

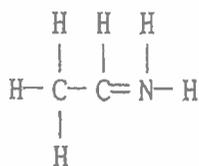
國立清華大學命題紙

95 學年度 生醫工程與環境科學 系(所) 甲組(分子生醫光電組) 碩士班入學考試

科目 有機化學 科目代碼 3004 共 6 頁第 1 頁 \*請在【答案卷卡】內作答

第一部分 選擇題 (No. 1-19) 請在答案卡作答  
 單選 每題3分 共57分

1) The formal charge on nitrogen in the compound below is \_\_\_\_\_



- A) +2                      B) +1                      C) 0                      D) -1                      E) -2

2) The HNC bond angle in the cation  $[\text{CH}_2\text{NH}_2]^+$  is approximately \_\_\_\_\_

- A)  $60^\circ$                       B)  $180^\circ$                       C)  $90^\circ$                       D)  $120^\circ$                       E)  $109.5^\circ$

3) Which of the statements below correctly describes the chair conformations of *trans*-1,4-dimethylcyclohexane?

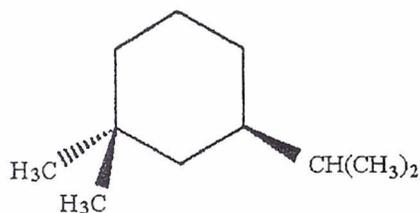
- A) The higher energy chair conformation contains two axial methyl groups.  
 B) The lower energy chair conformation contains one axial methyl group and one equatorial methyl group.  
 C) The higher energy chair conformation contains one axial methyl group and one equatorial methyl group.  
 D) The two chair conformations are of equal energy.  
 E) The lower energy chair conformation contains two axial methyl groups.

4) Given the bond dissociation energies below (in kcal/mol), estimate the  $\Delta H^\circ$  for the propagation step  
 $(\text{CH}_3)_2\text{CH}\cdot + \text{Cl}_2 \rightarrow (\text{CH}_3)_2\text{CHCl} + \text{Cl}\cdot$

$\text{CH}_3\text{CH}_2\text{CH}_2-\text{H}$	98
$(\text{CH}_3)_2\text{CH}-\text{H}$	95
$\text{Cl}-\text{Cl}$	58
$\text{H}-\text{Cl}$	103
$\text{CH}_3\text{CH}_2\text{CH}_2-\text{Cl}$	81
$(\text{CH}_3)_2\text{CH}-\text{Cl}$	80

- A) -40 kcal/mol                      B) +45 kcal/mol                      C) -22 kcal/mol                      D) +22 kcal/mol

5) How many asymmetric carbon atoms are present in the following compound?



- A) 0                      B) 1                      C) 2                      D) 3                      E) 4

6) What is the IUPAC name of the compound shown below?



- A) (1R,3S)-1,3-dichloro-1-ethyl-3-methylcyclopentane  
 B) (1R,3S)-1,3-dichloro-1-methyl-3-ethylcyclopentane  
 C) (1S,3S)-1,3-dichloro-1-ethyl-3-methylcyclopentane  
 D) (1R,4S)-1,4-dichloro-1-ethyl-4-methylcyclopentane  
 E) (1S,3R)-1,3-dichloro-3-ethyl-1-methylcyclopentane
- 7) Which of the following alkenes is the major product when 2-bromo-2-methylpentane is treated with potassium *tert*-butoxide in *tert*-butanol?
- A) 2-methylpent-2-ene  
 B) (Z)-4-methylpent-2-ene  
 C) 2-methylpent-1-ene  
 D) 4-methylpent-1-ene  
 E) (E)-4-methylpent-2-ene
- 8) Both (E)- and (Z)-hex-3-ene can be treated with D<sub>2</sub> in the presence of a platinum catalyst. How are the products from these two reactions related to each other?
- A) The products of the two isomers are related as constitutional isomers.  
 B) The products of the two isomers are related as diastereomers.  
 C) The (E)- and (Z)-isomers generate the same products in exactly the same amounts.  
 D) The (E)- and (Z)-isomers generate the same products but in differing amounts.  
 E) The products of the two isomers are related as enantiomers.
- 9) Which substrate would react most rapidly in an S<sub>N</sub>2 reaction?
- A) CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CH=CHBr  
 B) BrCH<sub>2</sub>CH<sub>2</sub>CH=CHCH<sub>3</sub>  
 C) CH<sub>3</sub>CHBrCH=CH<sub>2</sub>CH<sub>3</sub>  
 D) CH<sub>3</sub>CH<sub>2</sub>CH=CHCH<sub>2</sub>Br
- 10) How many distinct internal alkynes exist with a molecular formula of C<sub>6</sub>H<sub>10</sub>?
- A) 1  
 B) 2  
 C) 3  
 D) 4  
 E) 5

