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
丁組(醫學生物科技學程)

科目代碼：0706

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。

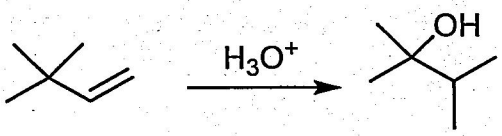
國立清華大學 112 學年度碩士班考試入學試題

系所班組別：生命科學暨醫學院乙組、丁組

考試科目（代碼）：有機化學(0502、0706)

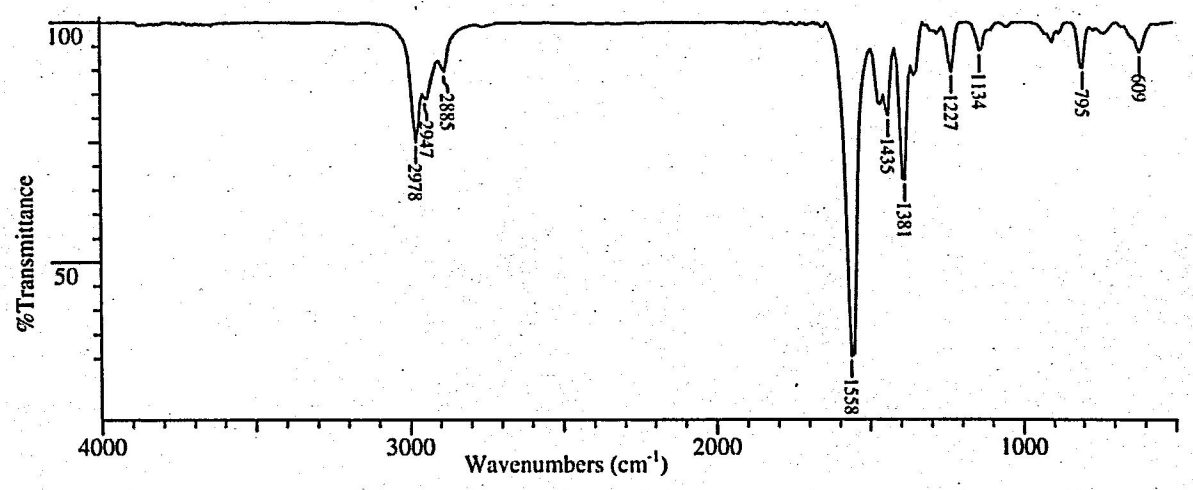
Part 1簡答題 (共14題, total 70%)

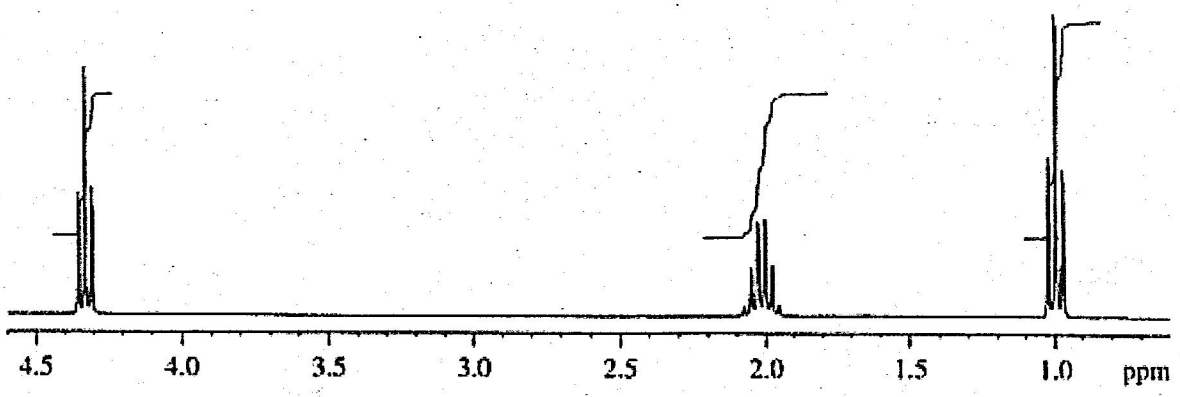
1. Propose a mechanism for the following transformation:

