

## CHAPTER

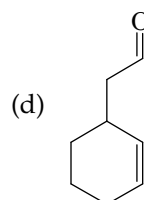
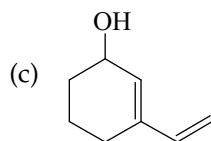
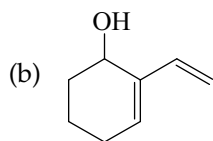
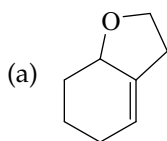
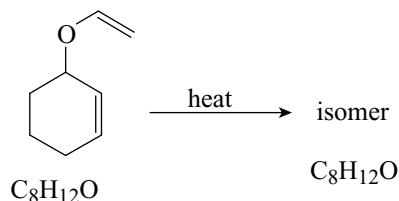
## 8

# Organic Reaction Mechanisms and Reagents

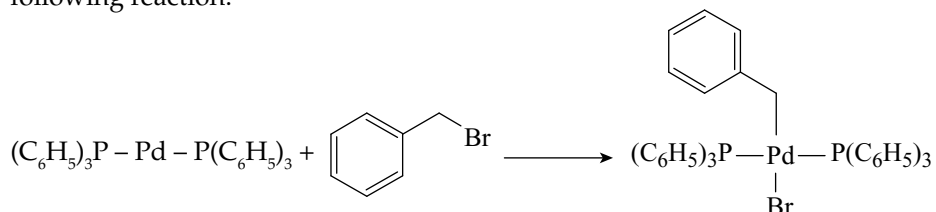
## Question Bank

### LEVEL 1

1. When the compound shown below is heated it undergoes a rearrangement to form an isomer. Identify the product.

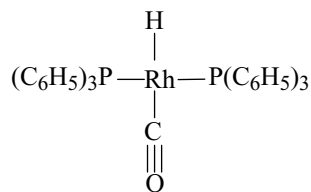


2. Organometallic reactions can be classified into fundamental reaction types. Classify the following reaction.



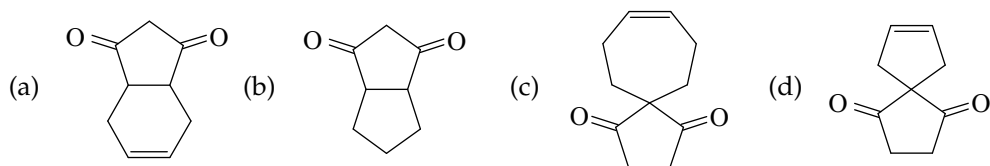
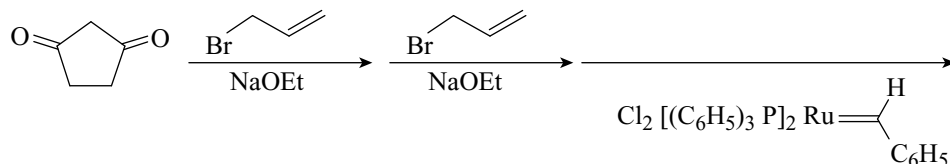
- (a) Ligand insertion                      (b) Ligand dissociation  
(c) Reductive elimination              (d) Oxidative addition

3. What is the electron count for the following transition metal complex?

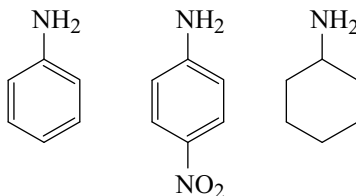


- (a) 14                      (b) 15                      (c) 16                      (d) 17

4. Predict the product of the following reaction sequence.

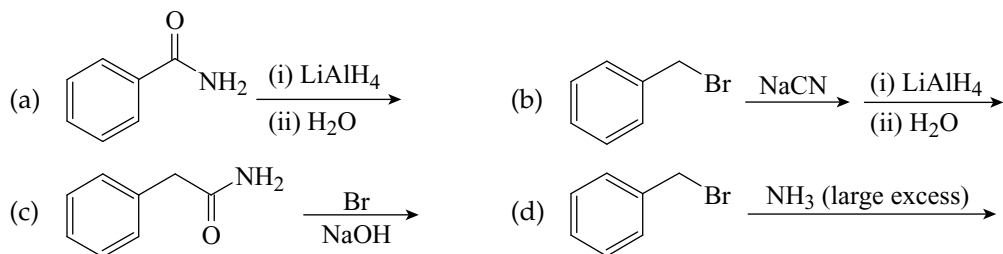


5. Consider the relative basicity of these three amines. Which statement is true?

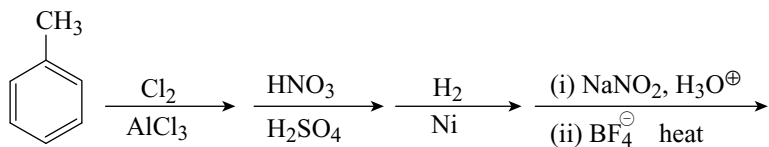


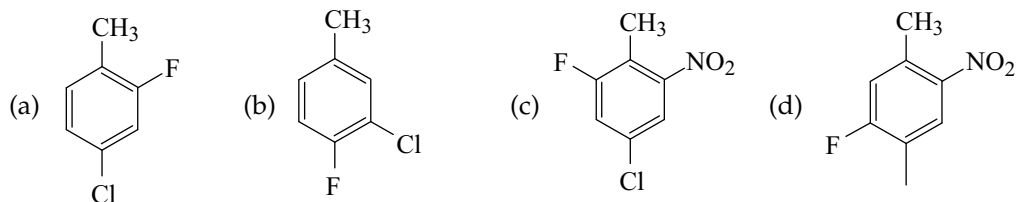
- (a) Cyclohexylamine is the strongest base and aniline is the weakest base  
 (b) Cyclohexylamine is the strongest base and 4-nitroaniline is the weakest base  
 (c) Aniline is the strongest base and cyclohexylamine is the weakest base  
 (d) Nitroaniline is the strongest base and cyclohexylamine is the weakest base

6. Which of the following syntheses of benzylamine is the least likely to work?

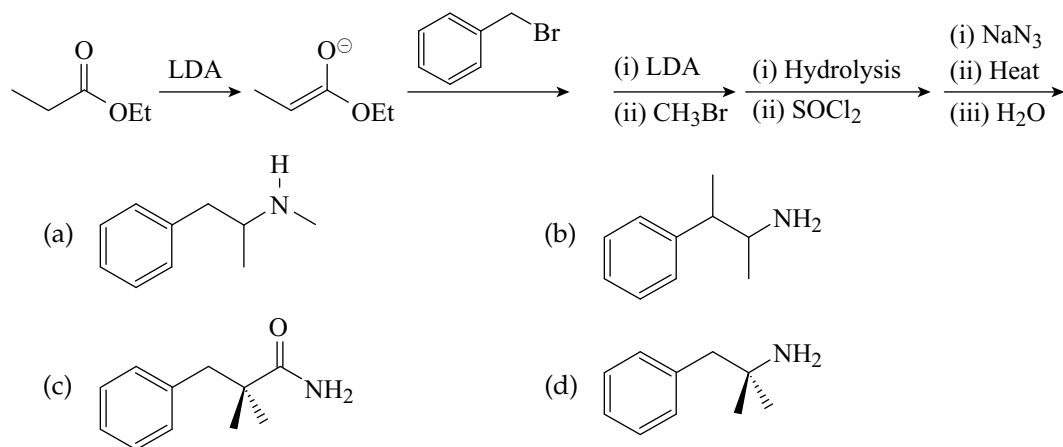


7. Predict the product of the following reaction sequence.

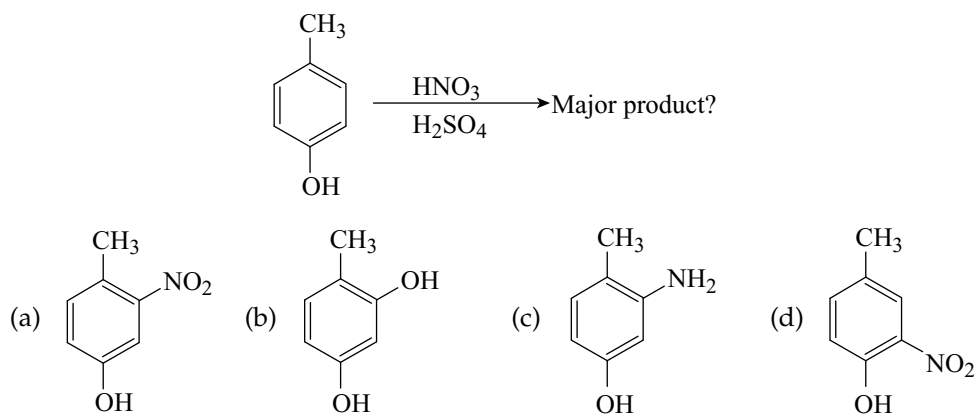




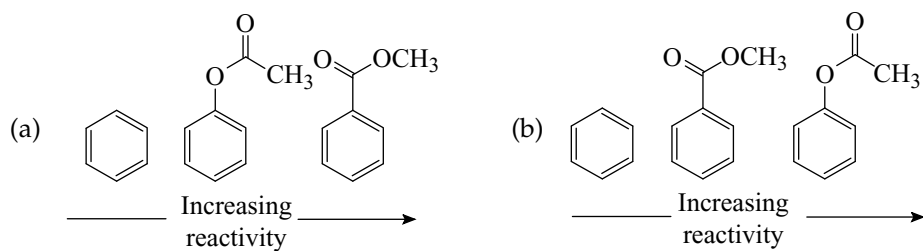
8. Predict the product of following reaction sequence.

