

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 112 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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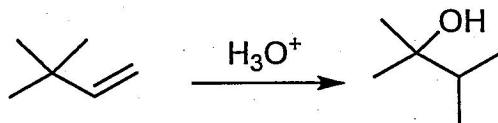
考試科目（代碼）：有機化學(0502、0706)

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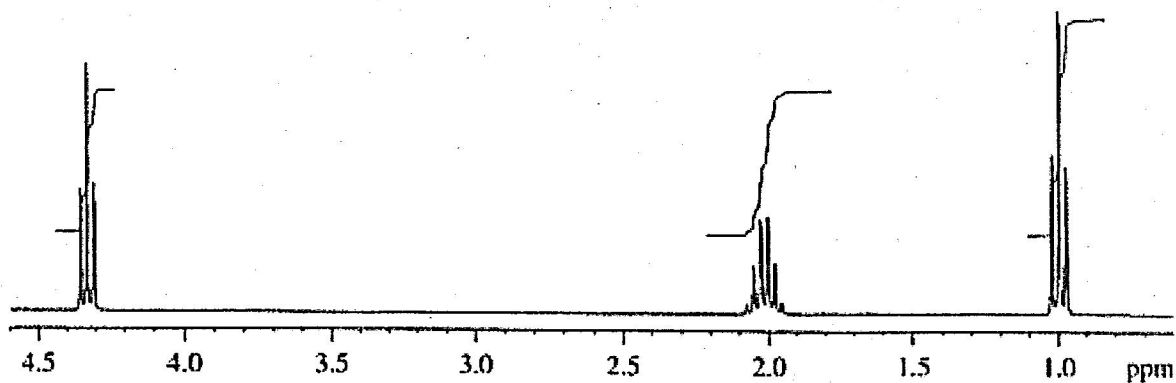
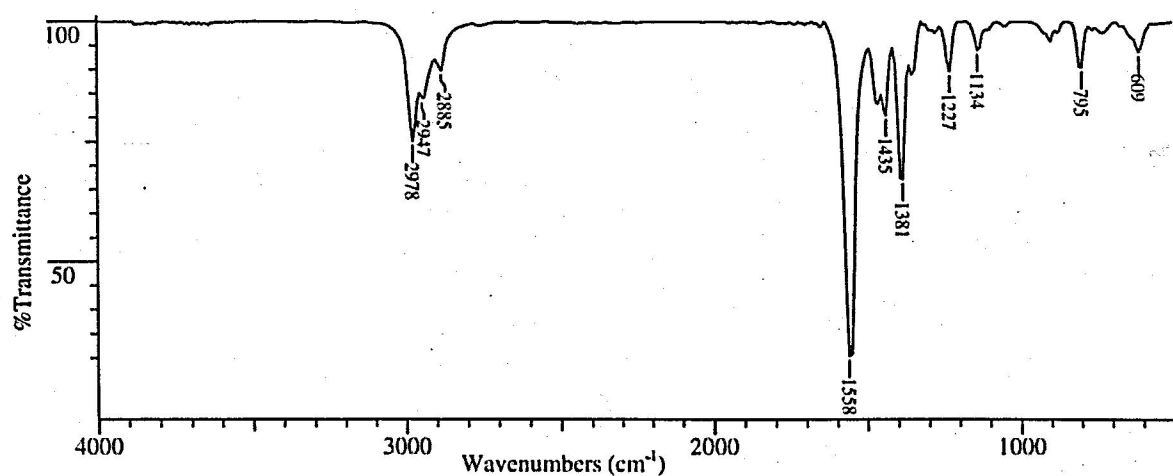
Part 1 簡答題 (共14題, total 70%)

1. Propose a mechanism for the following transformation:



6%

2. An unknown compound, I, has the formula $C_3H_7NO_2$. Elucidate the structure of I by scrutinizing its IR, 1H NMR and ^{13}C NMR spectra, shown below. 5%



