

《化學》

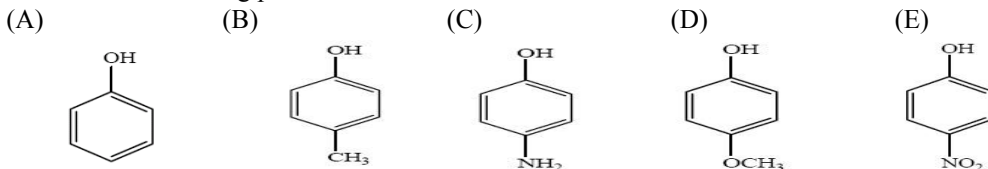
I. Choose one correct answer for the following questions

【單選題】每題 1 分，共計 60 分，答錯一題倒扣 0.25 分，倒扣至本大題零分為止，未作答，不給分亦不扣分。

(E) 1. Which family of compounds has the lowest pKa value
(A) alkane (B) alkene (C) alkyne (D) amine (E) alcohol

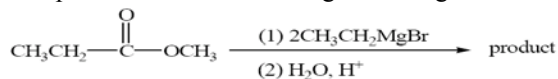
(D) 2. Claisen rearrangement of allyl phenyl ether to o-allylphenol is a sigmatropic rearrangement. This rearrangement is a [x, y] shift and proceeds under what condition.
(A) [1,3]; thermal (B) [1,3]; hv (C) [1,7]; hv (D) [3,3]; thermal (E) [3, 5]; hv

(E) 3. Which of the following phenols is the most acidic?



(E) 4. Which compound is a free-radical initiator?
(A) ethyl benzoate (B) isopropyl benzoate (C) n-propyl benzoate
(D) methyl benzoate (E) azobisisobutyronitrile (AIBN)

(B) 5. What product will the following reaction give?



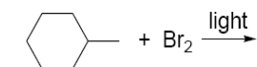
(A) 3-methyl-3-pentanol (B) 3-ethyl-3-pentanol (C) 3-pentanone
(D) ethyl propanoate (E) propanoic acid

(E) 6. Which one of the following compounds is a fatty acid?
(A) $\text{CH}_3(\text{CH}_2)_9\text{COOH}$ (B) $\text{CH}_3(\text{CH}_2)_{11}\text{COOH}$ (C) $\text{CH}_3(\text{CH}_2)_{13}\text{COOH}$
(D) $\text{CH}_3(\text{CH}_2)_{15}\text{COOH}$ (E) $\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$

(C) 7. Which of the molecules below can hydrogen bond to another of the same compound?
(A) $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$ (B) $\text{CH}_3\text{CH}_2\text{COOCH}_3$ (C) $(\text{CH}_3\text{CH}_2)_2\text{CHOH}$
(D) $(\text{CH}_3\text{CH}_2)_3\text{N}$ (E) all of the above

(A) 8. Which of the following compounds has the **highest** heat of combustion **per CH_2 group**?
(A) cyclopropane (B) cyclobutane (C) cyclopentane
(D) cyclohexane (E) all have equal $\Delta H_{\text{combustion}}$

(B) 9. What is the major product of the following reaction?

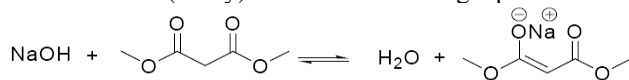


(A)  (B)  (C)  (D)  (E) no reaction occurs

(A) 10. Which of the following solvents could be described as polar and protic?

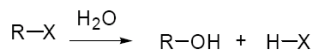
- (A) ethanol (B) acetonitrile
(C) dimethylformamide (D) tetrahydrofuran (E) diethyl ether

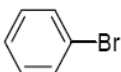
(B) 11. To which side (if any) would the following equilibrium lie?



- (A) to the left (B) to the right
(C) equally to the right and left (D) there is no way to tell
(E) only S_N2 , S_N1 and E2 reactions are possible

(C) 12. Which of the haloalkanes below would you expect to most rapidly undergo the reaction shown?



- (A) $\text{CH}_3\text{CH}_2\text{Br}$ (B)  (C) $(\text{CH}_3)_3\text{CBr}$ (D) $(\text{CH}_3)_2\text{CHBr}$ (E) $(\text{CH}_3)_3\text{CCH}_2\text{Br}$

(A) 13. A mixture of oct-1-yne, oct-2-yne, and oct-3-yne was hydrogenated in the presence of a platinum catalyst until hydrogen uptake ceased. If one assumes that the hydrogenation went to completion, how many different eight-carbon hydrocarbons were produced?

- (A) 1 (B) 2 (C) 3 (D) 6 (E) 8

(C) 14. Which of the following would you expect to have the **lowest** boiling point?