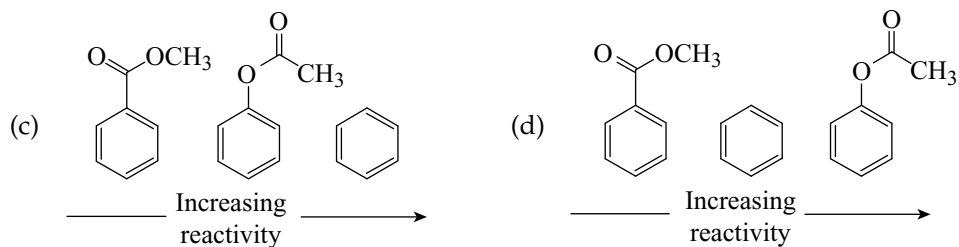


9. Choose the major product of the following reaction.

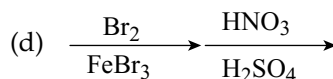
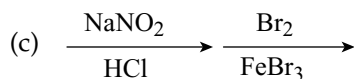
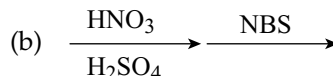
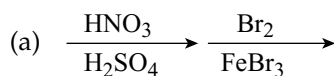
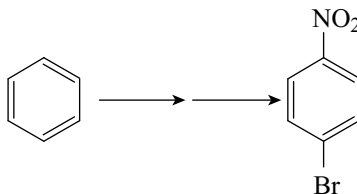


10. Choose the answer that has the following compounds arranged correctly with respect to increasing reactivity with  $\text{Br}_2/\text{FeBr}_3$ .

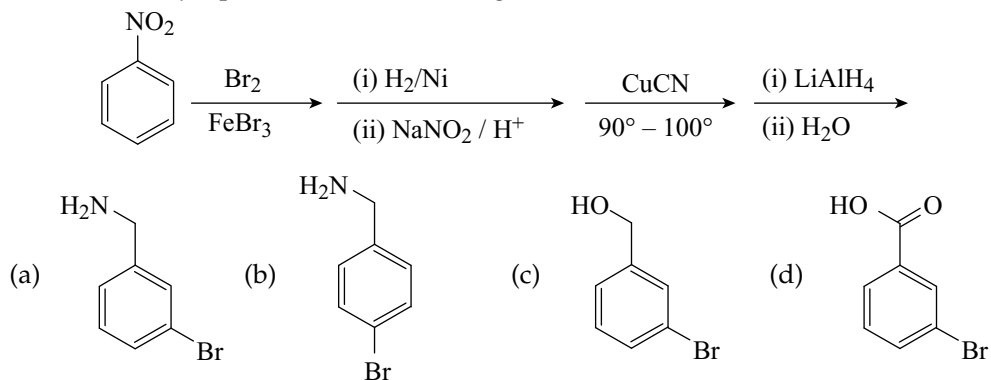




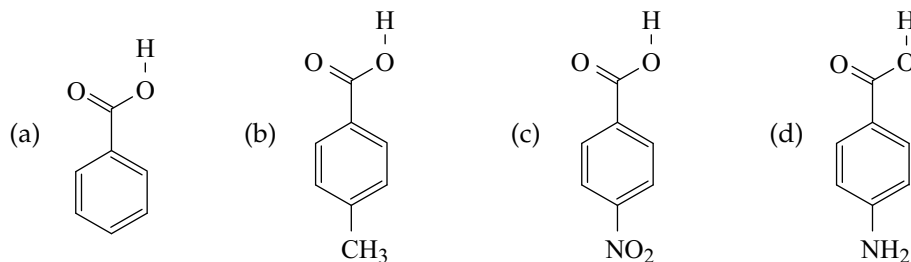
11. Choose the reaction sequence that could be used to perform the following transformation.



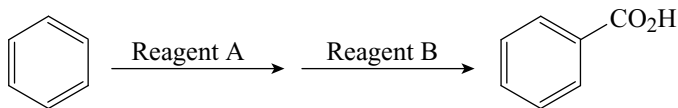
12. Predict the major product of the following reaction



13. Which of the following compounds is the most acidic? (lowest  $\text{pK}_a$ )

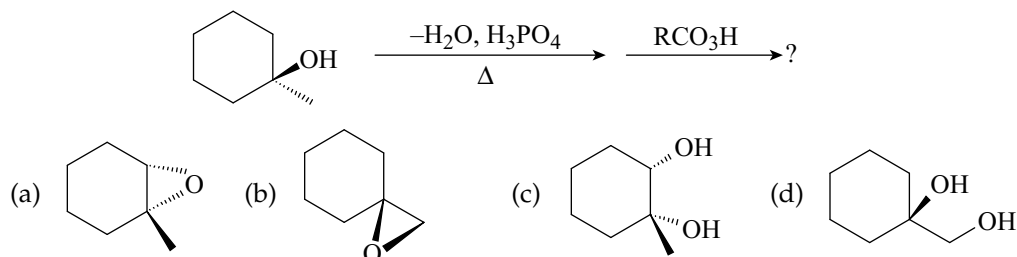


14. What could be reagents A and B for the following reactions?

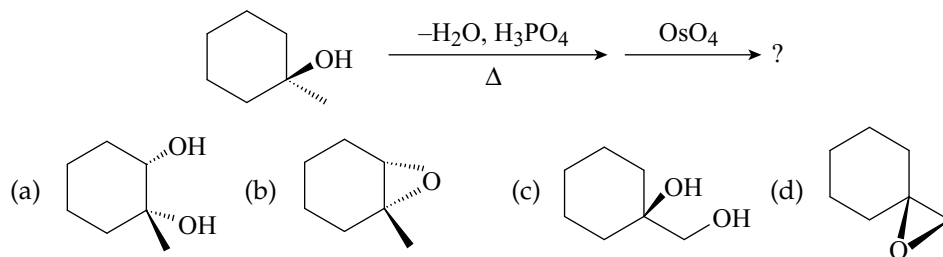


- (a) Reagent A:  $\text{CH}_3\text{CH}_2\text{Cl}$  /  $\text{AlCl}_3$ ; reagent B:  $\text{Na}_2\text{Cr}_2\text{O}_7$ , heat  
 (b) Reagent A:  $\text{CH}_3\text{COCl}$  /  $\text{AlCl}_3$ ; reagent B:  $\text{Na}_2\text{Cr}_2\text{O}_7$ , heat  
 (c) Reagent A:  $\text{HNO}_3$ ,  $\text{H}_2\text{SO}_4$ ; reagent B:  $\text{RCO}_3\text{H}$ , heat  
 (d) Reagent A:  $\text{CH}_3\text{COCl}$  /  $\text{AlCl}_3$ ; reagent B:  $\text{H}_2$ , Ni, heat

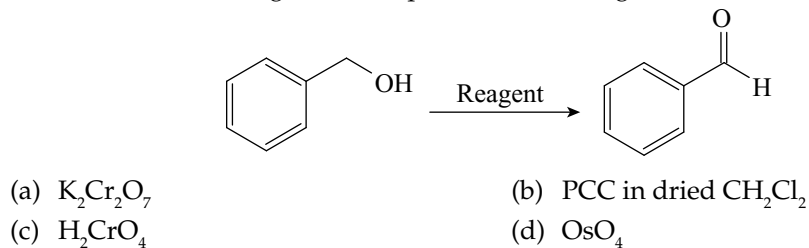
15. What could be the major product from the following reactions?



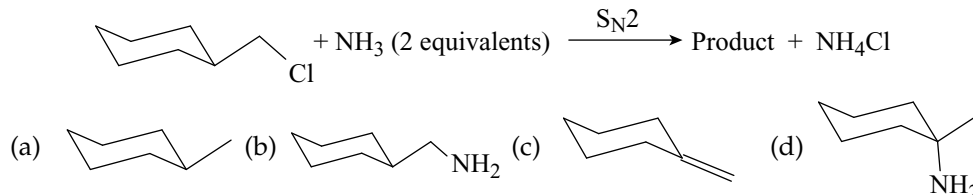
16. What could be the major product from the following reactions?



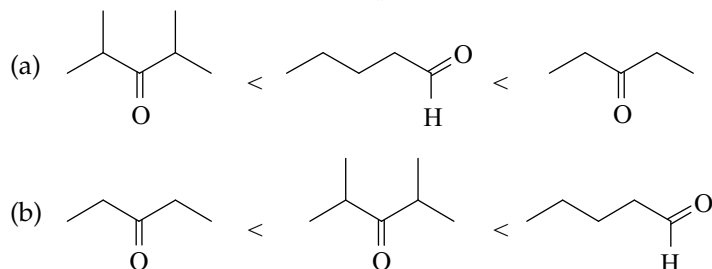
17. What could be the reagent to complete the following reaction?

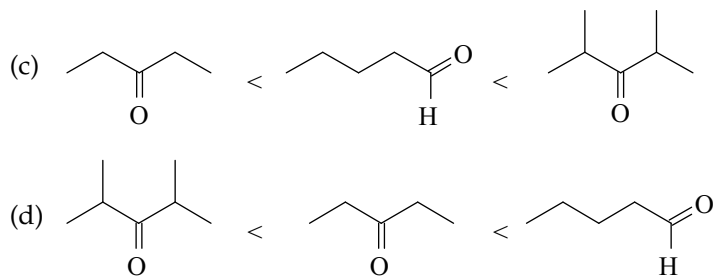


18. What could be the major product for the following reaction?

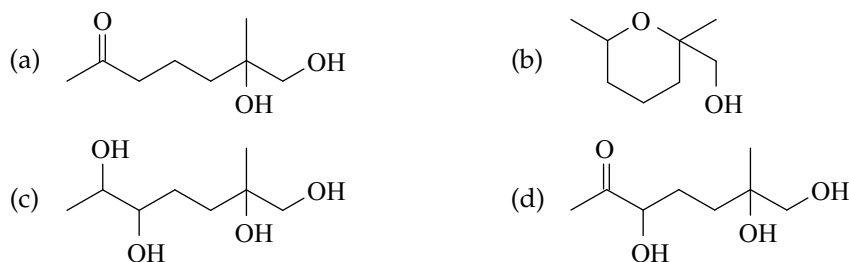
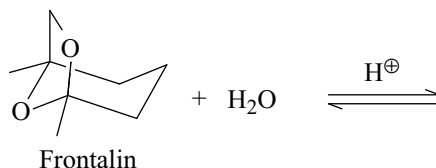


19. Choose order that has the following compounds correctly arranged with respect to increasing rate of reaction with  $\text{LiAlH}_4$  (most reactive compound on the right).