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科目 有機化學 科目代碼 3004 共 6 頁第 3 頁 \*請在【答案卷卡】內作答

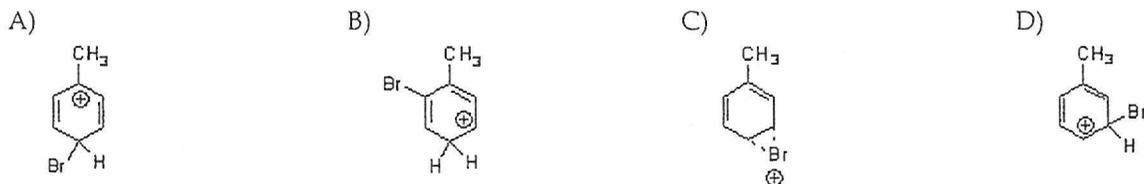
11) Which set of reagents will best convert 2,2-dimethylpropan-1-ol (neopentyl alcohol) to 4,4-dimethylpentan-2-ol?

- |   |   |  |  |
|---|---|--|--|
| A) 1. HCl, ZnCl <sub>2</sub><br>2. Mg<br>3. CH <sub>2</sub> O<br>4. H <sub>3</sub> O <sup>+</sup> | B) 1. HCl, ZnCl <sub>2</sub><br>2. Mg<br>3. CH <sub>3</sub> CHO<br>4. H <sub>3</sub> O <sup>+</sup> | C) 1. SOCl <sub>2</sub><br>2. Mg<br>3. CH <sub>3</sub> CHO<br>4. H <sub>3</sub> O <sup>+</sup> | D) 1. HCl<br>2. Mg<br>3. CH <sub>3</sub> CHO<br>4. H <sub>3</sub> O <sup>+</sup> |
|---|---|--|--|

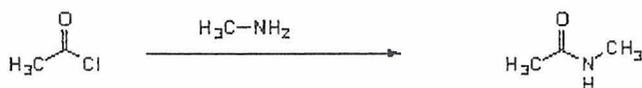
12) Nitrogen's lone pair electrons occupy what type of orbital in pyridine?

- A) p                      B) sp<sup>2</sup>                      C) s                      D) sp                      E) sp<sup>3</sup>

13) Which of the following is an intermediate in the bromination of toluene?



14) Which of the following is an intermediate in the mechanism for amide synthesis through acylation of an amine?



15) Acids can be reduced to aldehydes by:

- A) treatment with LiAlH<sub>4</sub>.  
 B) conversion to the anhydride followed by treatment with Mg and H<sub>3</sub>O<sup>+</sup>.  
 C) conversion to the amide followed by treatment with NaBH<sub>4</sub>.  
 D) conversion to the acid chloride followed by treatment with LiAlH[OC(CH<sub>3</sub>)<sub>3</sub>]<sub>3</sub>.  
 E) conversion to the ester followed by treatment with LiAlH<sub>4</sub>.

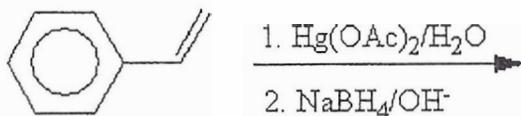
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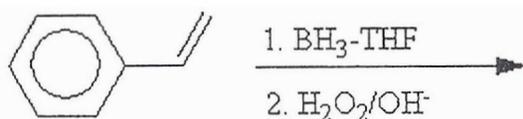
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16) Which of the following reactions will result in the formation of a secondary alcohol(s) in good yield?

