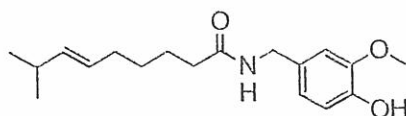


注意：本試題包含單選題及問答題兩部份

Part I. 單選題 (25 題, 50 分)

1. Which functional groups *are* present in the molecule of capsaicin?



Capsaicin

- (A) Alkene, ketone, amine, alcohol, ester
(B) Alkene, ketone, alcohol, ether
(C) Alkene, amine, phenol, ether
(D) Ether, phenol, alkene, amide
(E) Ester, phenol, alkene, amide
2. Regarding the use of potassium *tert*-butoxide as a base in E2 reactions, it is incorrect to state that:
(A) this base is more effective than ethoxide ion, because it (*tert*-BuOK) is the more basic of the two.
(B) it tends to give the anti-Zaitsev, i.e., Hofmann, product.
(C) it is more reactive in dimethyl sulfoxide than it is in *tert*-butyl alcohol.
(D) it favors E2 reactions over competing S_N2 reactions.
(E) it will form, predominantly, the more stable alkene.
3. The preferred conformation of *cis*-3-*tert*-butyl-1-methylcyclohexane is the one in which:
(A) the *tert*-butyl group is axial and the methyl group is equatorial.
(B) the methyl group is axial and the *tert*-butyl group is equatorial.
(C) both groups are axial.
(D) both groups are equatorial.
(E) the molecule exists in a boat conformation.
4. Which of the following molecules is achiral?
(A) (2*R*,3*R*)-2,3-Dichloropentane
(B) (2*R*,3*S*)-2,3-Dichloropentane
(C) (2*S*,4*S*)-2,4-Dichloropentane
(D) (2*S*,4*R*)-2,4-Dichloropentane
(E) Two of these
5. Which statement is **not** true for a *meso* compound?
(A) The specific rotation is 0°.
(B) There are one or more planes of symmetry.
(C) A single molecule is identical to its mirror image.
(D) More than one stereogenic center must be present.
(E) The stereochemical labels, (*R*) and (*S*), must be identical for each stereogenic center.

6. Which of these is **not** a Lewis acid?

- (A) AlBr_3 (B) BCl_3
(C) Ph_3P (D) D^+
(E) All the above are Lewis acids

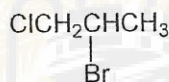
7. You want to synthesize 3-methyl-2-pentene from 2-chloro-3-methylpentane. Which reagent would you use?

- (A) $\text{CH}_3\text{CH}_2\text{ONa}$, $\text{CH}_3\text{CH}_2\text{OH}$, heat (B) HCl , heat
(C) $\text{NH}_3(\text{aq})$, 25°C (D) $\text{CH}_3\text{CO}_2\text{Na}$, $\text{CH}_3\text{CO}_2\text{H}$, heat
(E) $\text{CH}_3\text{CH}_2\text{OH}$, heat

8. Consider the addition of HCl to 3-methyl-1-butene. The major product of the reaction would be:

- (A) 1-Chloro-2-methylbutane (B) 2-Chloro-2-methylbutane
(C) 1-Chloro-3-methylbutane (D) 2-Chloro-3-methylbutane
(E) 1-Chloropentane

9. How many chemically distinct ^1H NMR signals are there in the following compound?



- (A) 1 (B) 2 (C) 3
(D) 4 (E) 5

10. The reaction of 1-butene with HBr in the presence of peroxides yields 1-bromobutane. The mechanism for the reaction involves:

- (A) attack on the alkene by a Br^+ ion. (B) attack on the alkene by a H^+ ion.
(C) attack on the alkene by a bromine atom, $\text{Br}\cdot$. (D) attack on the alkene by a hydrogen atom, $\text{H}\cdot$.
(E) isomerization of the 2-bromobutane produced initially.

11. Which of the reagents/techniques listed below would serve as the basis for a simple chemical test to distinguish between $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_2\text{CHO}$ and $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_2\text{CH}_2\text{OH}$?

- (A) KMnO_4 (B) IR spectroscopy
(C) Br_2 in CCl_4 (D) A and B
(E) All of the above

12. A thermodynamically-controlled reaction will yield predominantly:

- (A) the more/most stable product.
(B) the product whose formation requires the smallest free energy of activation.
(C) the product that can be formed in the fewest steps.
(D) the product that is formed at the fastest rate.
(E) the product which possesses the greatest potential energy.

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13. In the molecular orbital model of the cyclopentadienyl cation, how many non-bonding molecular orbitals are there?