- (A) $\text{CH}_3\text{CH}_2\text{OH}$ (B) $\text{CH}_3\text{CO}_2\text{H}$ (C) $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$
(D) $(\text{CH}_3\text{CH}_2)_2\text{NH}$ (E) $(\text{CH}_3\text{CH}_2)_3\text{N}$

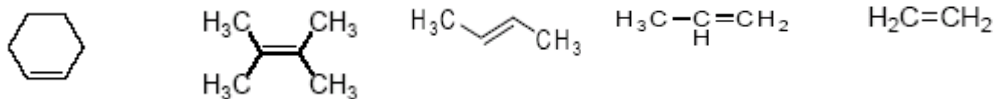
(B) 15. Which of the following structures, would be classified as anti-aromatic?

- (A) (B) (C) (D) (E) all of the above



(B) 16. Which alkene has the **lowest** heat of hydrogenation $\Delta H^\circ_{\text{hydrog}}$?

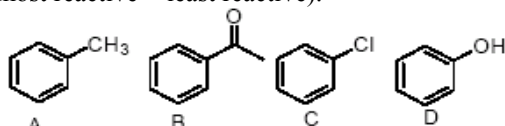
- (A) (B) (C) (D) (E)



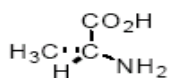
(C) 17. Which of the following alkyl halides would be suitable to use when forming a Grignard reagent?

- (A) $\text{BrCH}_2\text{CH}_2\text{CH}_2\text{CN}$ (B) $\text{CH}_3\text{COCH}_2\text{CH}_2\text{Br}$
(C) $(\text{CH}_3)_2\text{NCH}_2\text{CH}_2\text{Br}$ (D) $\text{H}_2\text{NCH}_2\text{CH}_2\text{Br}$ (E) all of the above

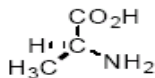
(D) 18. Rank the following aromatics in order of decreasing reactivity toward electrophilic aromatic substitution (most reactive > least reactive).



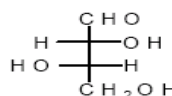
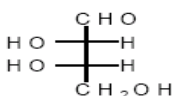
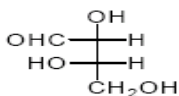
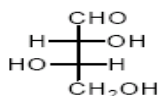
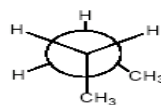
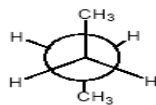
- (A) $A > C > D > B$ (B) $D > C > A > B$ (C) $B > C > A > D$ (D) $D > A > C > B$ (E) $C > A > D > B$



(C)

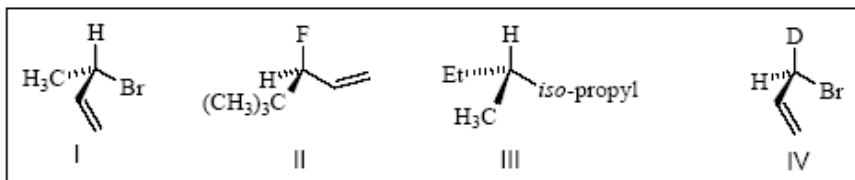


(D)



(E) none of the above

(A) 26. Which of the following molecules have the S configuration?



(A) I, II

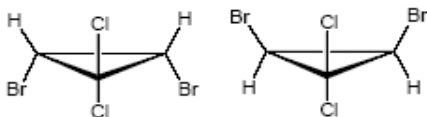
(B) I, III

(C) III, IV

(D) I, II, IV

(E) all of the above

(C) 27. How are the following compounds related?



(A) diastereomers

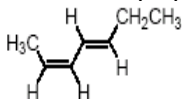
(B) enantiomers

(C) meso compounds

(D) optical isomers

(E) none of the above

(C) 28. What is the proper IUPAC name for the following molecule:



(A) (2E,4Z)-2,4-heptadiene

(B) (2E,3Z)-2,3-heptadiene

(C) (2Z,4E)-2,4-heptadiene

(D) (2E,4Z)-2,4-hexadiene

(E) (2Z,3E)-2,3-hexadiene

(B) 29. A chiral compound (C_5H_8) upon catalytic hydrogenation yields an achiral compound (C_5H_{10}). What is the best name for the former?

(A) 1-methylcyclobutene

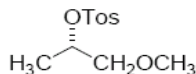
(B) 3-methylcyclobutene

(C) 1,2-dimethylcyclopropene

(D) cyclopentene

(E) none of them

(A) 30. Reaction of the following tosylate in its (S)-form with cyanide ion yields a nitrile product. What is the stereochemistry of the nitrile product?



(A) (S)-form

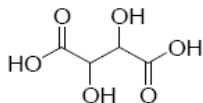
(B) (R)-form

(C) racemic form

(D) meso form

(E) none of them

(C) 31. How many total stereoisomer(s) of the following compound is(are) possible?



(A) 1

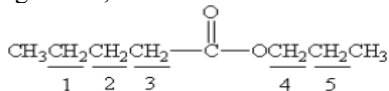
(B) 2

(C) 3

(D) 4

(E) 6

(D) 32. Which methylene group of the following compound whose chemical shift in NMR spectrum is the largest one, i.e. the most downfield one?

