state of carbon than the carbon in formaldehyde, $H_2C{=}O$?
I. $CH_3OH$
II. $HCO_2H$
III. $H_2CO_3$
(A) I (B) III (C) II and III (D) I, II, and III.

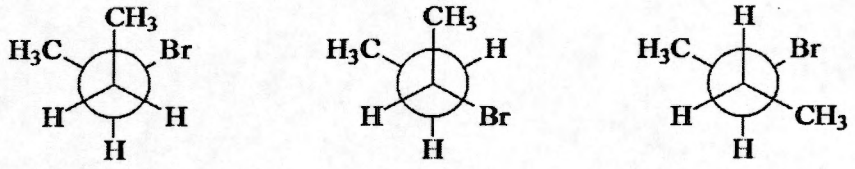
3. The IUPAC name of the following compound is



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

4. Which halogen forms the weakest bond to carbon?
(A) F (B) Cl (C) Br (D) I.

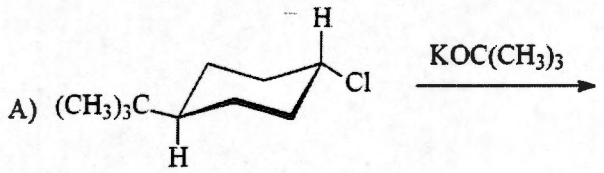
5. In the dehydrohalogenation of 2-bromobutane, which conformation below leads directly to the formation of *cis*-2-butene

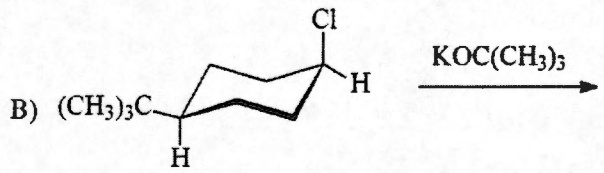


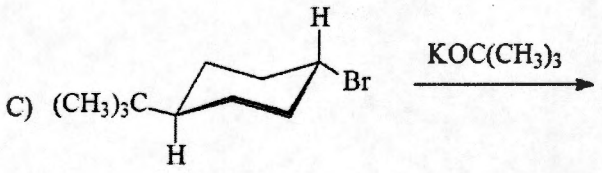

I　　II　　III

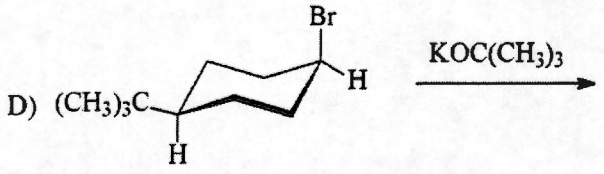
(A) only I　(B) only II　(C) only III　(D) I and II.

6. Which of the following would have the fastest rate of reaction to form 4-*tert*-butylcyclohexene?



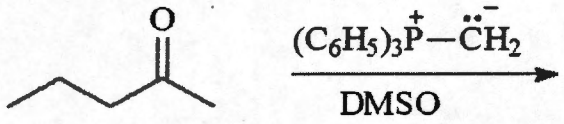



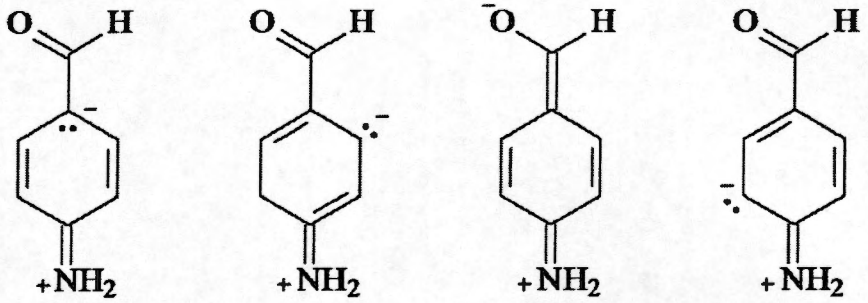

(A) A　(B) B　(C) C　(D) D.

7. What is the product of the reaction below?




(A) 2-methyl-1-pentene
(B) 2-methyl-2-propyloxirane
(C) 4-methyl-1-pentene
(D) 1-pentene

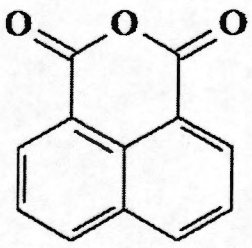
8. Which one of the following is not a resonance form of *para*-aminobenzaldehyde?