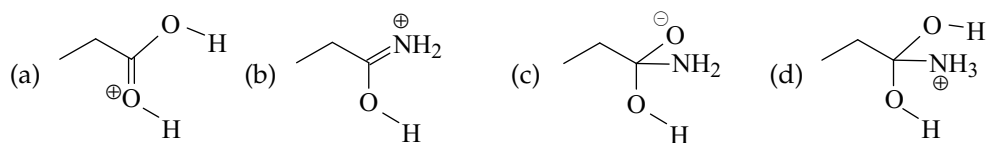




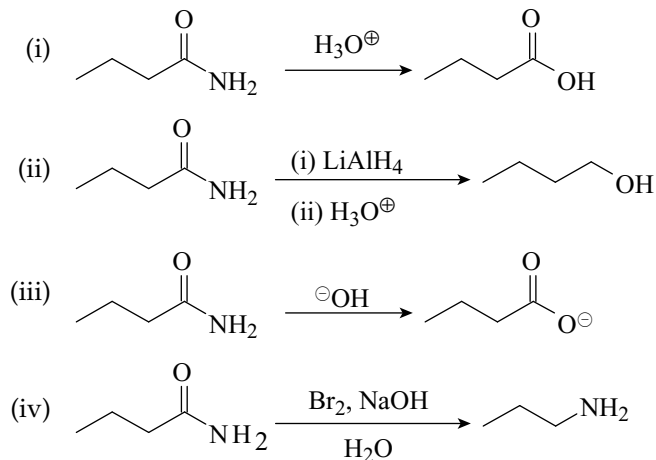
20. Choose the following compound that will cyclize to give the pheromone frontalin.



21. Choose the species that does not represent an intermediate in the acid-catalyzed hydrolysis of propionamide to carboxylic acid.

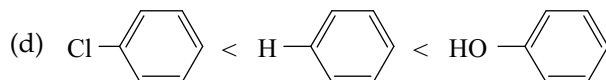
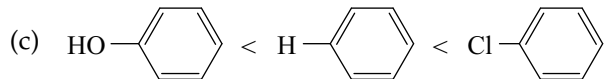
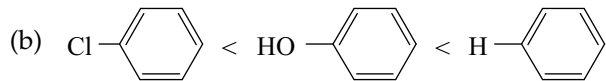
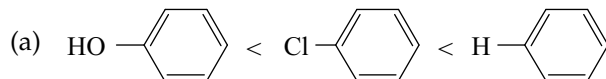


22. Choose the reaction(s) that will not proceed as shown hereunder.

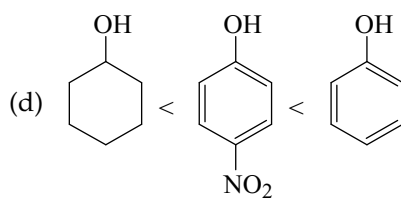
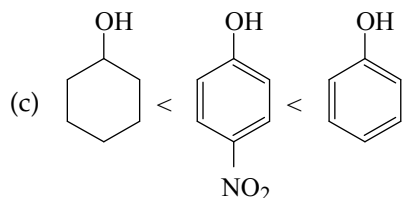
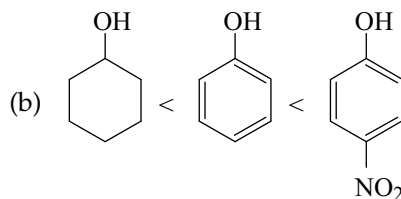
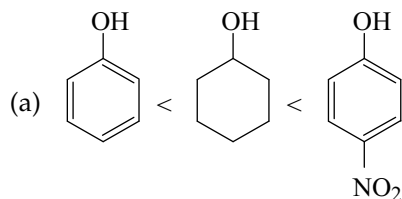


(a) Only i (b) Only ii (c) Only iii (d) Only iv

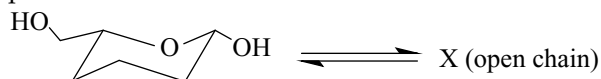
23. Choose the order that has the following aromatic compounds correctly arranged with respect to increasing reactivity towards  $\text{Br}_2/\text{FeBr}_3$



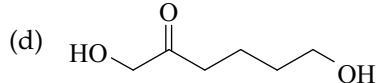
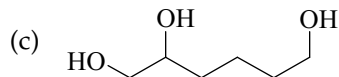
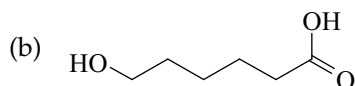
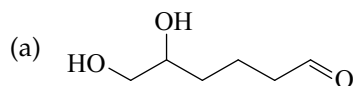
24. Choose the order that has the following alcohols correctly arranged with respect to increasing acidity.



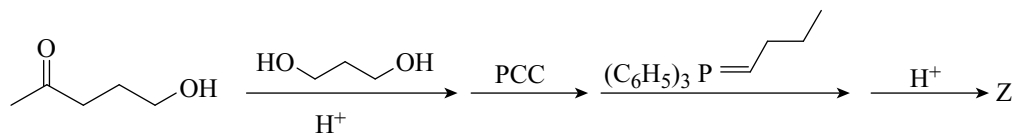
25. The compound shown below is a cyclic hemiacetal. It is in equilibrium with an acyclic open chain compound X.



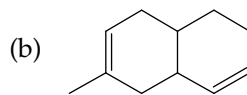
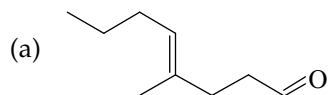
Identify the structure of compound X.

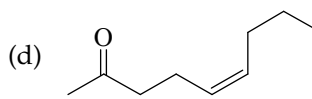
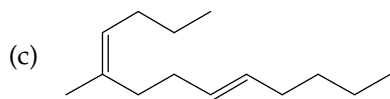


26. The reaction sequence shown below gives compound Z as the main product.

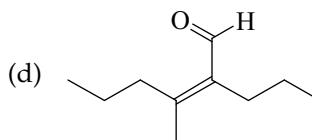
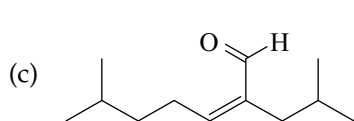
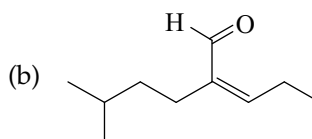
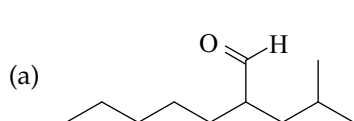
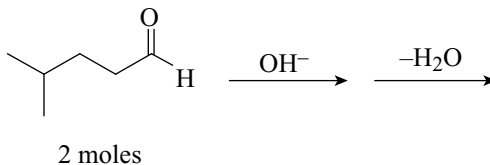


Identify the structure of compound Z.

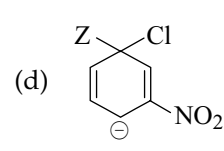
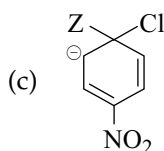
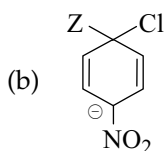
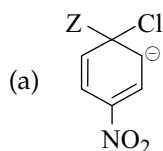




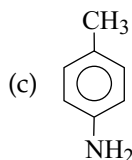
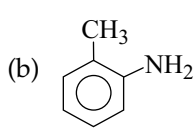
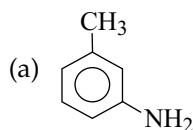
27. Predict the product of the following aldol condensation.



28. Which of the following structure is more stable?



29. Predict the nature of P in the following reaction



(d) All the three

30. Which of the following is most reactive towards aqueous HBr?

(a) 1-Phenyl-2-propanol

(b) 1-Phenyl-1-propanol

(c) 3-Phenyl-1-propanol

(d) 2-Phenyl-1-propanol

31. Ethylbenzene when treated with chlorine in presence of light mainly gives

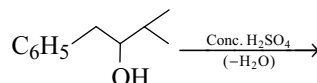
(a)  $\beta$ -phenylethyl chloride

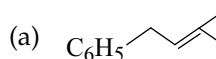
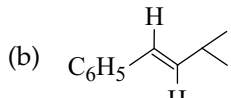
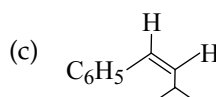
(b)  $\alpha$ -phenylethyl chloride

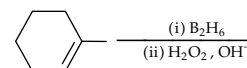
(c) o-chloroethyl benzene

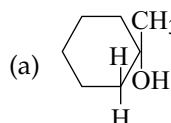
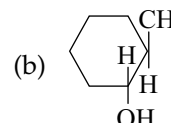
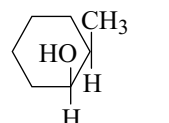
(d) o-and p-chloroethylbenzene

32. The following alcohol is treated with Conc.  $\text{H}_2\text{SO}_4$ , the major product obtained is



- (a)  (b) 
- (c)  (d) All the three will be formed in equal amounts

33.  X. The compound X is

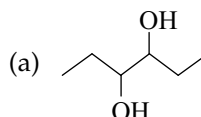
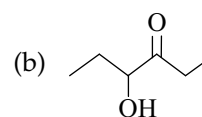
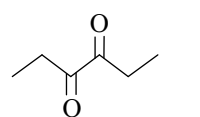
- (a)  (b)  (c)  (d) Both (b) and (c)

34. Give the nature of A and B in the given reaction

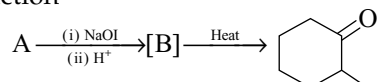


- (a) A and B both are  $(\text{CH}_3)_2\text{C}=\text{CH}_2$   
 (b) A and B, both are  $(\text{CH}_3)_2\text{CO} + \text{CH}_2\text{O}$   
 (c) A is  $(\text{CH}_3)_3\text{COH}$ , while B is  $(\text{CH}_3)_2\text{C}=\text{CH}_2$  or  $(\text{CH}_3)_2\text{CO}$   
 (d) A and B, both are  $(\text{CH}_3)_3\text{COH}$ , i.e., there is no reaction

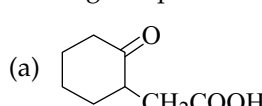
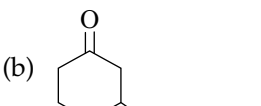
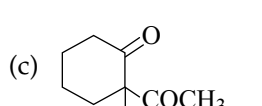
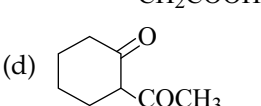
35. Which of the following is liable to be oxidized by periodic acid?