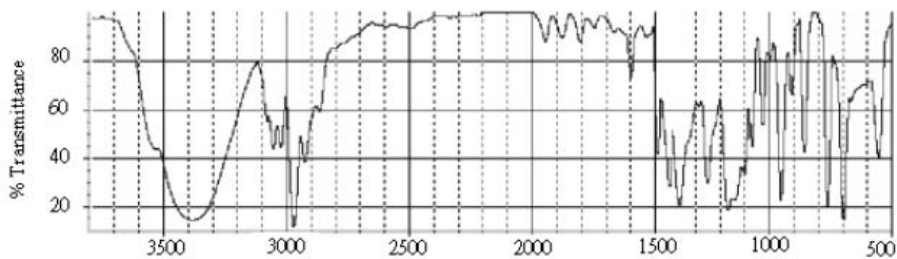


- (A) 1 (B) 2 (C) 3 (D) 4 (E) 5

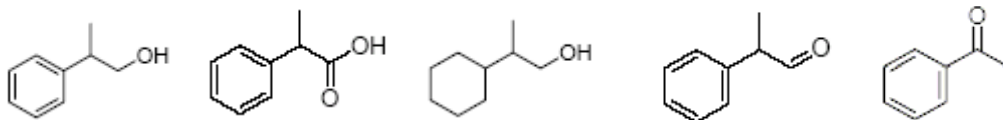
(D) 33. An NMR spectrometer is 400 MHz for ¹H-NMR spectra. How many MHz is it for ¹³C-NMR spectra?

- (A) 400 (B) 300 (C) 200 (D) 100 (E) 50

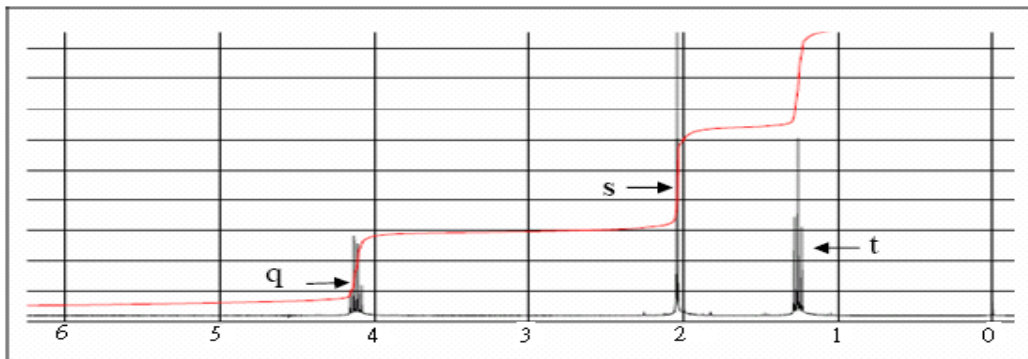
(A) 34. Which of the following structures is consistent with the IR spectra shown below?



- (A) (B) (C) (D) (E)



(D) 35. Which of the following structures is consistent with the ¹H NMR spectra shown below?

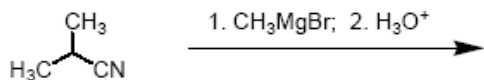


- (A) CH₃CH₂CH₂CH₃ (B) CH₃CH₂OH
 (C) (CH₃)₂CHOH (D) CH₃CO₂CH₂CH₃
 (E) CH₃CH₂CH₂CO₂H

(C) 36. How many signal(s) would be present in the ¹H NMR spectrum of acrylonitrile?

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

(C) 37. How many ¹H NMR signal(s) is(are) present for the product of the following reaction?

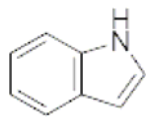


- (A) 1 (B) 2 (C) 3 (D) 4 (E) 5

(E) 38. Which of the following amino acids does not have an aromatic substructure within its side chain?

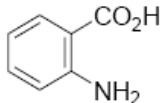
- (A) tryptophan (B) tyrosine (C) phenylalanine (D) histidine (E) leucine

(C) 39. The name of the following compound is



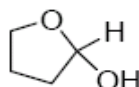
- (A) imidazole (B) pyrrole (C) indole (D) pyrimidine (E) pyridine

(A) 40. The name of the following compound is



- (A) anthranilic acid (B) salicylic acid (C) phthalic acid (D) triflic acid (E) adipic acid

(E) 41. The best description of the following compound is



- (A) an amide (B) an acetal (C) an ester (D) an ether (E) a hemiacetal

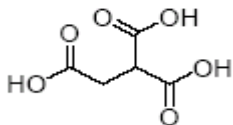
(B) 42. What is the correct structure for anisole?

- (A) (B) (C) (D) (E)

(A) 43. What is the product of cyclohexene reaction with potassium permanganate ($\text{KMnO}_4, \text{H}_3\text{O}^+$)?