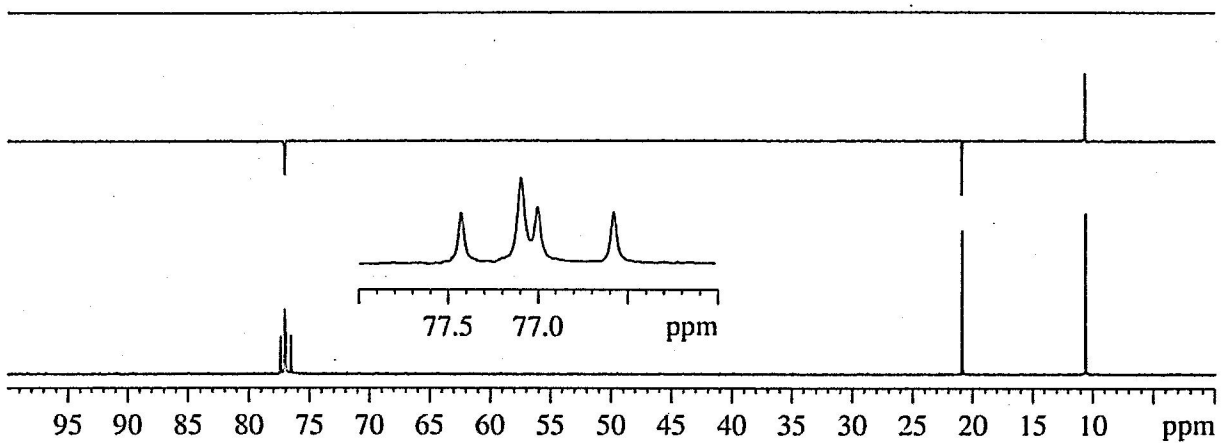


6%

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%







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%

Compound W ($C_{10}H_{12}$) $\xrightarrow[\text{light}]{\text{NBS, } CCl_4}$ Compound X ($C_{10}H_{11}Br$) $\xrightarrow[\text{t-BuOH}]{\text{t-BuOK}}$ Compound Y ($C_{10}H_{10}$)

Decolorizes bromine water

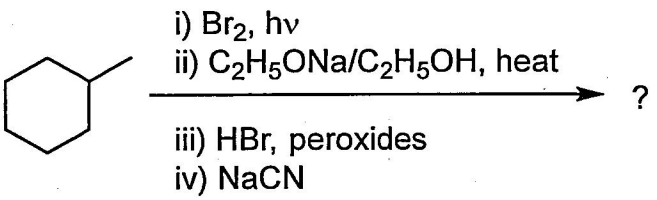
$\xrightarrow[\text{2) } H_3O^+]{\text{1) } KMnO_4,\ OH^-,\ \text{heat}}$ Compound Z ($C_{10}H_{12}O_4$)

^{1}HNMR of compound Z:
2 broad singlets between 11.0-12.0 ppm

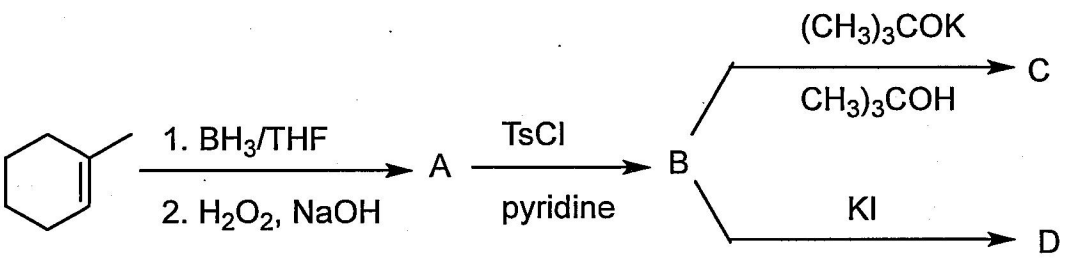
multiplet between 7-8 ppm

2 triplets between 2-4 ppm

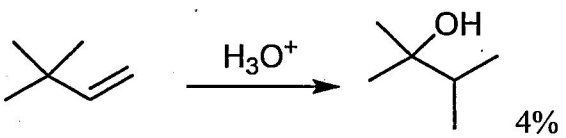
5. Complete the following reaction sequence: indicate regiochemical/stereochemical details as relevant. 6%