- (a)  (b)  (c)  (d) All of these

36. From the given set of reaction



starting compound A corresponds to

- (a)  (b) 
- (c)  (d) 

37. Methanoic acid is heated with Conc.  $\text{H}_2\text{SO}_4$  to form

- (a) CO (b)  $\text{CO}_2$  (c)  $\text{CH}_4$  (d)  $(\text{COOH})_2$

38. When ethane-1,2-dioic acid is heated with Conc.  $\text{H}_2\text{SO}_4$  it gives

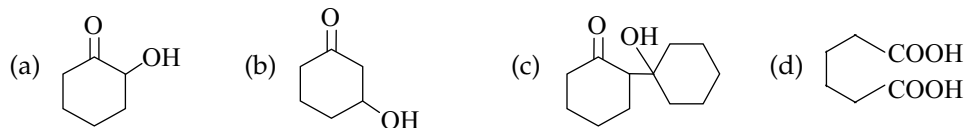
- (a)  $\text{CO} + \text{HCOOH}$  (b)  $\text{CO}_2 + \text{HCOOH}$   
 (c)  $\text{CO} + \text{CO}_2 + \text{HCOOH}$  (d)  $\text{CO} + \text{CO}_2 + \text{H}_2\text{O}$

39. When sodium formate is heated with soda lime, we get

- (a)  $\text{CH}_4$  (b)  $\text{H}_2$  (c) sodium oxalate (d) no action

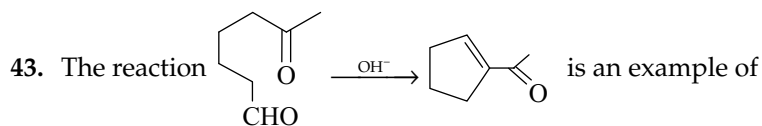
40. Sodium formate is heated at  $360^{\circ}\text{C}$  to give  
 (a) CO (b)  $\text{CO}_2$  (c) sodium oxalate (d) no action

41. When cyclohexanone is treated with  $\text{Na}_2\text{CO}_3$  solution, we get

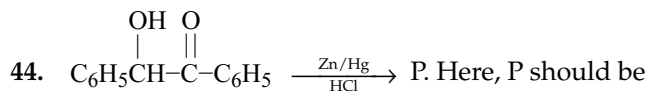


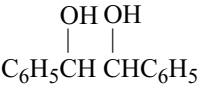
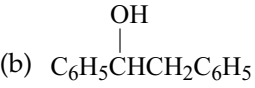
42. Which of the following reagent reacts in different ways with  $\text{CH}_3\text{CHO}$ ,  $\text{HCHO}$  and  $\text{C}_6\text{H}_5\text{CHO}$ ?

- (a) Fehling's solution (b)  $\text{C}_6\text{H}_5\text{NHNH}_2$   
 (c) Ammonia (d)  $\text{HCl}$



- (a) Oxidation reaction (b) Reduction  
 (c) Both (d) Aldol condensation



- (a)  (b)   
 (c)  $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_2\text{C}_6\text{H}_5$  (d)  $\text{C}_6\text{H}_5\text{CH}=\text{CHC}_6\text{H}_5$

45. Nitrobenzene can be reduced to aniline by

- (i)  $\text{H}_2/\text{Ni}$  (ii)  $\text{Sn}/\text{HCl}$  (iii)  $\text{Zn}/\text{NaOH}$  (iv)  $\text{LiAlH}_4$   
 (a) i, ii and iii (b) i and ii (c) i, ii and iv (d) only ii

46. 1-Methylcyclopentene can be converted into 2-methylcyclopentanol by

- (a) acid-catalyzed hydration  
 (b) hydroboration oxidation  
 (c) epoxide formation followed by reduction with  $\text{LiAlH}_4$   
 (d) oxymercuration-demercuration

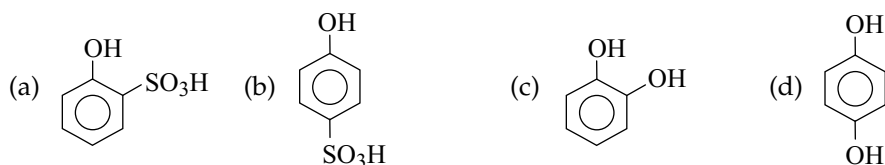
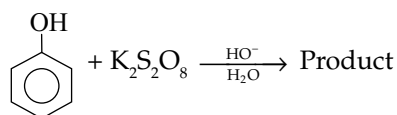
47. 2-Methylpropanol-2 can be obtained by the acid-catalyzed hydration of

- (a)  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$  (b)  $\text{CH}_3\text{CH}=\text{CHCH}_3$   
 (c)  (d) Either of the three

48. Predict the nature of P in the following reaction  $\text{CH}_3\text{C}\equiv\text{CCH}_3 \xrightarrow[\text{heat}]{\text{NaNH}_2/\text{inert solvent}}$  P

- (a)  $\text{CH}_2=\text{CHCH}=\text{CH}_2$  (b)  $\text{CH}_2=\text{C}=\text{CH}-\text{CH}_3$   
 (c)  $\text{CH}_3\text{CH}_2\text{C}\equiv\text{CH}$  (d) No reaction

49. Identify the nature of product in the following reaction



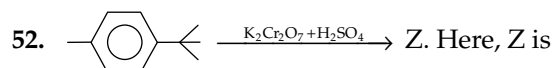
50. Arrange the following alcohols in order of increasing ease of dehydration



- (a)  $\text{ii} < \text{i} < \text{iv} < \text{iii}$  (b)  $\text{iv} < \text{iii} < \text{ii} < \text{i}$   
(c)  $\text{iv} < \text{iii} < \text{i} < \text{ii}$  (d)  $\text{ii} < \text{i} < \text{iii} < \text{iv}$

51. 1,2-Diethylbenzene on ozonolysis gives.....different products

- (a) 1 (b) 2 (c) 3 (d) 4

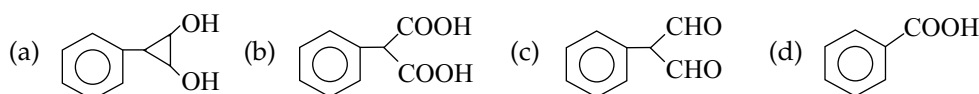
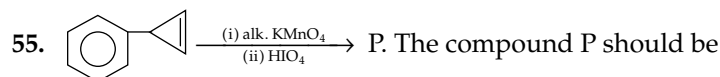


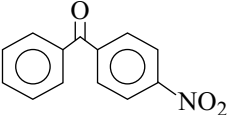
53. When o-hydroxybenzaldehyde is heated with ethanoic anhydride in the presence of sodium ethanoate, compound formed during the reaction is

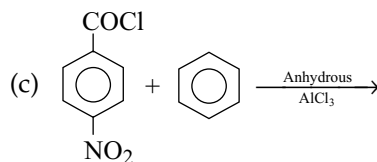
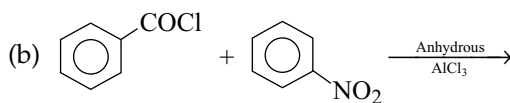
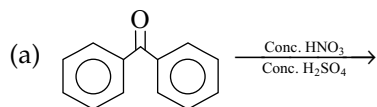


54. A new carbon-carbon bond is formed in

- (i) Aldol condensation (ii) Kolbe's reaction  
(iii) Reimer-Tiemann reaction (iv) Wurtz Fittig reaction  
(a) i, iii (b) ii, iii (c) i, iii, iv (d) All of these

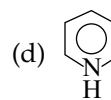
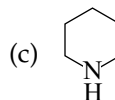
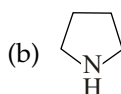
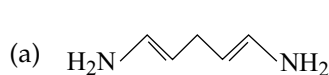


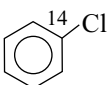
56. Which are the starting materials for the preparation of 

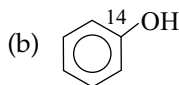
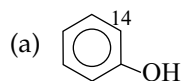


(d) Any of the three

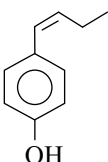
57.  $\text{Cl}^-\text{H}_3\text{N}^+ \text{---} \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{N}^+\text{H}_3\text{Cl}^- \xrightarrow{\text{Heat}} \text{Z}$ ; Z is

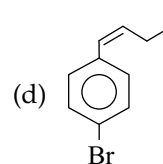
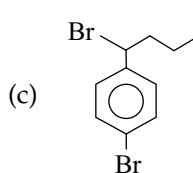
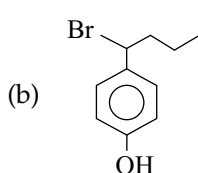
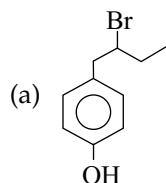


58.  + NaOH(aq.)  $\xrightarrow{400^\circ\text{C}}$  Product is



(c) Both (a) and (b) (d) No reaction

59.  + HBr  $\longrightarrow$  Z, Z is



60.  $\text{Me}_2\text{CHOCMe}_3 \xrightarrow{\text{HI}} \text{X} + \text{Y}$

Predict the nature of product and the type of reaction involved in their formation.