- (A) adipic acid (B) glutaric acid (C) hexanoic acid (D) tartaric acid (E) glutamic acid

(C) 44. When the following acid is heated to 230°C , carbon dioxide is evolved and a new compound is formed. What is the new compound?



- (A) malonic acid (B) adipic acid (C) succinic acid (D) glutaric acid (E) oxalic acid

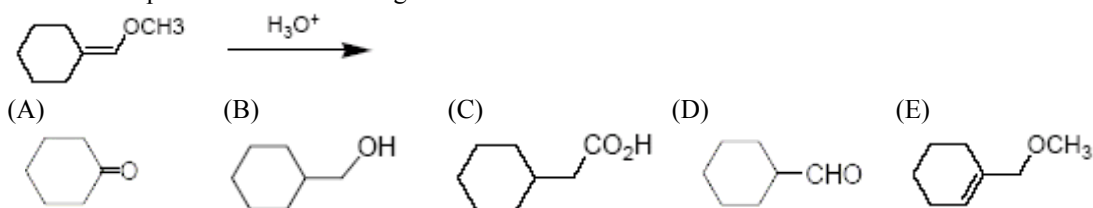
(E) 45. One of the following four amines is tertiary. Which one?

- (A) N-methylpropanamine (B) propanamine (C) pyrrole
(D) piperidine (E) none of them

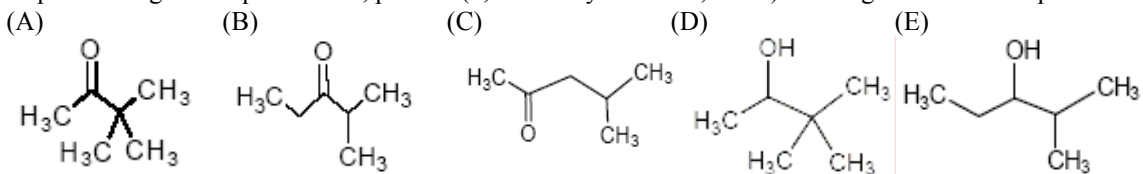
(C) 46. Cyclopentanone can react with diazomethane to produce

- (A) cyclopentyl amine (B) piperidine (C) cyclohexanone
(D) cyclopentanol (E) no reaction

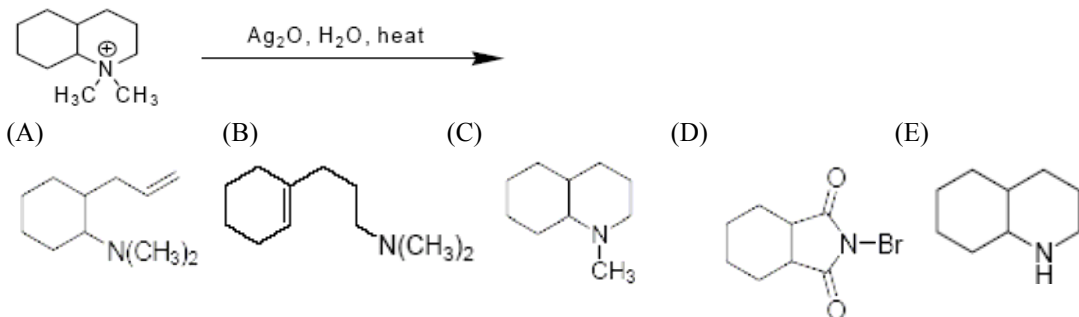
(D) 47. What is the product of the following reaction?



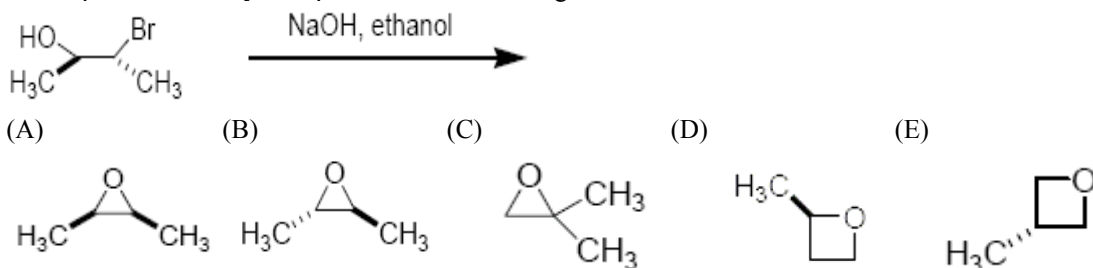
(A) 48. Upon heating with aqueous acid, pinacol (2,3-dimethylbutane-2,3-diol) rearranges. What is the product?