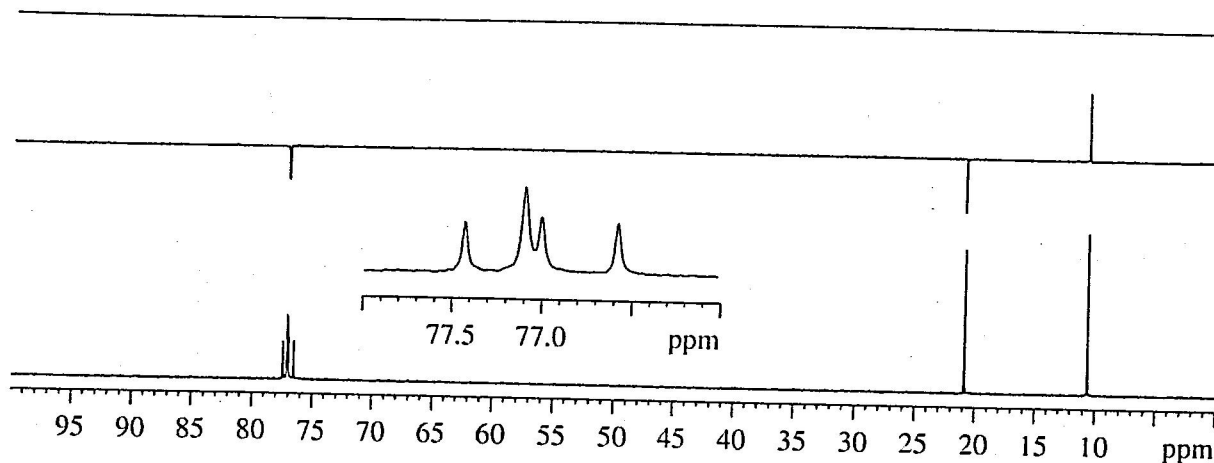
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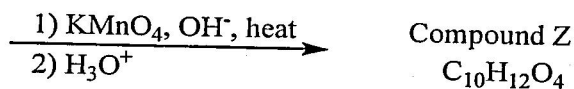
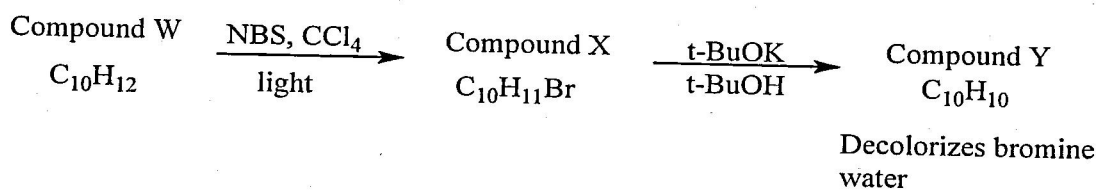
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3. Draw bond-line formulas of all monochloro derivatives that might be formed when 1,1-dimethylcyclobutane is allowed to react with Cl_2 under UV irradiation. For each structure, indicate, with an asterisk, any stereocenters that might be present. 4%
4. Determine the identification of compounds W, X, Y and Z using the structural information shown below. 6%



^1H NMR of compound Z:

2 broad singlets between

11.0-12.0 ppm

multiplet between 7-8 ppm

2 triplets between 2-4 ppm

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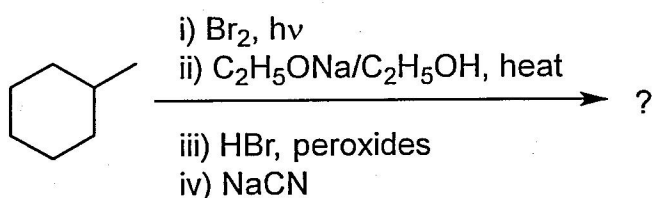
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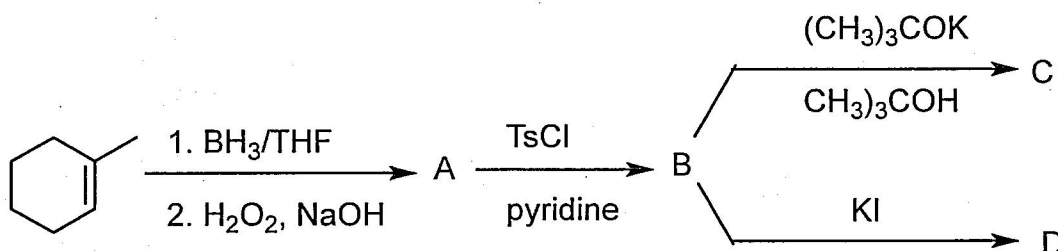
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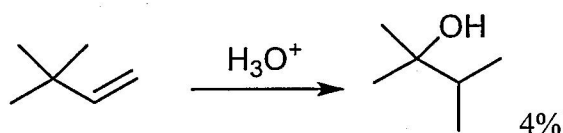
5. Complete the following reaction sequence: indicate regiochemical/stereochemical details as relevant. 6%



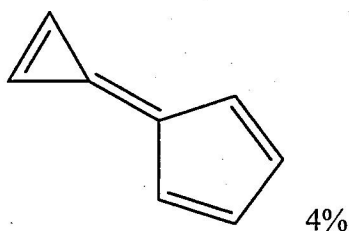
6. Complete the following reaction sequence, giving structures for compounds A, B, C and D: 6%



7. Propose a mechanism for the following transformation:



8. Briefly explain why the aromatic hydrocarbon shown possesses a significant dipole moment. Use diagrams as needed to illustrate/clarify your answer.