(a)  $\text{Me}_2\text{CHI}$  and  $\text{Me}_3\text{COH}$ , formed by  $\text{S}_{\text{N}}1$  reaction

(b)  $\text{Me}_2\text{CHI}$  and  $\text{Me}_3\text{Cl}$ , formed by  $\text{S}_{\text{N}}1$  reaction

(c)  $\text{Me}_2\text{CHI}$  and  $\text{Me}_3\text{COH}$ , formed by  $\text{S}_{\text{N}}2$  reaction

(d)  $\text{Me}_2\text{CHOH}$  and  $\text{Me}_3\text{Cl}$ , formed by  $\text{S}_{\text{N}}2$  reaction

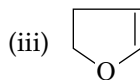
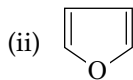
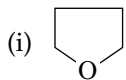
61. Anisole is treated with HI under two different conditions



The nature of A to D will be

- (a) A and B are  $\text{CH}_3\text{I}$  and  $\text{C}_6\text{H}_5\text{OH}$ , while C and D are  $\text{CH}_3\text{OH}$  and  $\text{C}_6\text{H}_5\text{I}$   
 (b) A and B are  $\text{CH}_3\text{OH}$  and  $\text{C}_6\text{H}_5\text{I}$ , while C and D are  $\text{CH}_3\text{I}$  and  $\text{C}_6\text{H}_5\text{OH}$   
 (c) Both A and B as well as both C and D are  $\text{CH}_3\text{I}$  and  $\text{C}_6\text{H}_5\text{OH}$   
 (d) A and B are  $\text{CH}_3\text{I}$  and  $\text{C}_6\text{H}_5\text{OH}$ , while there is no reaction in the second case.

62. Arrange the following in decreasing order of solubility in water

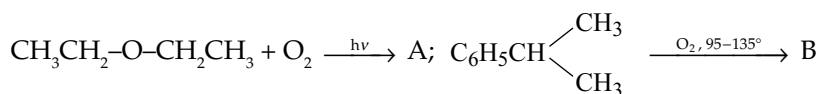


- (a)  $i > iii > ii$       (b)  $iii > ii > i$       (c)  $ii > iii > i$       (d) All are equally soluble

63. The ethereal linkage ( $-\text{C}-\text{O}-\text{C}-$ ) is cleaved by

- (a)  $\text{HBr}$       (b)  $\text{HNO}_3$       (c) Both (a) and (b)      (d) None

64. Predict the compounds A and B in the following reactions



- (a)  $\text{CH}_3\text{CH}_2-\text{O}-\text{O}-\text{CH}_2\text{CH}_3$  and  $\text{C}_6\text{H}_5-\text{C} \begin{matrix} \text{CH}_3 \\ | \\ \text{CH}_3 \end{matrix} -\text{O}-\text{OH}$  respectively

- (b)  $\text{CH}_3\text{CH}_2-\text{O}-\text{O}-\text{CH}_2\text{CH}_3$  and  $\text{C}_6\text{H}_5-\text{CH} \begin{matrix} \text{CH}_3 \\ | \\ \text{CH}_2-\text{O}-\text{OH} \end{matrix}$  respectively

- (c)  $\text{CH}_3\text{CH} \begin{matrix} \text{OOH} \\ | \end{matrix} -\text{O}-\text{CH}_2\text{CH}_3$  and  $\text{C}_6\text{H}_5-\text{C} \begin{matrix} \text{CH}_3 \\ | \\ \text{CH}_3 \end{matrix} -\text{O}-\text{OH}$  respectively

- (d) No reaction and  $\text{C}_6\text{H}_5-\text{C} \begin{matrix} \text{CH}_3 \\ | \\ \text{CH}_3 \end{matrix} -\text{O}-\text{OH}$  respectively

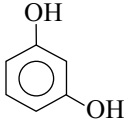
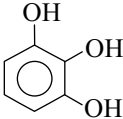
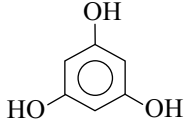
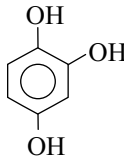
65. Products ( $\text{P}_2$ )  $\xleftarrow{\text{anhy. HI}}$   $(\text{CH}_3)_3\text{C}-\text{O}-\text{CH}_3 \xrightarrow{\text{Conc. HI}}$  Products ( $\text{P}_1$ )

The products  $\text{P}_1$  and  $\text{P}_2$  respectively are

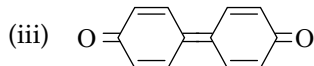
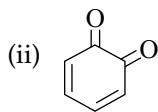
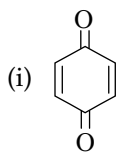
- (a)  $(\text{CH}_3)_3\text{COH} + \text{CH}_3\text{I}$  and  $(\text{CH}_3)_3\text{CI} + \text{CH}_3\text{OH}$   
 (b)  $(\text{CH}_3)_3\text{CI} + \text{CH}_3\text{OH}$  and  $(\text{CH}_3)_3\text{COH} + \text{CH}_3\text{I}$   
 (c)  $(\text{CH}_3)_3\text{CI} + \text{CH}_3\text{OH}$  in both cases  
 (d)  $\text{CH}_3\text{I}$  and  $(\text{CH}_3)_3\text{COH}$  in both cases

66. Cyclobutylethene is treated with dil.  $\text{H}_2\text{SO}_4$  to form

- (a) 2-cyclobutylethanol      (b) 1-cyclobutyl-2-ethanol  
 (c) 2-methylcyclopentanol      (d) 1-methylcyclopentanol

67. The decreasing order of acidic character of the compounds is  
 $\text{CH}_3\text{C} \equiv \text{CH}$ ,  $\text{MeOH}$ ,  $\text{Me}_2\text{CHOH}$ ,  $\text{Me}_3\text{COH}$ ,  $\text{H}_2\text{O}$   
 (a)  $\text{CH}_3\text{C} \equiv \text{CH} > \text{Me}_3\text{COH} > \text{Me}_2\text{CHOH} > \text{MeOH} > \text{H}_2\text{O}$   
 (b)  $\text{MeOH} > \text{Me}_2\text{CHOH} > \text{Me}_3\text{COH} > \text{H}_2\text{O} > \text{CH}_3\text{C} \equiv \text{CH}$   
 (c)  $\text{Me}_3\text{COH} > \text{Me}_2\text{CHOH} > \text{MeOH} > \text{H}_2\text{O} > \text{CH}_3\text{C} \equiv \text{CH}$   
 (d)  $\text{MeOH} > \text{H}_2\text{O} > \text{Me}_2\text{CHOH} > \text{Me}_3\text{COH} > \text{CH}_3\text{C} \equiv \text{CH}$
68. Arrange the following in the decreasing order of acidic strength  
 (i) Phenol                      (ii) p-nitrophenol      (iii) m-cresol                      (iv) p-cresol  
 (a) ii > iii > iv > i                                              (b) ii > i > iii > iv  
 (c) ii > i > iv > iii                                              (d) iii > iv > ii > i
69. Which of the following will be most acidic  
 (a) o-Aminophenol                                              (b) p-Aminophenol  
 (c) m-Aminophenol                                              (d) None of these
70. Arrange the following in increasing acidic character  
 (i) Phenol                                              (ii) m-nitrophenol  
 (iii) m-chlorophenol                                              (iv) m-cresol  
 (a) iv < i < iii < ii                                              (b) iv < i < ii < iii  
 (c) i < iv < iii < ii                                              (d) iii < ii < iv < i
71. Which of the following compounds can react with hydroxylamine?  
 (a)       (b)       (c)       (d) 
72. Which of the following statement is true regarding amount of  $\text{AlCl}_3$  required during Friedel-Craft acetylation using acetyl chloride or acetic anhydride?  
 (a) Both require same amount  
 (b) Acetylation with acetyl chloride requires more amount  
 (c) Acetylation with acetic anhydride requires more amount  
 (d) Nothing is definite
73. Which of the following gives effervescences of  $\text{CO}_2$  with  $\text{NaHCO}_3$  solution?  
 (a)  $\text{HCOOH}$                                               (b) 2,4,6-trinitrophenol  
 (c) Both (a) and (b)                                              (d) None of these
74. 2,4,6-Trinitrophenol can be prepared in good yield  
 (a) by the nitration of 2,4-dinitrochlorobenzene  
 (b) by the nitration of 2,4-dinitrophenol  
 (c) by both (a) and (b)  
 (d) neither by (a) nor by (b)

75. The correct stability order of the following three quinones is



- (a) i > iii > ii                      (b) i = iii > ii  
(c) i = ii > iii                      (d) iii > i > ii

76. Which of the following is most stable, and which one is least stable?

- (i) HCHO              (ii) CH<sub>3</sub>CHO              (iii) CH<sub>3</sub>COCH<sub>3</sub>              (iv) Cl<sub>3</sub>CCHO  
(a) (iii) is most stable and (i) is least              (b) (iv) is most stable and (i) is least  
(c) (iii) is most stable and (iv) is least              (d) All the four are equally stable

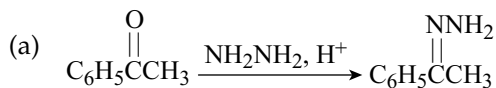
77. Which of the following has highest and lowest hydration equilibrium constant?

- HCHO, CH<sub>3</sub>CHO, CH<sub>3</sub>COCH<sub>3</sub>  
(a) HCHO-Highest, CH<sub>3</sub>CHO-Lowest  
(b) CH<sub>3</sub>CHO-Highest, HCHO-Lowest  
(c) HCHO-Highest, CH<sub>3</sub>COCH<sub>3</sub>-Lowest  
(d) CH<sub>3</sub>COCH<sub>3</sub>-Highest, HCHO-Lowest

78. CH<sub>3</sub>COCH<sub>2</sub>Cl  $\xrightarrow{\text{OH}^-, \text{Cl}_2}$  Product P is

- (a) ClCH<sub>2</sub>COCH<sub>2</sub>Cl                      (b) CH<sub>3</sub>COCHCl<sub>2</sub>  
(c) Both (a) and (b)                      (d) ClCH<sub>2</sub>COOH + CH<sub>3</sub>Cl

79. Which of the following is an example of nucleophilic addition?



- (c) Both (a) and (b)  
(d) None of the two

80. Propanal and propanone, both have same molecular formula (C<sub>3</sub>H<sub>6</sub>O), what do you expect about their boiling points?

- (a) Both have same boiling point.  
(b) Boiling point of propanal is higher than the boiling point of propanone.  
(c) Boiling point of propanal is lower than the boiling point of propanone.  
(d) Nothing can be predicted.