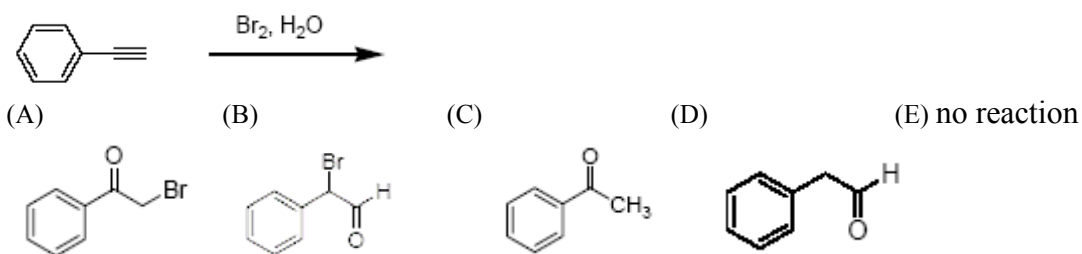
(A) 49. Major product of the following reaction is:



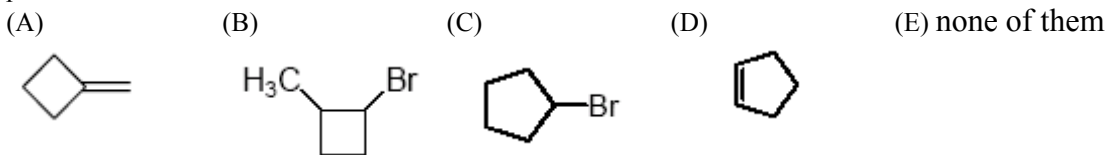
(A) 50. What product would you expect from the following reaction?



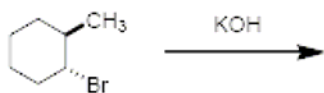
(A) 51. What product would you expect from the following reaction:

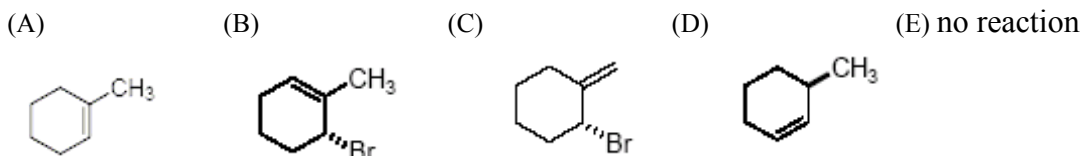


(B) 52. Vinylcyclopropane reacts with HBr to yield a rearranged alkyl bromide. What is the structure of the final product?

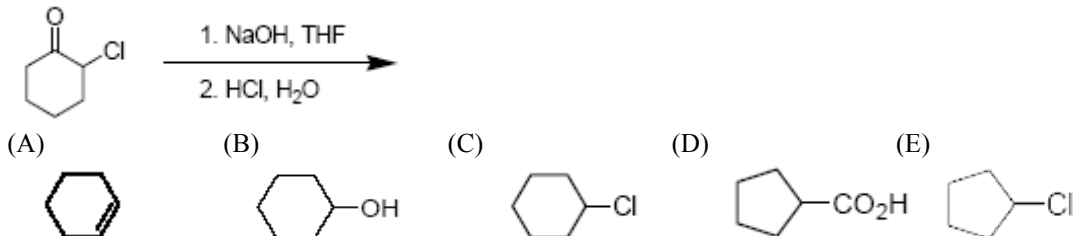


(D) 53. What product would you expect from the following reaction?

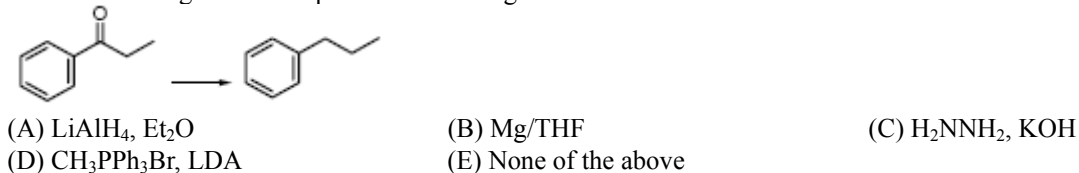




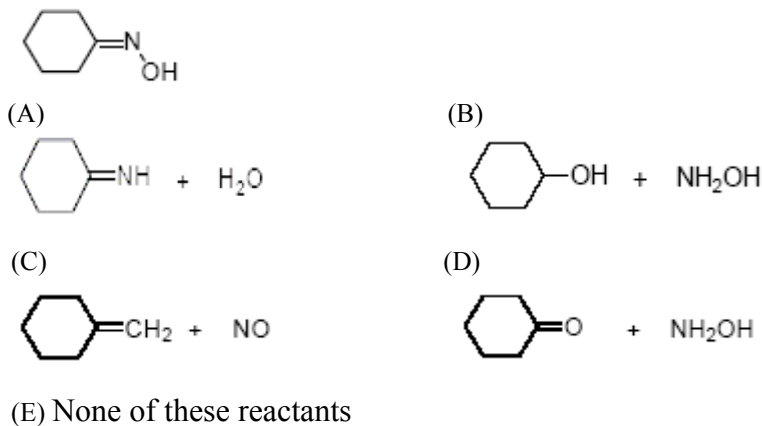
(D) 54. What product would you expect from the following reaction?