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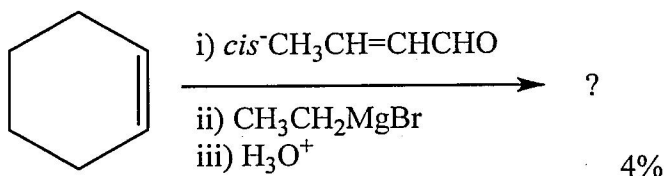
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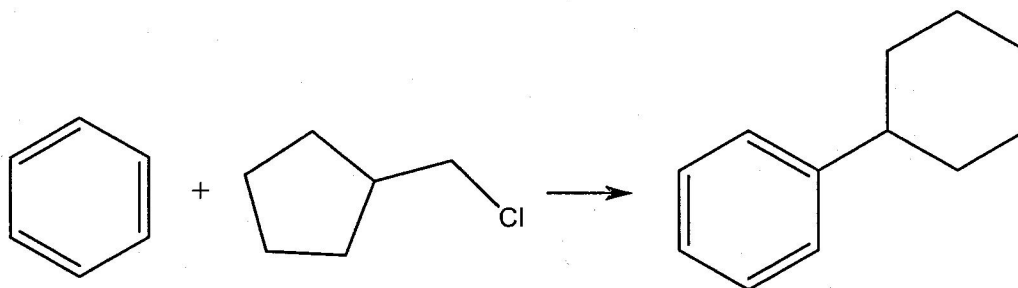
9. Complete the following sequence of reactions, giving structural details of all key intermediates.



4%

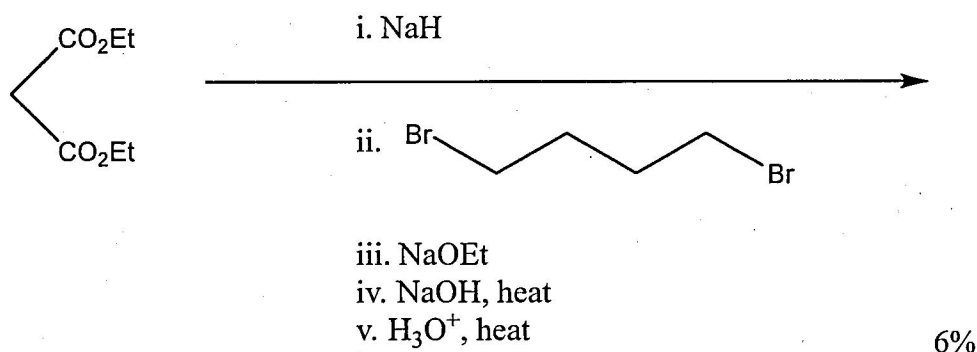
10. Explain briefly why cyclopentadiene readily reacts with strong bases. 4%

11. Draw a mechanism that explains the formation of the following product in this Friedel-Crafts alkylation:



6%

12. Complete the following reaction sequence, giving structural details of all significant intermediates X, Y, and final product Z.



6%

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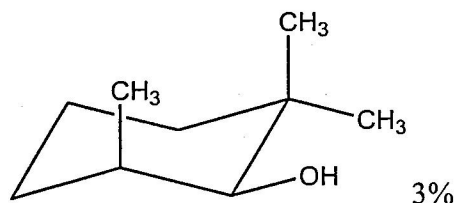
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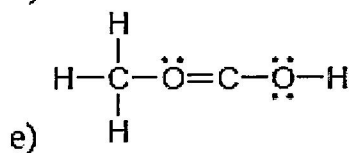
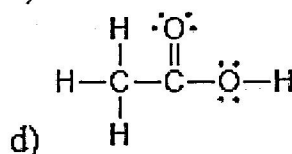
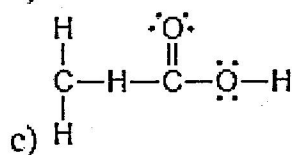
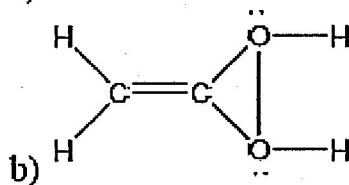
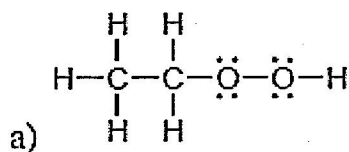
13. Draw Fischer projection formulas for all stereoisomers of 2,4-dimethyl-3-hexanol, giving stereochemical details for each structure. 6%