81. Which of the following statement is false about 1,3-dithiane,

- (a) 1,3-Dithiane can react with RLi  
(b) It can be alkylated by CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>Br

- (c) It can be alkylated by  $\text{Me}_2\text{CHX}$   
 (d) 1,3-Dithane can be used for preparing aldehydes and ketones

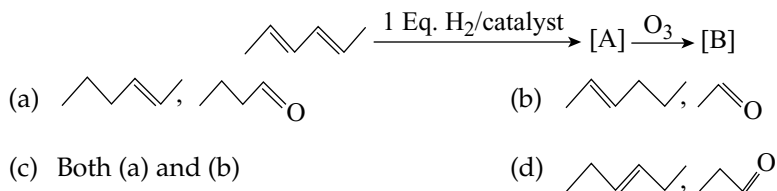
82. In dilute aqueous solution, formaldehyde exists as

- (a) Formaldehyde (b) Paraldehyde (c) Trioxymethylene (d) Methylene glycol

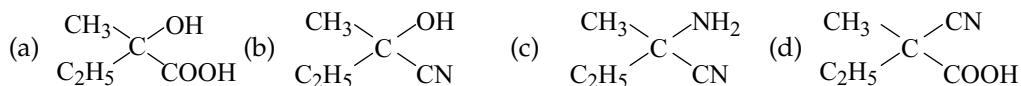
83. The major driving force for the hydration of chloral is

- (a) less steric hinderance in the product  
 (b) less force of repulsion in the product  
 (c) hydrogen bonding in the product  
 (d) electronegativity of the three chlorine atoms

84. The products A and B in the following reactions are



85.  $\text{CH}_3\text{C}(=\text{O})\text{C}_2\text{H}_5 + \text{NaCN} + \text{NH}_4\text{Cl} \xrightarrow{\text{NH}_4\text{OH}} \text{Z}$ ; Z is



86. The compound having the formula,  $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{OC}_2\text{H}_5$

- (a) forms dioxime (b) undergoes iodoform test  
 (c) both (a) and (b) (d) neither of the two

87. Fehling's solution can be used for distinguishing between

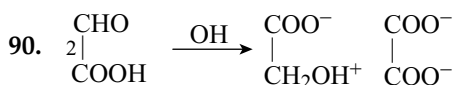
- (a)  $\text{CH}_3\text{CHO}$  and  $\text{C}_6\text{H}_5\text{CHO}$  (b)  $\text{CH}_3\text{CHO}$  and  $\text{CH}_3\text{COCH}_2\text{OH}$   
 (c) Both (a) and (b) (d) None of these

88. Which of the following is least reactive with a nucleophile?

- (a) Methanal (b) Propanone (c) 3-Pentanone (d) 2-Pentanone

89. Aldehydic group can be protected

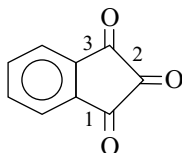
- (a) by acetal formation against alkaline oxidizing agents.  
 (b) by mercaptal formation against acidic oxidizing agents.  
 (c) both (a) and (b)  
 (d) none of the above



The above reaction can said to be an example of

- (a) Intramolecular Cannizzaro reaction    (b) Intermolecular Cannizzaro reaction  
(c) Crossed Cannizzaro reaction    (d) Tischenko reaction

91. Ninhydrin has three keto groups, which of the keto group is expected to be hydrated most easily?



- (a) 2                      (b) 3                      (c) 1                      (d) All are equally hydrated

92.  $\text{C}_2\text{H}_5\text{O}-\overset{\text{O}}{\parallel}{\text{C}}-\text{OC}_2\text{H}_5 + 2\text{CH}_3\text{MgBr} \longrightarrow \text{A}$ ; A is

- (a)  $(\text{CH}_3)_2\text{C}(\text{OH})-\text{C}_2\text{H}_5$     (b)  $\text{C}_2\text{H}_5-\overset{\text{OH}}{\underset{\text{C}_2\text{H}_5}{\text{C}}}-\text{CH}_3$     (c)  $\text{CH}_3\text{COOH}$     (d)  $\text{CH}_3\text{COCH}_3$

93.  $\xrightarrow[\text{(ii) Heat}]{\text{(i) O}_3 / \text{H}_2\text{O}}$  A; A is

- (a)  $\text{CH}_2(\text{COOH})_2$     (b)  $\text{CH}_3\text{COOH}$     (c)  $\text{HCOOH}$     (d)  $\text{HCHO}$

94. Which is least reactive towards addition of HCl?

- (a)  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$                       (b)  $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$   
(c)  $\text{CH}_3\text{CH}_2\text{C}\equiv\text{CCH}_3$                       (d)  $\text{CH}_3\text{CH}=\text{CHCHO}$

95. Which of the following is true regarding preparation of aldehydes and ketones?

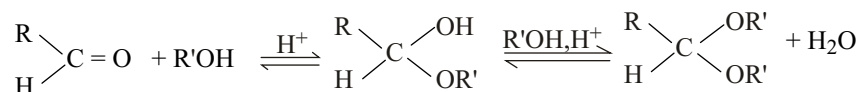
- (i) Both can be prepared by the oxidation of the concerned alcohol with copper at about  $250^\circ\text{C}$ .  
(ii) Both can be prepared by the oxidation of the concerned alcohol by Oppenauer oxidation.  
(iii) Both can be prepared by the oxidation of respective alcohol with acidic dichromate.  
(a) i                      (b) ii and iii                      (c) i and iii                      (d) All the three

96. Observe the following structures and pick up the correct statement.

- (i)  $\text{>C}=\text{O}$                       (ii)  $\text{>C}=\overset{+}{\text{O}}\text{H}$

- (a) Carbonyl carbon of (i) is more electrophilic than that of (ii).  
(b) Carbonyl carbon of (i) is less electrophilic than that of (ii).  
(c) Carbonyl carbon of both structures has equal electrophilic character.  
(d) It depends upon the complete structure of the compound

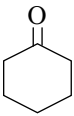
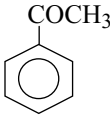
97. Acetal formation is a reversible reaction



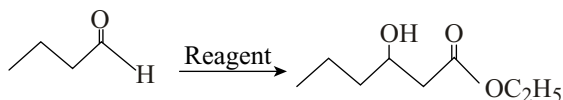
Under what conditions, the reaction can be forced to proceed only in right (forward) direction?

- (a) Using excess of alcohol
- (b) Using high temperature
- (c) Using dilute acid and excess of alcohol
- (d) Using dry acid and excess of alcohol

98. Which of the following does not react with sodium bisulphite?

- (i) HCHO      (ii)  $\text{CH}_3\text{COC}_2\text{H}_5$       (iii)       (iv) 
- (a) iii and iv      (b) ii and iv      (c) i      (d) All reacts

99. Which of the following reagent can be used for carrying out the reaction outlined below?



- (a)  $\text{BrMgCH}_2\text{COOC}_2\text{H}_5$  (b)  $\text{BrZnCH}_2\text{COOC}_2\text{H}_5$   
 (c)  $\text{LiCH}_2\text{COOC}_2\text{H}_5$  (d) Any of the three

100. Which of the following statement is false?

- (a) Cannizzaro reaction is given by aldehydes in presence of alkali
- (b) Aldol condensation is given by aldehydes in presence of alkali
- (c) Aldol condensation is given by aldehydes and ketones in presence of acids
- (d) None of these

101. Carbonyl compounds, sensitive to both acids as well as bases, can be reduced to hydrocarbons by

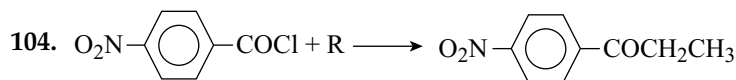
- (a) Clemmensen reduction
- (b) Wolf-Kishner reduction
- (c) Thioacetal reduction
- (d) All of the three

102. What should be the product when ethylmethyl ketone is treated with peracetic acid

- (a) Ethyl acetate
- (b) Methyl propanoate
- (c) Both (a) and (b)
- (d) Only acetic acid

103. Which of the following complex hydride is a stronger reducing agent?

- (a)  $\text{Li}^+[\text{AlH}_4]^-$
- (b)  $\text{Li}^+[\text{Al}(\text{OCMe}_3)_3\text{H}]^-$
- (c)  $\text{Al}(\text{CH}_2\text{CHMe}_2)_2\text{H}$
- (d) All are strong reducing agents



The reagent R may be

- (i)  $\text{CH}_3\text{CH}_2\text{MgBr}$  (ii)  $\text{CH}_3\text{CH}_2\text{Li}$   
 (iii)  $(\text{CH}_3\text{CH}_2)_2\text{Cd}$  (iv)  $(\text{CH}_3\text{CH}_2)_2\text{CuLi}$   
 (a) i or ii (b) i or ii or iii (c) iii or iv (d) Any of the four

105. Which one does not belong to the same compound?

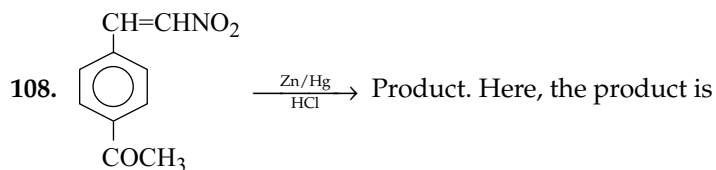
- (a) Paraformaldehyde (b) Paraldehyde  
 (c) Trioxane (d) Formalin

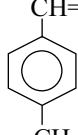
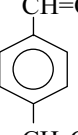
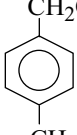
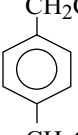
106. Which of the following is not a good reagent in Wittig reaction?

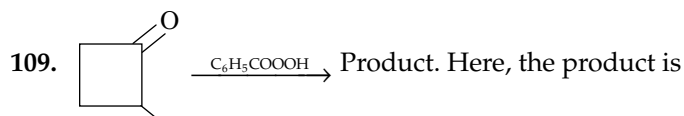
- (a)  $\text{Ph}_3\text{P}=\text{CH}_2$  (b)  $\text{Ph}_3\text{P}^+\text{CH}^-\text{CH}_2\text{CH}_3$   
 (c)  $(\text{CH}_3)_3\text{CCH}=\text{PPh}_3$  (d)  $\text{C}_6\text{H}_5\text{COCH}=\text{PPh}_3$

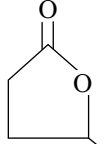
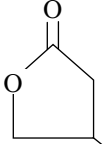
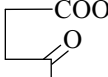
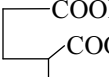
107. Which of the following is not formed in iodoform reaction?