I　　II　　III　　IV

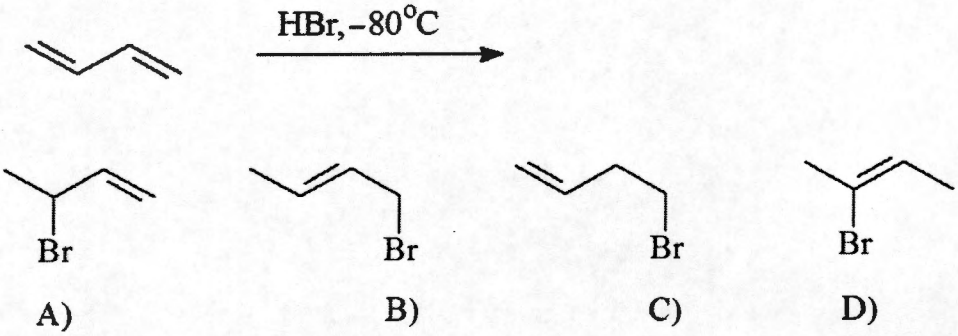
(A) I　(B) II　(C) III　(D) IV

9. The compound shown below is classified as a(n)



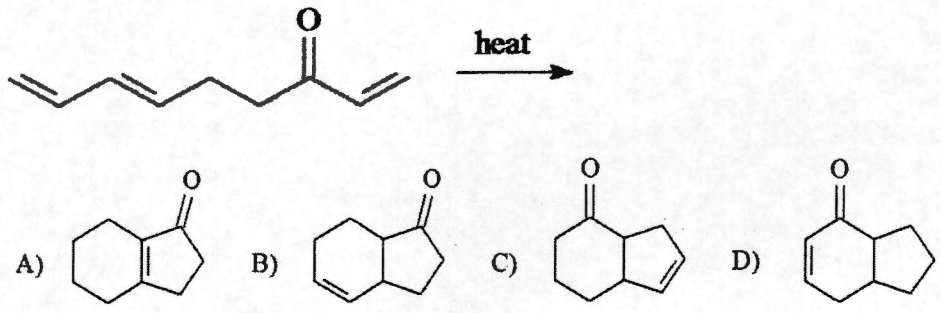

(A) lactone. (B) β-ketoester. (C) diketone. (D) carboxylic acid anhydride.

10. What is the kinetically controlled product in the following reaction?




(A) A (B) B (C) C (D) D.

11. Which of the following is the product of the intramolecular Diels-Alder reaction shown below?

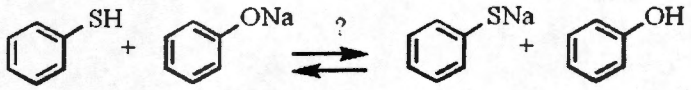



(A) A (B) B (C) C (D) D.

12. Consider the structure of the $AlH4^{-}$ ion. The formal charge of Al is
(A) −1. (B) 0. (C) +1. (D) +3.

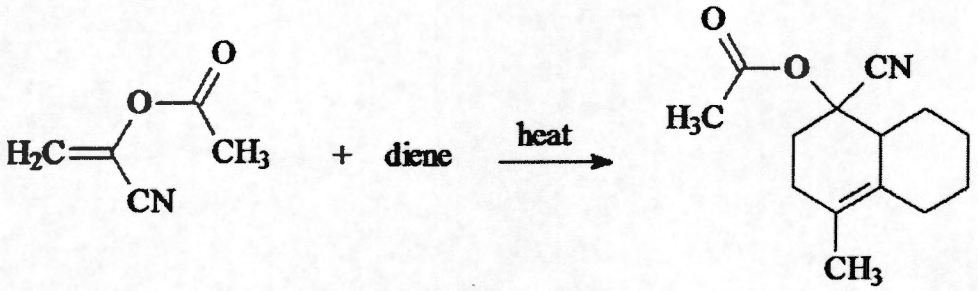
13. Which of the following best describes the role of the coenzyme $NAD^{+}$ (nicotinamide adenine dinucleotide) in biological chemistry?
(A) It reduces other species. (B) It oxidizes other species. (C) It catalyzes oxidation-reduction reactions. (D) It inhibits oxidation-reduction reactions.