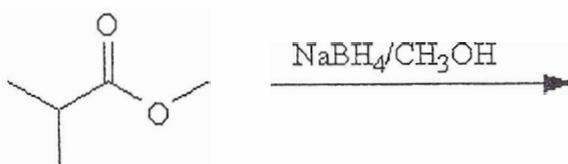
A)



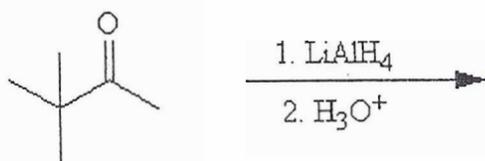
B)



C)

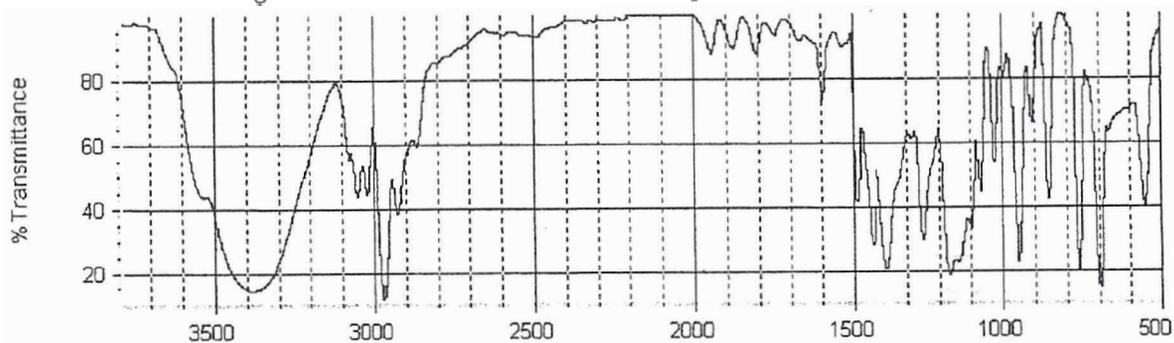


D)

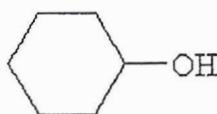


E) both A and D

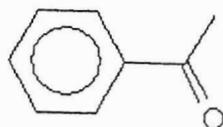
17) Which of the following structures is consistent with the IR spectra shown below?



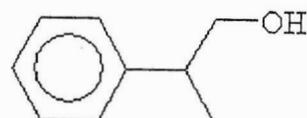
A)



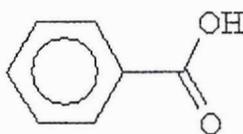
C)



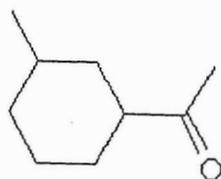
E)



B)

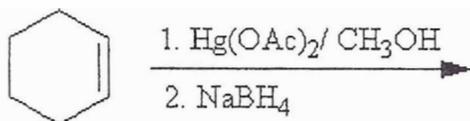


D)

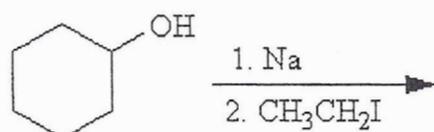


18) Which of the following reactions or series of reactions will lead to the formation of methoxycyclohexane?

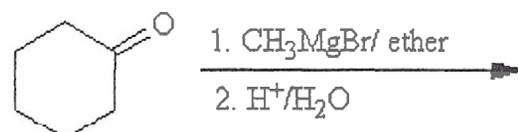
A)



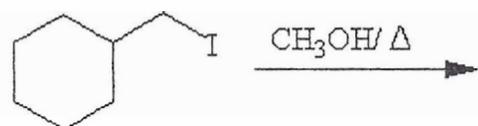
B)



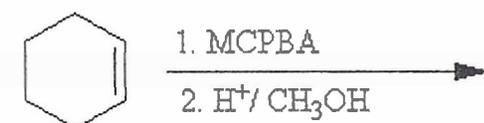
C)