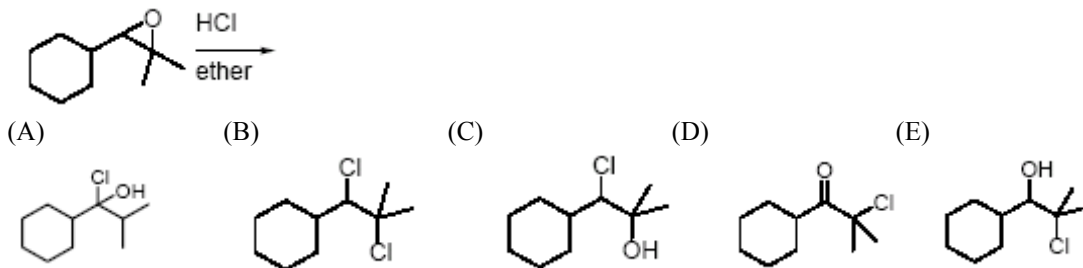
(C) 55. Provide the reagents to complete the following transformation.



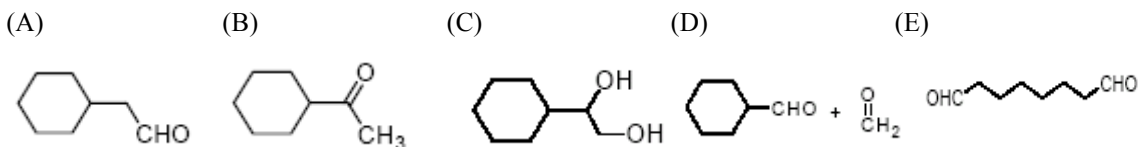
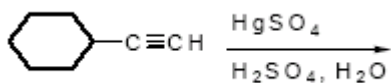
(D) 56. What reactants would be required to prepare the oxime shown below?



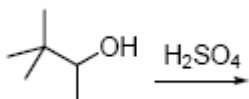
(E) 57. What is the major product for the following reaction?



(B) 58. What is the major product for the following reaction?

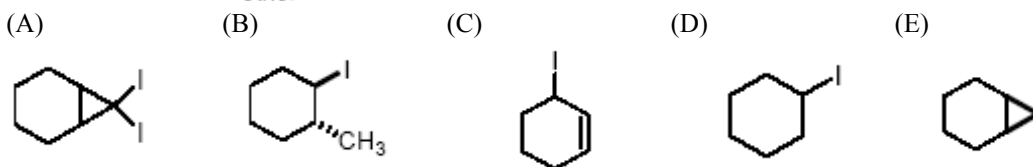
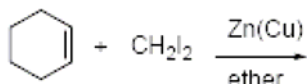


(A) 59. What is the major product for the following reaction?



- (A) 2,3-dimethyl-2-butene (B) 2,3-dimethyl-1-butene
 (C) 3,3-dimethyl-1-butene (D) 3,3-dimethyl-1-butanol |
 (E) None of the above

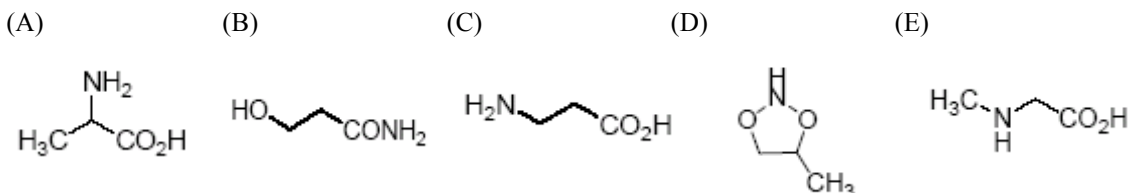
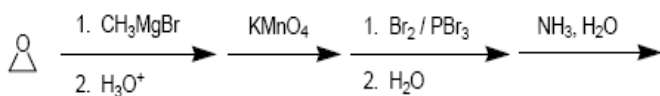
(E) 60. What is the major product for the following reaction?



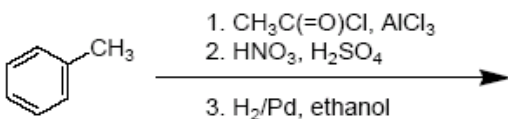
II. Choose one correct answer for the following questions

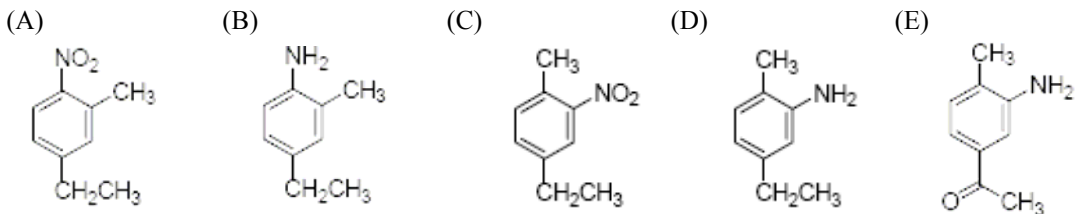
【單選題】每題 2 分，共計 40 分，答錯一題倒扣 0.5 分，倒扣至本大題零分為止，未作答，不給分亦不扣分。

(A) 61. What would be the structure of the final product of the following synthesis?