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

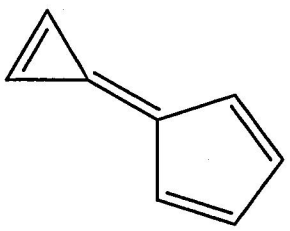


7. Propose a mechanism for the following transformation:



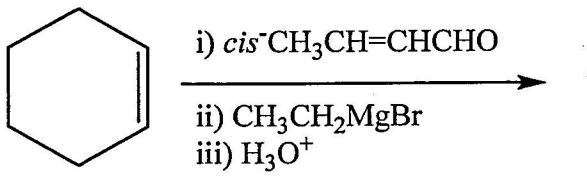
4%

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



4%

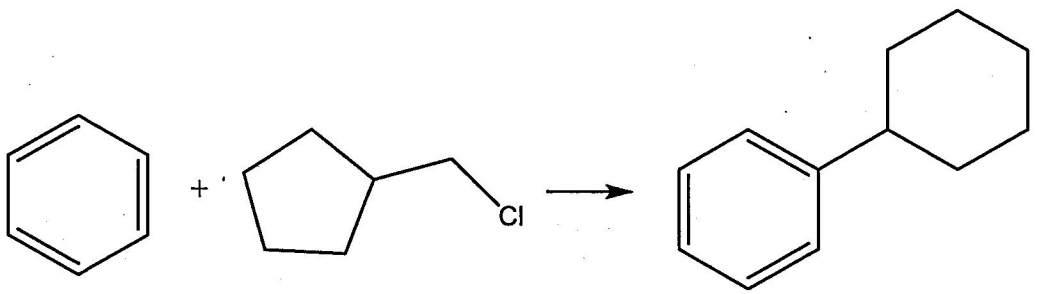
9. Complete the following sequence of reactions, giving structural details of all key intermediates.



4%

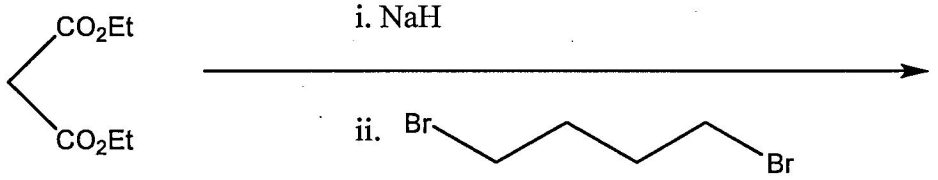
10. Explain briefly why cyclopentadiene readily reacts with strong bases. 4%

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.

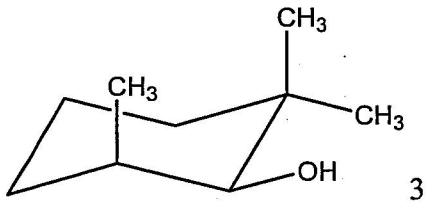


iii. NaOEt
iv. NaOH, heat
v. H_3O^+, heat

6%

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?

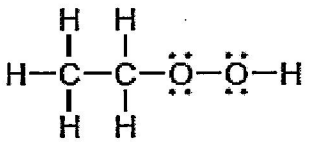


3%

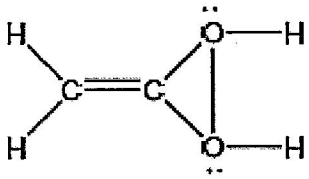
Part 2 單選題 (共 20 題, 1.5% each, total 30%)

1. Which is NOT a correct Lewis structure?

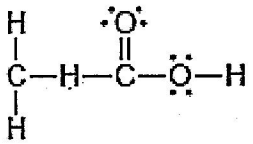
a)



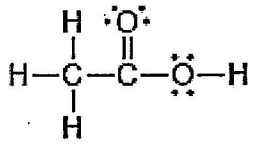
b)



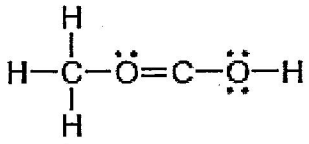
c)



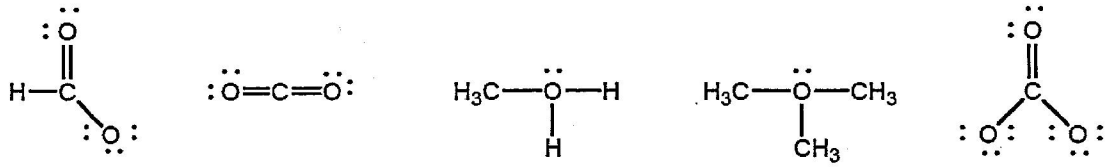
d)



e)



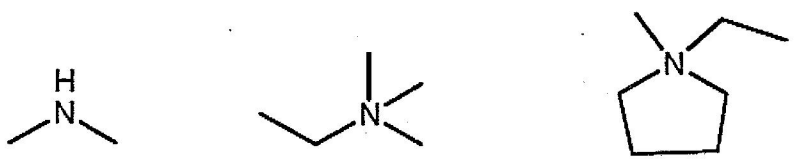
2. Which structure(s) contain(s) an oxygen that bears a formal charge of +1?