14. What is the IUPAC name of the following compound?



Part 2 單選題 (共 20 題, 1.5% each, total 30%)

1. Which is NOT a correct Lewis structure?



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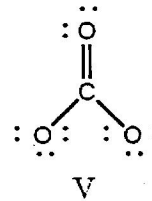
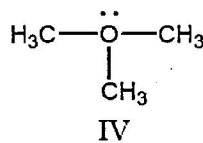
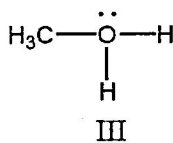
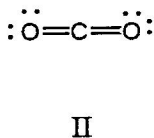
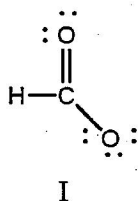
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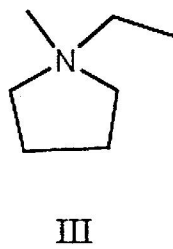
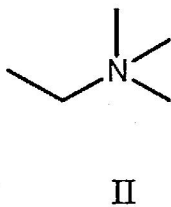
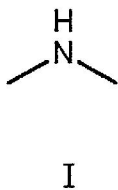
*請在【答案卷】作答

2. Which structure(s) contain(s) an oxygen that bears a formal charge of +1?



- a) I and II
- b) III and IV
- c) V
- d) II
- e) I and V

3. Which compound contains a nitrogen atom with a formal positive charge?



- a) I
- b) II
- c) III
- d) More than one of these choices.
- e) None of these choices.

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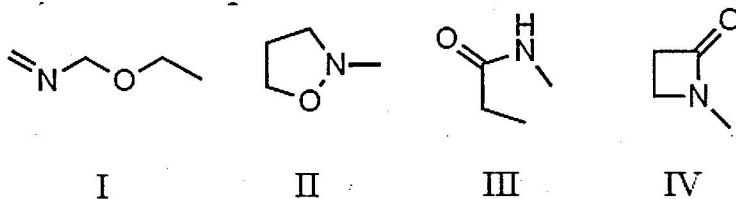
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*請在【答案卷】作答

4. Which compound is not a constitutional isomer of the others?

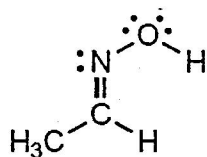


- a) I
- b) II
- c) III
- d) IV
- e) All of these choices are isomers of each other.

5. cis-trans isomerism is possible only in the case of:

- a) $\text{CH}_2=\text{CBr}_2$
- b) $\text{CH}_2=\text{CHBr}$
- c) $\text{BrCH}=\text{CHBr}$
- d) $\text{Br}_2\text{C}=\text{CHBr}$
- e) $\text{Br}_2\text{C}=\text{CBr}_2$

6. Identify the atomic orbitals in the C-N sigma bond in the following oxime:



- a) ($2sp^2$, $2sp^2$)
- b) ($2sp^3$, $2sp^3$)
- c) ($2sp$, $2sp$)
- d) ($2sp^2$, $2sp^3$)
- e) ($2sp$, $1s$)

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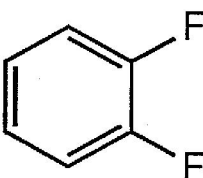
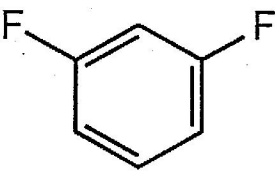
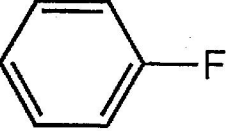
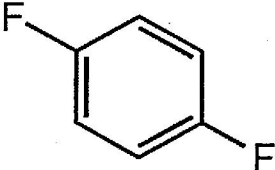
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*請在【答案卷】作答

7. The bond angles for the **bold-faced C** in $\text{CH}_3\text{CH}_2\text{CH}_2^+$ would be expected to be approximately:

- a) 60°
- b) 90°
- c) 105°
- d) 109°
- e) 120°

8. Which molecule does not have a dipole moment?

- a)  A benzene ring with two fluorine atoms at adjacent positions (ortho).
- b)  A benzene ring with two fluorine atoms at meta positions.
- c)  A benzene ring with two fluorine atoms at para positions.
- d)  A benzene ring with fluorine atoms at positions 1, 2, and 4.

e) None of these choices

9. Which compound would you expect to have the highest boiling point?

- a) ethyl alcohol
- b) ethyl amine
- c) chloroethane
- d) water
- e) ethane

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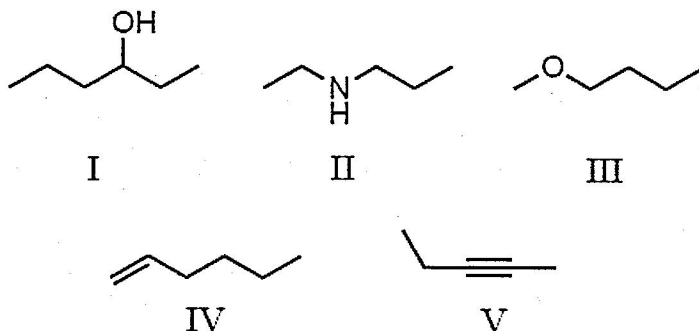
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10. The solid alkane $\text{CH}_3(\text{CH}_2)_{18}\text{CH}_3$ is expected to exhibit the greatest solubility in which of the following solvents?

- a) CCl_4
- b) CH_3OH
- c) H_2O
- d) CH_3NH_2
- e) $\text{HOCH}_2\text{CH}_2\text{OH}$

11. The IR spectrum of which of the following substances is likely to show a small, but sharp peak at 2200 cm^{-1} ?



- a) I
- b) II
- c) III
- d) IV
- e) V

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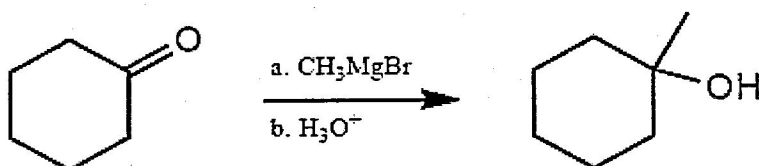
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*請在【答案卷】作答

12. For the following reaction sequence (it is not necessary to understand the chemistry) what significant change(s) would be expected by IR (ignoring C-H absorptions) ?



- a) A peak around 1710 cm⁻¹ would disappear and a new peak around 3300-3500 cm⁻¹ would appear.
- b) A peak around 1710 cm⁻¹ would appear and a new peak around 1650 cm⁻¹ would disappear.
- c) A peak around 2150 cm⁻¹ would disappear and a new peak around 3300-3500 cm⁻¹ would appear.
- d) No change would be observed.
- e) None of these choices.
13. The reaction between which combination of substances below cannot be classified as a Bronsted-Lowry acid-base reaction?
- a) CH₃Li + C₂H₅OH
- b) H₂SO₄ + CH₃CO₂Na
- c) BF₃ + NH₃
- d) H₃O⁺ + CH₃NH
- e) two of these choices
14. Which of the following organic compounds is the strongest acid?
- a) C₆H₁₂ pK_a = 52
- b) CH₃CH₃ pK_a = 50
- c) CH₃CH₂OH pK_a = 18
- d) CH₃CO₂H pK_a = 5
- e) CF₃CO₂H pK_a = 0

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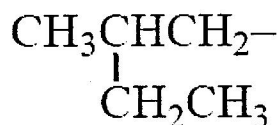
15. Which is an incorrect statement?

- a) RSH compounds are stronger acids than ROH compounds.
- b) PH_3 is a weaker base than NH_3 .
- c) NH_2^- is a stronger base than OH^- .
- d) OH^- is a stronger base than OR^- .
- e) H^- is a stronger base than OR^- .