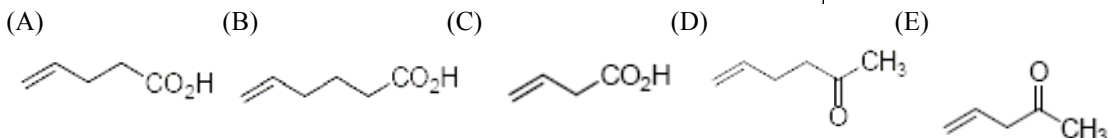
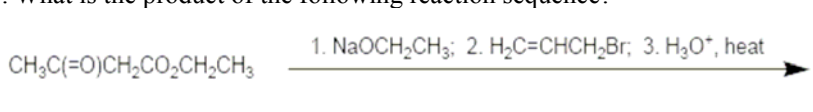


(D) 62. The final product of the following synthesis is

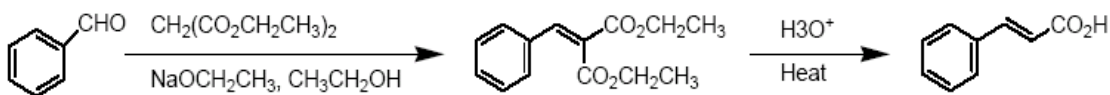




(D) 63. What is the product of the following reaction sequence?

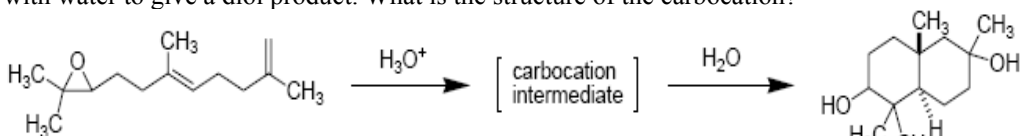


(E) 64. Which of the following statements about the reaction shown below is correct?



- (A) the product name is cinnamic acid
 (B) the reaction is called Knoevenagel reaction
 (C) one of the starting compound is diethyl malonate
 (D) the second step includes an intramolecular decarboxylation
 (E) all are correct statements

(A) 65. Treatment of the following epoxide with aqueous acid produces a carbocation intermediate that reacts with water to give a diol product. What is the structure of the carbocation?



- (A) 
- (B) 
- (C) 
- (D) 
- (E) none of them

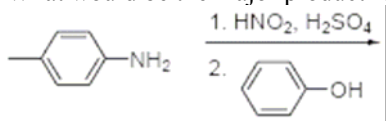
(E) 66. Which alcohol has the highest boiling point?

- (A) methanol (B) ethanol (C) n-propanol (D) n-butanol (E) n-pentanol

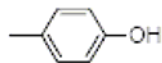
(C) 67. Reduction of 2-butanone with NaBH_4 yields 2-butanol. Which of the following description is **true**?

- (A) NaBH_4 is the oxidizing agent.
 (B) 2-butanone ($\text{C}_4\text{H}_8\text{O}$) receives two hydrides from NaBH_4 to form 2-butanol ($\text{C}_4\text{H}_{10}\text{O}$)
 (C) the product contains a chiral center
 (D) the product is optical active
 (E) None of the above

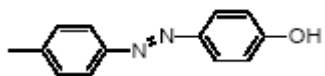
(C) 68. What would be the major product for the following reaction?



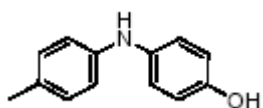
(A)



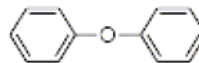
(C)



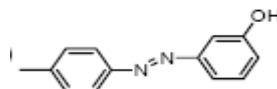
(E)



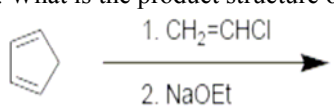
(B)



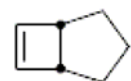
(D)



(B) 69. What is the product structure of the following reaction?



(A)



(B)



(C)

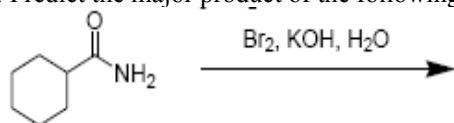


(D)

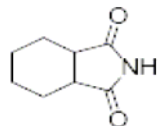


(E) none of them

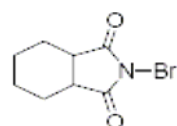
(C) 70. Predict the major product of the following reaction:



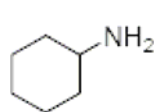
(A)



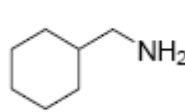
(B)



(C)

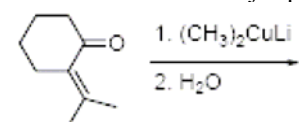


(D)

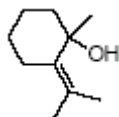


(E) no reaction

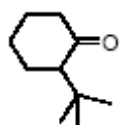
(B) 71. What would be the major product from the following reaction?