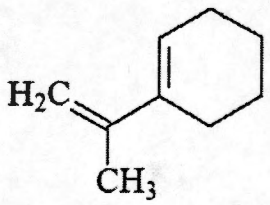
14. To which side, if any, would the reaction below lie?

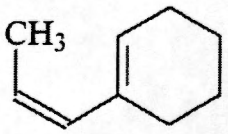


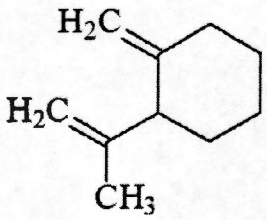

(A) to the right. (B) to the left

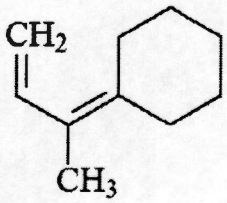
15. Identify the diene used in the reaction shown below.




A) 

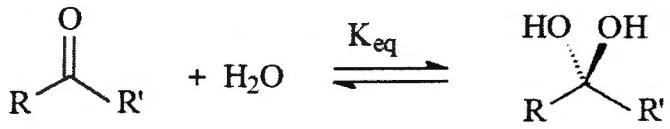

B) 


C) 


D) 


(A) A　(B) B　(C) C　(D) D

16. Which of the following has the largest Keq for the formation of the hydrate (as shown below)?




A) $CH_3CCH_3$ (O)

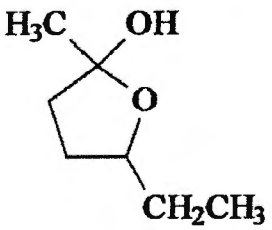
B) $CH_3CCH_2Cl$ (O)

C) $CH_3CCHCl_2$ (O)

D) $CH_3CCCl_3$ (O)

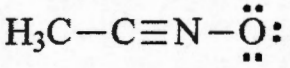
(A) A　(B) B　(C) C　(D) D

17. The compound shown below is the cyclic hemiacetal of



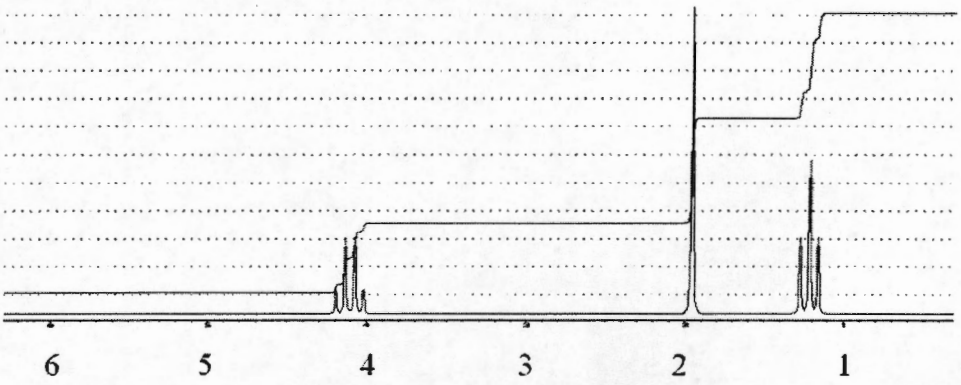

(A) 5-hydroxyheptanal.
(B) 5-hydroxy-2-heptanone.
(C) 6-hydroxy-3-heptanone.
(D) 6-hydroxyheptanal.

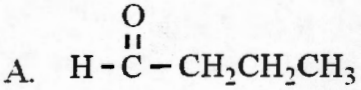
18. The formal charges on the nitrogen and oxygen in the following structures are, respectively

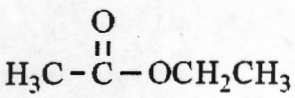


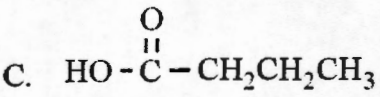
(A) +1, -1　(B) 0, -1　(C) +1, 0　(D) 0, 0

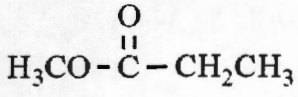
19. Which structure is consistent with this 1H NMR spectrum?




A. 

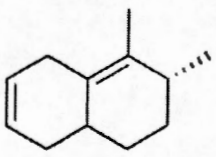
B. 

C. 

D. 

(A) A　(B) B　(C) C　(D) D

20. How many degrees of unsaturation are present in this molecule?



(A) 1　(B) 2　(C) 3　(D) 4　(E) 5