16. An acid, HA, has the following thermodynamic values for its dissociation in water at 27°C : $\Delta H = -8.0\text{ kJ mol}^{-1}$; $\Delta S = -70\text{ J K}^{-1}\text{mol}^{-1}$. The ΔG for the process is:

- a) $+29\text{ kJ mol}^{-1}$
- b) $+13\text{ kJ mol}^{-1}$
- c) -6.1 kJ mol^{-1}
- d) -13 kJ mol^{-1}
- e) -29 kJ mol^{-1}

17. An IUPAC name for the group



- a) Isopentyl
- b) Isoamyl
- c) sec-Butylmethyl
- d) 2-Methylbutyl
- e) 2-Ethylpropyl

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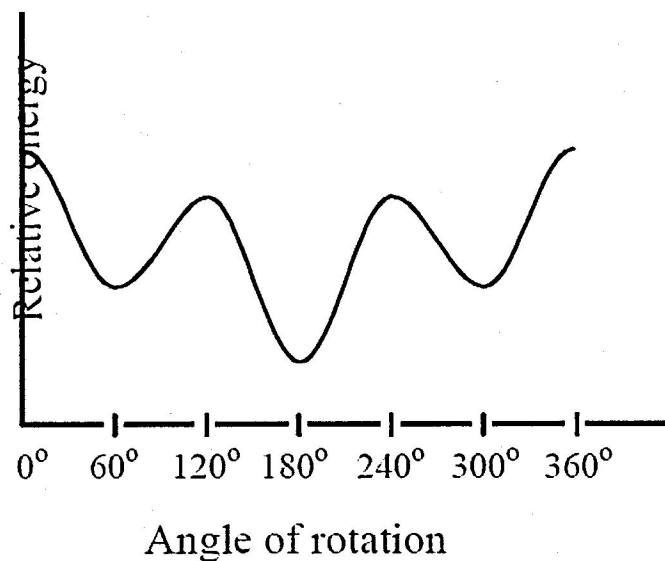
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*請在【答案卷】作答

18. Consider the graph below, which is a plot of the relative energies of the various conformations of 2,3-dimethylbutane, viewed through the C-2—C-3 bond. The conformations corresponding to the 120° and 240° are:



- a) eclipsed, more stable than the conformation at 0°
- b) eclipsed, more stable than the conformation at 180°
- c) staggered, more stable than the conformation at 0°
- d) staggered, less stable than the conformation at 180°
- e) two of these choices are true

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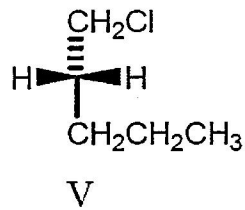
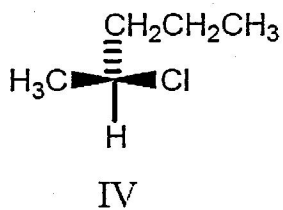
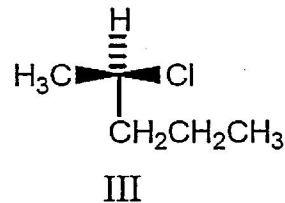
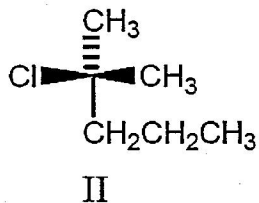
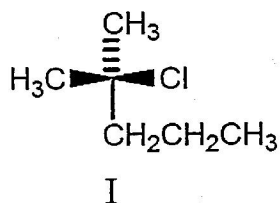
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*請在【答案卷】

19. Pairs of enantiomers are:



- a) I, II and III, IV
- b) I, II
- c) III, IV
- d) IV, V
- e) None of the structures.

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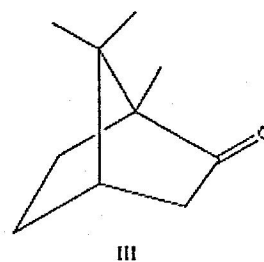
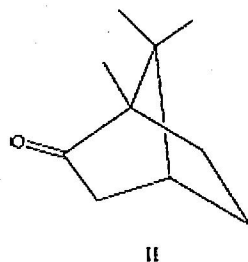
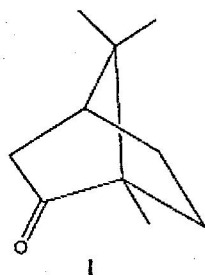
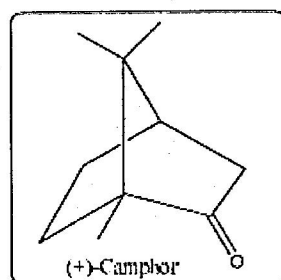
系所班組別：生命科學暨醫學院乙組、丁組

考試科目（代碼）：有機化學(0502、0706)

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*請在【答案卷】作答

20. Which of the following are enantiomers of the compound (+)-camphor



- a) I only
- b) I and II only
- c) II only
- d) I and III only
- e) I, II and III