- (a)  $\text{CH}_3\text{COCH}_2\text{I}$  (b)  $\text{ICH}_2\text{COCH}_2\text{I}$  (c)  $\text{CH}_3\text{COCHI}_2$  (d)  $\text{CH}_3\text{COCl}_3$



- (a)  (b)  (c)  (d) 



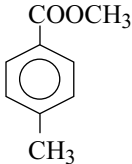
- (a)  (b)  (c)  (d) 

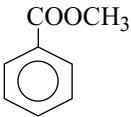
110. Acetyl chloride does not react with

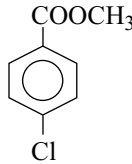
- (a) Water (b) Sodium acetate  
 (c) 2-methylpropene (d) It reacts with all the three

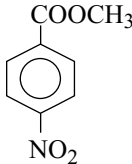
111. Which of the following statement is true?

- (a) At room temperature, formyl chloride is present in the form of CO and HCl.  
 (b) Acetamide behaves as a weak base as well as a weak acid.  
 (c)  $\text{CH}_3\text{CONH}_2 \xrightarrow{\text{LiAlH}_4} \text{CH}_3\text{CH}_2\text{NH}_2$ .  
 (d) All of the above.

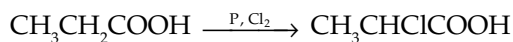
112. Which of the following reaction is possible?
- (i)  $\text{CH}_3\text{COCl} + \text{H}_2\text{O} \longrightarrow \text{CH}_3\text{COOH} + \text{HCl}$
  - (ii)  $\text{CH}_3\text{COOCH}_3 + \text{HBr} \longrightarrow \text{CH}_3\text{COBr} + \text{CH}_3\text{OH}$
  - (iii)  $\text{CH}_3\text{CONH}_2 + \text{HBr} \longrightarrow \text{CH}_3\text{COBr} + \text{NH}_3$
  - (iv)  $\text{CH}_3\text{COOCOCH}_3 + \text{H}_2\text{O} \longrightarrow 2\text{CH}_3\text{COOH}$
- (a) i and iv                      (b) i, iii and iv                      (c) i, ii and iv                      (d) All the four
113. Which of the following is not possible?
- (a)  $\text{ICH}_2\text{COOH} + \text{NaCl} \xrightarrow{\text{Acetone}} \text{ClCH}_2\text{COOH} + \text{NaI}$
  - (b)  $\text{ClCH}_2\text{COOH} + \text{NaI} \xrightarrow{\text{Acetone}} \text{ICH}_2\text{COOH} + \text{NaCl}$
  - (c) Both (a) and (b)
  - (d) None of these
114. Acid amide do not undergo the usual properties of carbonyl,  $\text{C}=\text{O}$  group because
- (a) it is a weak base                      (b) it is a weak acid
  - (c) it is amphoteric                      (d) its carbonyl carbon is not electron deficient
115. Which of the following statement is true regarding aspirin, a commonly used antipyretic and analgesic? Given  $\text{pK}_a$  for aspirin = 3.5; pH in stomach and small intestine is 2.5 and 8, respectively.
- (a) It is completely ionized in the stomach and almost un-ionized in the small intestine.
  - (b) It is ionized in the small intestine and almost un-ionized in the stomach.
  - (c) It is ionized in the stomach and almost un-ionized in the small intestine.
  - (d) It is neither ionized in stomach nor in intestine.
116. Which of the following will undergo alkaline hydrolysis most rapidly?
- (a) 

(b) 

(c) 

(d) 

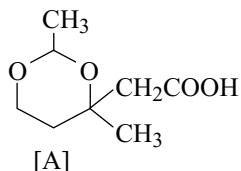
117. HVZ reaction involves the use of P and  $\text{Cl}_2$



The function of phosphorus is

- (a) as a catalyst
  - (b) in the formation of  $\text{PCl}_3$  which carries out halogenation at the  $\alpha$ -carbon atom
  - (c) in the formation of  $\text{PCl}_3$  which converts  $-\text{COOH}$  into  $-\text{COCl}$
  - (d) none of the these
118. Hydrolysis of esters in presence of an acid is a reversible reaction. What is true about ester hydrolysis in presence of a base?
- (a) It is irreversible because salts of carboxylic acids are insoluble.
  - (b) It is irreversible because salts of carboxylic acids have high melting points.
  - (c) It is irreversible because carboxylate ion is resonance stabilized.
  - (d) It is a reversible reaction.

119. Compound A is formed by the interaction of

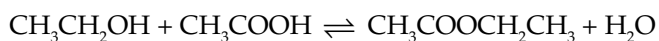


- (a)  $\text{CH}_3\text{COOH}$  and  $\text{HO}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CHO}$
- (b)  $\text{CH}_3\text{CHO}$  and  $\text{HO}-\text{CH}_2-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2-\text{COOH}$
- (c)  $\text{CH}_3\text{COCH}_2\text{COOH}$  and  $\text{HO}-\text{CH}_2-\text{CH}_2-\text{C}(\text{OH})(\text{CH}_3)-\text{CHO}$
- (d)  $\text{CH}_3\text{CHO}$  and  $\text{HO}-\text{CH}_2-\text{CH}_2-\text{C}(\text{OH})(\text{CH}_3)-\text{COOH}$

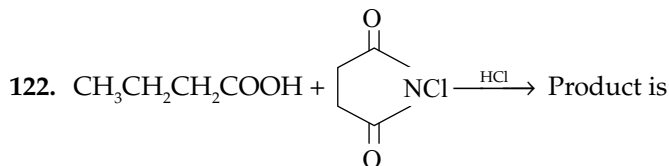
120. What is the main product when  $\text{HOOC}-\text{C}_6\text{H}_{10}-\text{COOH}$  is heated?

- (a)
- (b)
- (c)
- (d)

121. The yield of ester in esterification can be increased by



- (a) removing water (b) taking ethanol in excess
- (c) taking acetic acid in excess (d) all the above factors

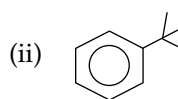
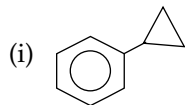


- (a)  $\text{CH}_3\text{CH}_2\text{CH}(\text{Cl})\text{COOH}$  (b)  $\text{ClCH}_2\text{CH}_2\text{CH}_2\text{COOH}$
- (c)  $\text{CH}_3\text{CH}(\text{Cl})\text{CH}_2\text{COOH}$  (d) All the three

123. The correct order of decarboxylation of the three acids is

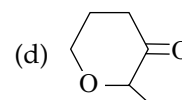
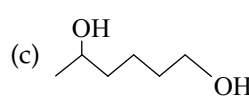
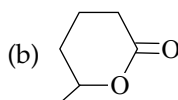
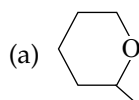
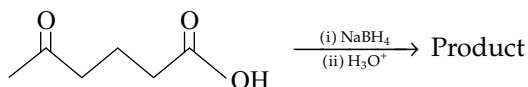
- (i)
- (ii)
- (iii)
- (a) iii > ii > i (b) iii = ii > i (c) iii > ii = i (d) iii = ii = i

124. Which statement is true regarding oxidation of the following two compounds?

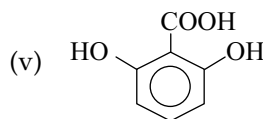
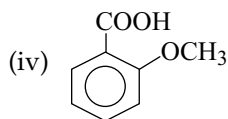
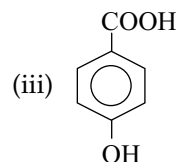
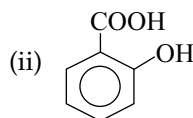
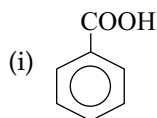


- (a) Both are oxidizable to benzoic acid under similar conditions
- (b) It is very difficult to oxidize either of the two
- (c) Compound (i) is oxidizable to benzoic acid easily while compound (ii) is oxidizable only under vigorous conditions to benzoic acid
- (d) Compound (i) is oxidizable to benzoic acid, while (ii) is oxidizable only under vigorous conditions to 2,2-dimethylpropanoic acid

125. Predict the nature of end product in the following reaction

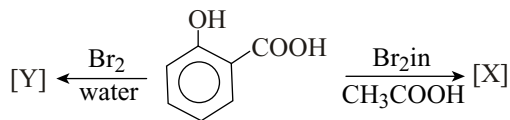


126. The correct order for the acidic character of the following carboxylic acids is

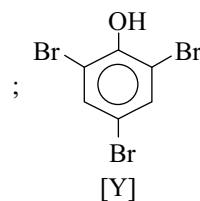
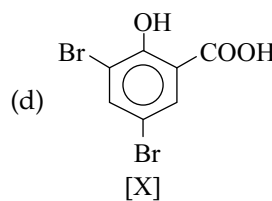
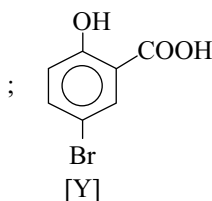
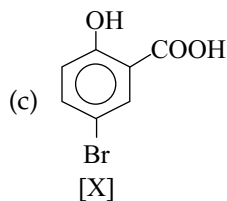
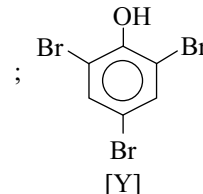
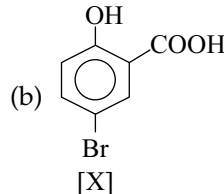
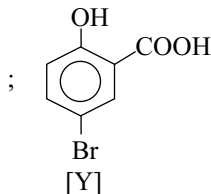
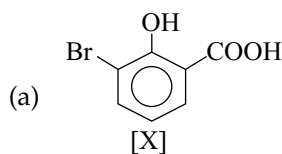


- (a)  $\text{iv} > \text{i} > \text{ii} > \text{iii} > \text{v}$
- (b)  $\text{v} > \text{ii} > \text{iii} > \text{i} > \text{iv}$
- (c)  $\text{v} > \text{ii} > \text{iv} > \text{iii} > \text{i}$
- (d)  $\text{v} > \text{ii} > \text{iv} > \text{i} > \text{iii}$

127. Salicylic acid is treated with bromine under two different conditions.



Predict the nature of [X] and [Y] in the following reactions



128. Which of the following statements is true?

- (a) Hydrogen bonding always increases the acidic character of a species.
- (b) Hydrogen bonding always decreases the acidic character of a species.
- (c) Hydrogen bonding may increase or decrease the acidic character of a species.
- (d) Hydrogen bonding play no role in determining the acidity of a species.