I　　II　　III　　IV　　V

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

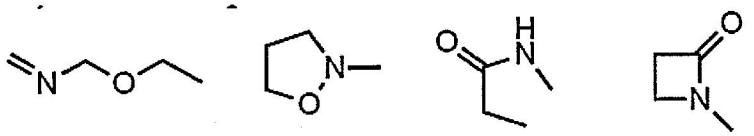
3. Which compound contains a nitrogen atom with a formal positive charge?



I　　II　　III

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

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



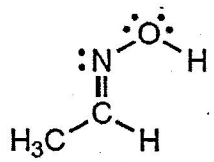
I　　II　　III　　IV

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) $CH_2=CBr_2$
b) $CH_2=CHBr$
c) $BrCH=CHBr$
d) $Br_2C=CHBr$
e) $Br_2C=CBr_2$

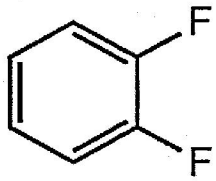
6. Identify the atomic orbitals in the C-N sigma bond in the following oxime:

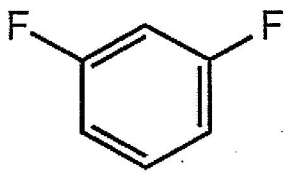


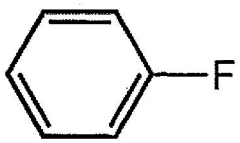
a) (2sp2, 2sp2)
b) (2sp3, 2sp3)
c) (2sp, 2sp)
d) (2sp2, 2sp3)
e) (2sp, 1s)

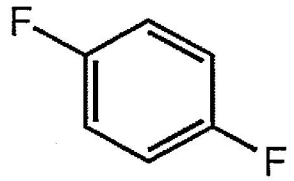
7. The bond angles for the **bold-faced C** in $CH_3CH_2\mathbf{C}H_2^+$ would be expected to be approximately:
   a) 60°
   b) 90°
   c) 105°
   d) 109°
   e) 120°

8. Which molecule does not have a dipole moment?

a) 

b) 

c) 

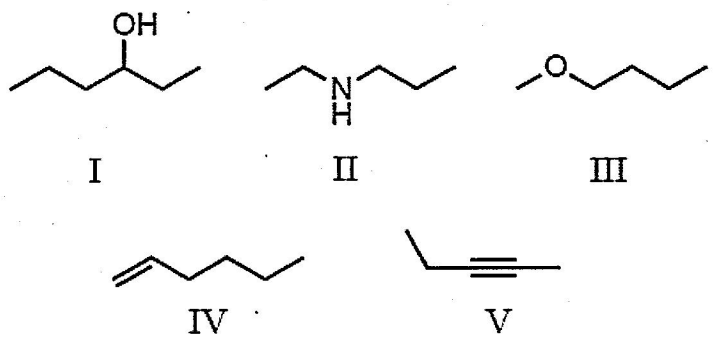
d) 

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

10. The solid alkane $CH_3(CH_2)_{18}CH_3$ 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) $HOCH_2CH_2OH$

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

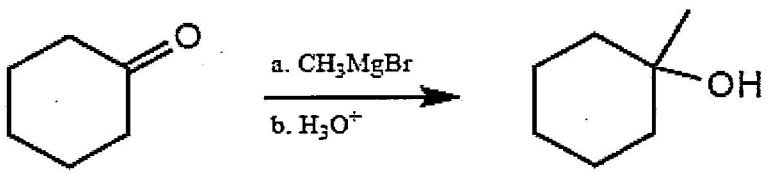


I　　II　　III

IV　　V

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

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) ?



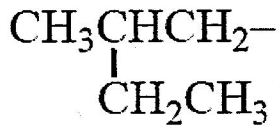
a) A peak around 1710 cm^{-1} would disappear and a new peak around 3300-3500 cm^{-1} would appear.
b) A peak around 1710 cm^{-1}would appear and a new peak around 1650 cm^{-1} would disappear.
c) A peak around 2150 cm^{-1} would disappear and a new peak around 3300-3500 cm^{-1} would appear.
d) No change 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) $CH_3Li + C_2H_5OH$
b) $H_2SO_4 + CH_3CO_2Na$
c) $BF_3 + NH_3$
d) $H_3O^+ + CH_3NH$
e) two of these choices