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

14. Which of these is the rate-determining step in the nitration of benzene?

- (A) Protonation of nitric acid by sulfuric acid.
(B) Protonation of sulfuric acid by nitric acid.
(C) Loss of a water molecule by the protonated species to produce the nitronium ion.
(D) Addition of the nitronium to benzene to produce the arenium ion.
(E) Loss of a proton by the arenium ion to form nitrobenzene.

15. Which reagent(s) would you use to carry out the following transformation?

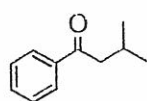
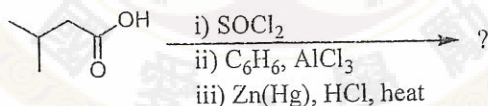


- (A) Br₂, heat, and light (B) KMnO₄, OH⁻, heat (then H₃O⁺)
(C) Cl₂, FeCl₃ (D) HNO₃/H₂SO₄
(E) SO₃/H₂SO₄

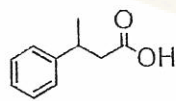
16. The ¹H NMR spectrum of a compound with formula C₇H₁₄O gives two signals. Which of these structures is a possible one for this compound?

- (A) 2-Heptanone (B) 3-Heptanone (C) 2,4-Dimethyl-3-pentanone
(D) 2,2-Dimethyl-3-pentanone (E) Two of the above

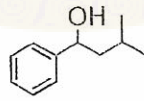
17. What would be the product of the following reaction sequence?



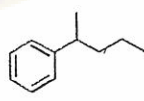
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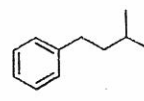
II



III



IV



V

- (A) I (B) II (C) III
(D) IV (E) V

18. Identify the reagent(s) that would bring about the following reaction:

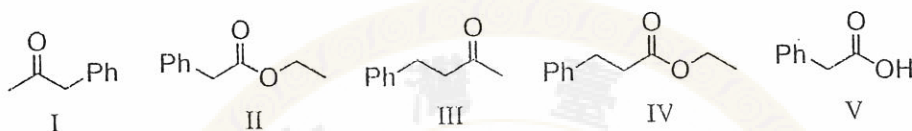
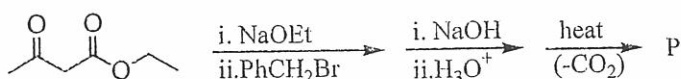


- (A) H₂/Ni (B) Li/liq. NH₃ (C) LiAlH[OC(CH₃)₃]₃, ether
(D) NaBH₄, CH₃OH (E) LiAlH₄, ether

19. Which of the reactions listed below would serve as a synthesis of benzyl acetate, $\text{CH}_3\text{CO}_2\text{CH}_2\text{C}_6\text{H}_5$?

- (A) Benzyl alcohol + acetic anhydride
(B) Benzyl alcohol + acetic acid + H_3O^+
(C) Benzyl alcohol + acetyl chloride
(D) Answers A) and C) only
(E) Answers A), B), and C)

20. What would be the product, P, of the following reaction sequence?



- (A) I
(D) IV

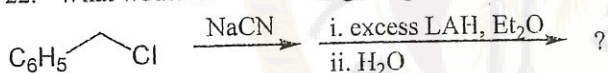
- (B) II
(E) V

- (C) III

21. Which compound would be formed when 2-methylbutanal is treated with a solution of NaOD in D_2O ?

- (A) $\text{CH}_3\text{CH}_2\text{CD}(\text{CH}_3)\text{CHO}$ (B) $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CDO}$ (C) $\text{CH}_3\text{CHD}(\text{CH}_3)\text{CH}_2\text{CHO}$ (D) $\text{CH}_2\text{DCH}_2\text{CH}(\text{CH}_3)\text{CHO}$ (E) $\text{CH}_3\text{CH}_2\text{CD}(\text{CH}_3)\text{CDO}$

22. What would be the final organic product of the following reaction?

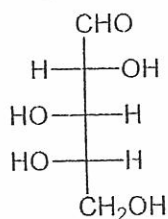


- (A) $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$ (B) $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_2\text{NH}_2$ (C) $\text{C}_6\text{H}_5\text{CH}_2\text{CH}(\text{CH}_3)\text{CN}$
(D) $\text{C}_6\text{H}_5\text{CH}_2\text{CH}=\text{NH}$ (E) $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$

23. Which reagent will distinguish between $\text{C}_6\text{H}_5\text{NH}_2$ and $(\text{C}_6\text{H}_5)_2\text{NH}$?

- (A) $\text{HCl}(\text{aq})$ (B) $\text{NaOH}(\text{aq})$ (C) $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}/\text{OH}^-$, then H_3O^+
(D) Br_2/CCl_4 (E) KMnO_4