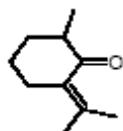
(A)



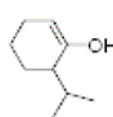
(B)



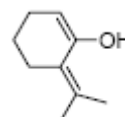
(C)



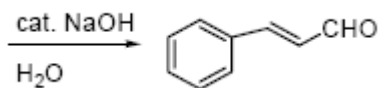
(D)



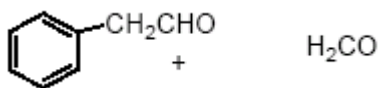
(E)



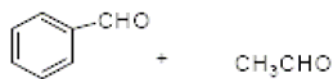
(B) 72. What reactants would be used to produce cinnamaldehyde?



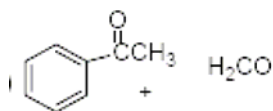
(A)



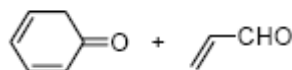
(B)



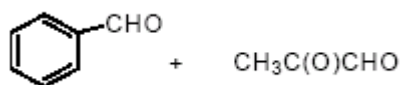
(C)



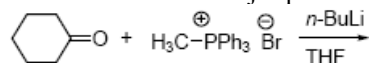
(D)



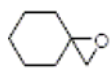
(E)



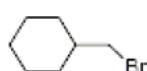
(E) 73. What would be the major product from the following reaction?



(A)



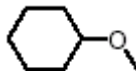
(B)



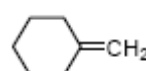
(C)



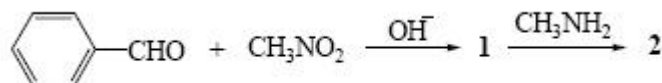
(D)



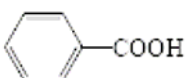
(E)



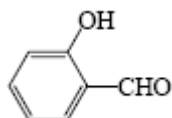
(E) 74. What is the product 1 of the following reactions?



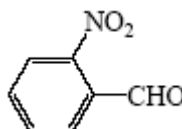
(A)



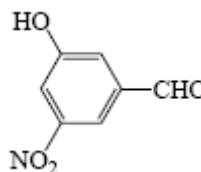
(B)



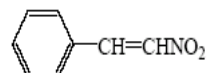
(C)



(D)

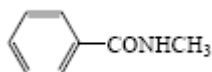


(E)

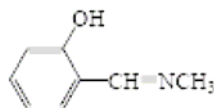


(E) 75. What is the product 2 in the question 74?

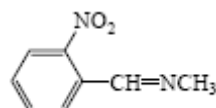
(A)



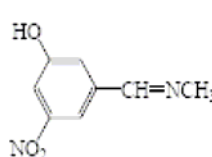
(B)



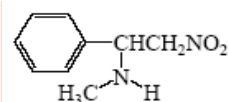
(C)



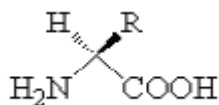
(D)



(E)



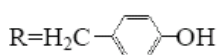
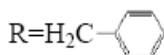
(E) 76. Which α -amino acid is not optical active?



- (A) R=H
(D)

- (B) R=CH₃
(E)

- (C) R=CH(CH₃)₂

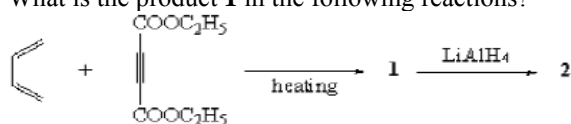


- (D) 77. A molecular cation is produced by McLafferty rearrangement in the mass spectrum of the following compound. How large is its m/z?



- (A) 44 (B) 56 (C) 57 (D) 58 (E) 60

- (E) 78. What is the product **1** in the following reactions?

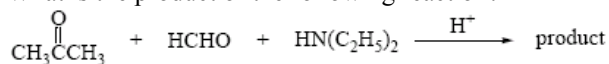


- (A) (B)
- (C) (D)
- (E)

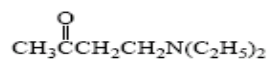
- (A) 79. What is the product **2** in the question 78?

- (A) (B)
- (C) (D)
- (E)

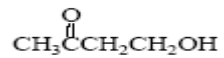
- (A) 80. What is the product of the following reaction?



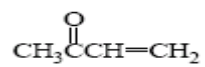
(A)



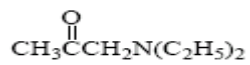
(B)



(C)



(D)

(E) $\text{CH}_3\text{N}(\text{C}_2\text{H}_5)_2$