14. Which of the following organic compounds is the strongest acid?
a) C_6H_{12} $pK_a = 52$
b) CH_3CH_3 $pK_a = 50$
c) CH_3CH_2OH $pK_a = 18$
d) CH_3CO_2H $pK_a = 5$
e) CF_3CO_2H $pK_a = 0$

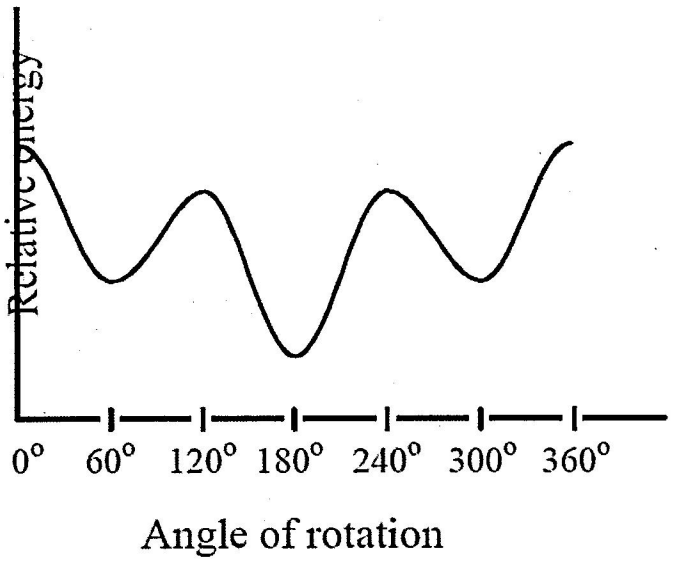
15. Which is an incorrect statement?
    a) RSH compounds are stronger acids than ROH compounds.
    b) PH_3 is a weaker base than NH_3.
    c) NH_2^- is a stronger base than OH^-.
    d) OH^- is a stronger base than OR^-.
    e) H^- is a stronger base than OR^-.

16. An acid, HA, has the following thermodynamic values for its dissociation in water at 27° C: $\Delta H = -8.0$ kJ mol^{-1}; $\Delta S = -70$ J $K^{-1}mol^{-1}$. The ΔG for the process is:
    a) +29 kJ mol^{-1}
    b) +13 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 

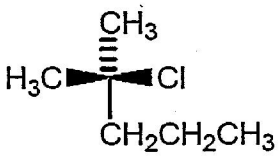
    a) Isopentyl
    b) Isoamyl
    c) sec-Butylmethyl
    d) 2-Methylbutyl
    e) 2-Ethylpropyl

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:

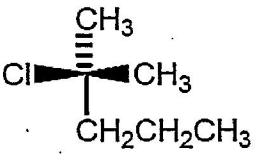


a) eclipsed, more stable than the conformation at 0°
b) eclipsed, more stable than the conformation at 180°
c) staggered, more stable than the conformation at 0°
d) staggered, less stable than the conformation at 180°
e) two of these choices are true

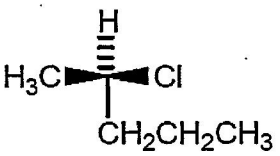
19. Pairs of enantiomers are:



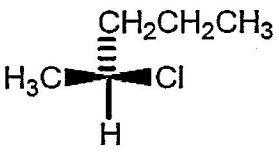
I



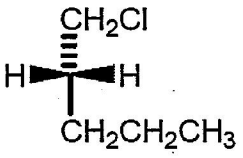
II



III



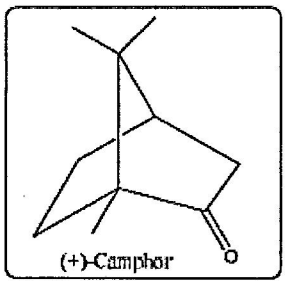
IV

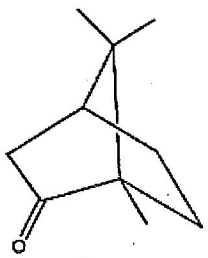


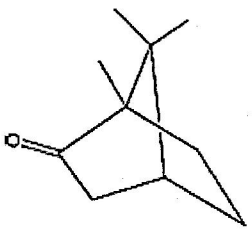
V

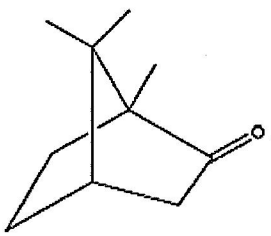
a) I, II and III, IV
b) I, II
c) III, IV
d) IV, V
e) None of the structures.

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




I


II


III

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