24. What are the correct designations for the stereogenic centers in this aldose?



- (A) 2R,3S,4R
(D) 2S,3S,4R

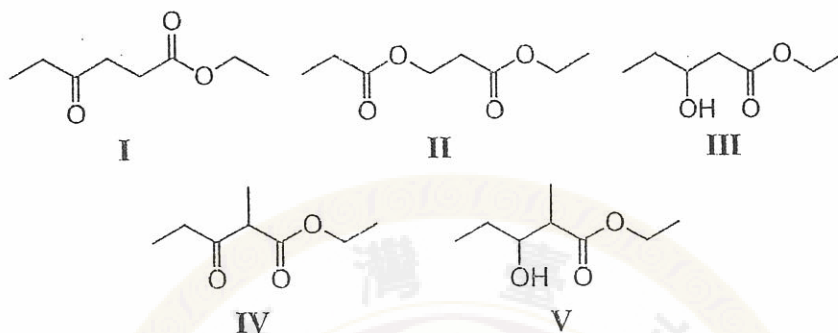
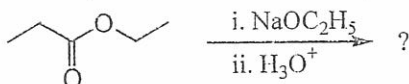
- (B) 2R,3S,4S
(E) 2R,3R,4S

- (C) 2S,3R,4R

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25. What would be the major product of the following reaction?



(A) I (B) II (C) III (D) IV (E) V

Part II. 問答題 (6題, 50分)

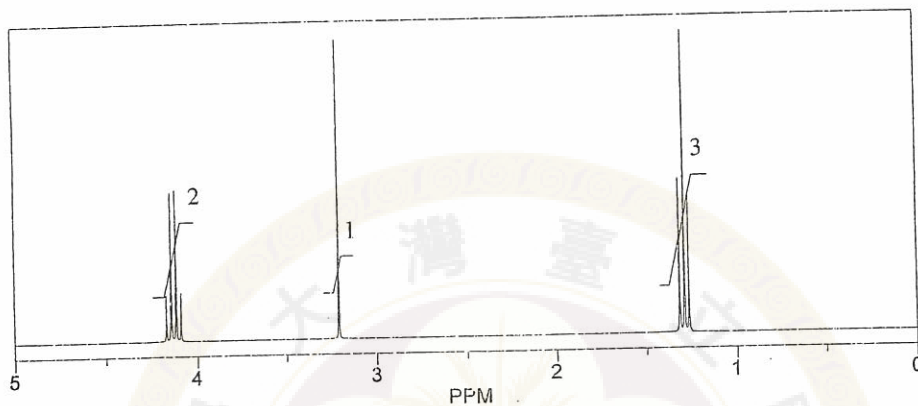
1. Draw the Lewis structure of the nitrite ion, NO_2^- , clearly indicating resonance contributors as well as non-bonding pairs of electrons and formal charges, as relevant. (6 points)
2. Give a detailed reaction mechanism for the reaction expected to occur when 2-bromo-2-methylpentane is heated with methanol. Draw clear structural formulas of all relevant species and use curved arrows to represent electron flow. Also indicate which step is likely to be rate-determining. (10 points)
3. Propose a reasonable synthetic strategy for the synthesis of *trans*-6-methyl-3-heptene from 4-methyl-1-pentyne. (8 points)
4. The Lewis structures of both pyridine and pyrrole have an electron pair on the nitrogen atom, suggesting that both substances might possess basic properties. However, only pyridine reacts readily with HCl to form pyridinium chloride, while pyrrole is rather unreactive. Explain clearly, using relevant diagrams to illustrate/clarify your answer. (8 points)

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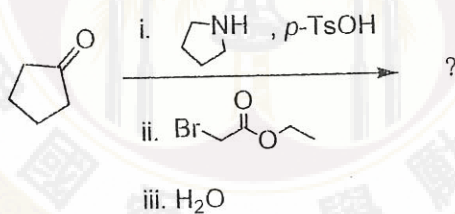
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5. What is the structure of the compound in the following $^1\text{H-NMR}$ spectrum with the molecular formula $\text{C}_7\text{H}_{12}\text{O}_4$? The $^{13}\text{C-NMR}$ spectrum shows peaks at 14.1, 40.8, 61.0 and 166.8 ppm. $^1\text{H-NMR}$ spectrum is shown below and the relative integration is given. Please provide step-by-step explanations for your answers. (10 points)



6. What is the final product of the following reaction sequence? Give structural details of all significant intermediates. (8 points)



試題隨卷繳回