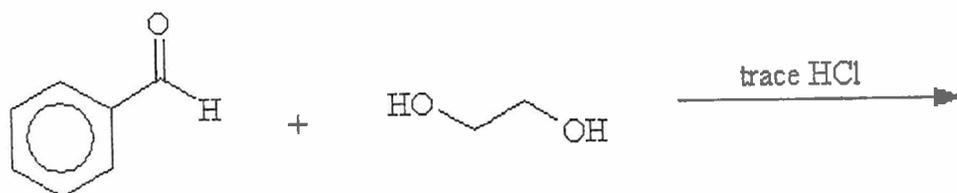
D)



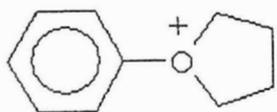
E)



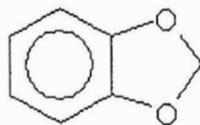
19) What would be the product of the following reaction?



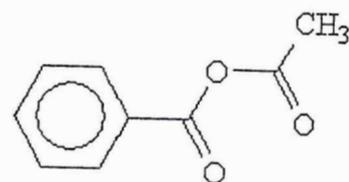
A)



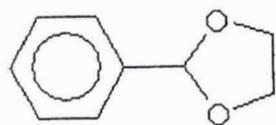
C)



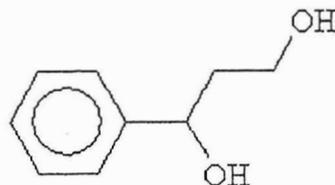
E)



B)



D)

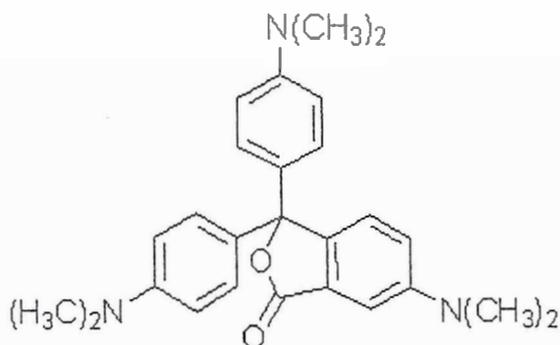


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第二部分 非選擇題 (No. 20-25) 請在答案卷作答  
 共43分

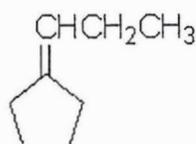
- 20) Answer the following questions for the  $\pi$  molecular orbitals of 1,3-butadiene:
- Which are the bonding MOs and which are the antibonding MOs?
  - Which MOs are symmetric and which are asymmetric?
  - Which MO is the HOMO and which is the LUMO in the ground state?
  - Which MO is the HOMO and which is the LUMO in the excited state?
- 8 points
- 21) Explain why a [2+2] cycloaddition reaction will not occur at room temperature. Recall that at room temperature all molecules have a ground-state electronic configuration; that is, the electrons are in the available orbitals with the lowest energy.
- 5 points
- 22) Many credit-card slips do not have carbon paper. Nevertheless, when you sign the slip, an imprint of your signature is made on the bottom copy. The carbonless paper contains tiny capsules that are filled with the colorless compound whose structure is shown here:



When you press on the paper, the capsules burst and the colorless compound comes into contact with the acid-treated paper, forming a highly colored compound. What is the structure of the colored compound?

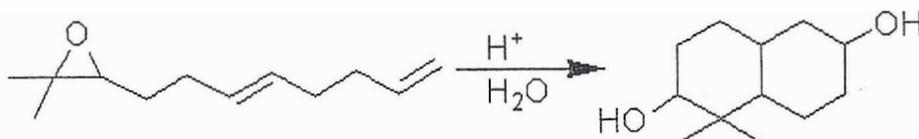
4 points

- 23) Show how each of the following compounds can be synthesized from benzene:
- p*-chloroaniline 5 points
  - o*-bromopropylbenzene 5 points
  - o*-chlorophenol 7 points
- 24) What carbonyl compound and what phosphonium ylide are needed to synthesize the following compound?



3 points

- 25) Propose a mechanism for the following reaction.



6 points