129. Choose the correct statement regarding acidic character of acetic acid,  $\text{CH}_3\text{COOH}$  and peroxyacetic acid,  $\text{CH}_3\text{COOOH}$ .

- (a) Peroxyacetic acid is stronger acid than acetic acid since the former has one extra oxygen, an electronegative element.
- (b) Peroxyacetic acid is stronger than acetic acid because its conjugate base is a weaker base than acetate.
- (c) Peroxyacetic acid is weaker than acetic acid because its conjugate base is less stable than that of acetate ion.
- (d) Both are equally strong.

130. A carboxylic acid can best be converted into acid chloride by using

- (a)  $\text{PCl}_5$
- (b)  $\text{SOCl}_2$
- (c)  $\text{HCl}$
- (d)  $\text{ClCOCOCl}$

131. The yield of acid amide in the reaction,  $\text{RCOCl} + \text{NH}_3 \longrightarrow \text{RCONH}_2$ , is maximum when

- (a) acid chloride and ammonia are treated in equimolar ratio
- (b) acid chloride and ammonia are treated in 1:2 molar ratio
- (c) acid chloride and ammonia are treated in 2:1 molar ratio
- (d) All the three give nearly similar result

132. Which of the following statement is not upto the mark?

- (a)  $\text{R} - \overset{\text{O}}{\parallel} \text{C} - \text{OR}' \xrightarrow{\text{OH}^-} \text{R} - \overset{\text{O}}{\parallel} \text{C} - \text{O}^- + \text{R}'\text{OH}$  (a base-catalyzed reaction)
- (b)  $\text{CH}_3\text{COOC}_2\text{H}_5 \xrightarrow{\text{OH}^-} \text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH}$  (reaction involves acyl-oxygen fission)
- (c)  $\text{C}_6\text{H}_5\text{COOH} + \text{CH}_3\text{OH} \xrightarrow{\text{H}^+} \text{C}_6\text{H}_5\text{COOCH}_3 + \text{H}_2\text{O}$  (reaction involves acyl-oxygen fission)
- (d)  $\text{CH}_3\text{COOCH}(\text{CH}_3)\text{C}_2\text{H}_5 \xrightarrow{\text{OH}^-} \text{CH}_3\text{COO}^- + \text{HOCH}(\text{CH}_3)\text{C}_2\text{H}_5$   
(configuration of the reactant is retained)

133. The products in the following reaction are



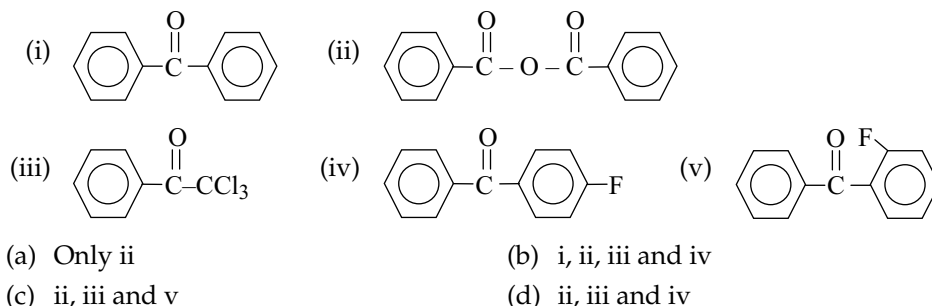
- (a)  $\text{C}_6\text{H}_5\text{CH}_2\text{OH} + \text{C}_6\text{H}_5\text{CH}_2\text{OH}$
- (b)  $\text{C}_6\text{H}_5\text{CH}_3 + \text{C}_6\text{H}_5\text{CH}_3$
- (c)  $\text{C}_6\text{H}_5\text{CH}_2\text{OH} + \text{C}_6\text{H}_5\text{CH}_3$
- (d)  $\text{C}_6\text{H}_5\text{COOH} + \text{C}_6\text{H}_5\text{CH}_3$

134. Pyrolysis of  $\text{CH}_3\overset{\text{CH}_3}{\underset{|}{\text{COOCHCH}_2\text{CH}_3}}$  gives

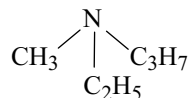
- (a) 1-butene and 2-butene in equimolar ratio
- (b) 1-butene and 2-butene in 1:2 molar ratio
- (c) 1-butene and 2-butene in 3:2 molar ratio
- (d) 1-butene and 2-butene in 2:3 molar ratio

135. The relative stability of the four acid derivatives towards nucleophiles is  
 (a) Amide > Ester > Acid anhydride > Acid chloride  
 (b) Amide > Acid anhydride > Ester > Acid chloride  
 (c) Acid chloride > Acid anhydride > Ester > Amide  
 (d) Acid chloride > Ester > Acid anhydride > Amide
136. Which of the following statement is true about the hydrolysis of acetic anhydride?  
 (i) It is more easily hydrolyzed in acidic medium than in neutral.  
 (ii) It is more easily hydrolyzed in alkaline medium than in neutral.  
 (iii) It is equally hydrolyzed in all the three media.  
 (iv) It is more easily hydrolyzed in neutral than in acidic media.  
 (v) It is more easily hydrolyzed in neutral than in alkaline medium.  
 (a) i and ii (b) iii (c) iv and v (d) i and v

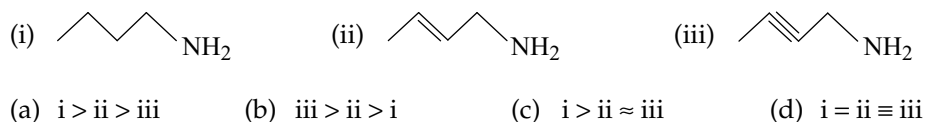
137. Which of the following compounds can undergo nucleophilic substitution easily?



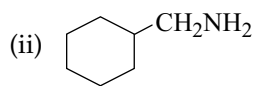
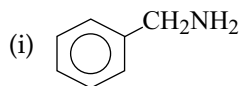
138. Which statement is true regarding the following structure?



- (a) It is a chiral molecule (b) It exists in two resolvable optically active forms  
 (c) Both (a) and (b) (d) Neither (a) nor (b)
139. Introduction of a methyl group in ammonia markedly increases the basic strength of ammonia in aq. solution, but introduction of the second methyl group increases only marginally the basic strength of methyl amine in water. This is due to  
 (a) different type of hybridization in the two amines.  
 (b) protonated dimethyl amines are more solvated than methyl amine.  
 (c) protonated dimethyl amine is more solvated than the protonated methyl amine.  
 (d) protonated dimethyl amine is less stable than the protonated methyl amine.
140. The basic character of ethyl amine, diethyl amine and triethyl amine in chlorobenzene is  
 (a)  $C_2H_5NH_2 < (C_2H_5)_2NH < (C_2H_5)_3N$  (b)  $C_2H_5NH_2 < (C_2H_5)_3N < (C_2H_5)_2NH$   
 (c)  $(C_2H_5)_3N < (C_2H_5)_2NH < C_2H_5NH_2$  (d)  $(C_2H_5)_3N < C_2H_5NH_2 < (C_2H_5)_2NH$
141. The correct order of decreasing basic character of the three aliphatic primary amines is



142. Which of the statement is true regarding the basicity of the following two primary amines?



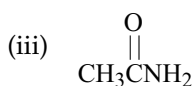
- (a) Both are equally basic because both are 1° amines.  
 (b) i > ii because it is an aromatic amine.  
 (c) ii > i because it is an aliphatic amine  
 (d) i < ii because of difference in the nature of β-carbon.

143. The correct order of decreasing basic character is



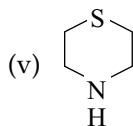
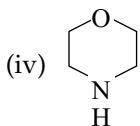
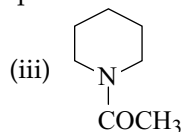
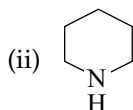
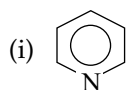
- (a) ii > i > iii > iv      (b) iv > ii > i > iii  
 (c) iv > iii > ii > i      (d) iv > ii > iii > i

144. The correct order of increasing basicity is



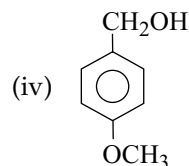
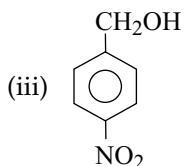
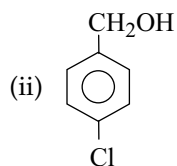
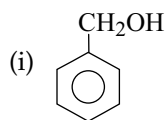
- (a) ii < iii < i      (b) i ≈ iii < ii      (c) i < ii < iii      (d) iii < i < ii

145. The relative order of basic character of the following compound is



- (a) ii > i > iii > iv > v      (b) ii > iii > iv > v > i  
 (c) ii > v > iv > i > iii      (d) ii > iv > v > iii > i

146. The basic character of the following alcohols is



- (a) iv > i > ii > iii      (b) ii > iii > iv > i  
 (c) iv > ii > iii > i      (d) i > ii > iii > iv

147. When aniline is treated with acetyl chloride in presence of anhydrous aluminium chloride, the main product is

- (a) o-aminoacetophenone      (b) p-aminoacetophenone  
 (c) Both (a) and (b)      (d) m-aminoacetophenone

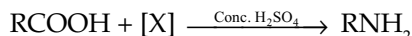


- (a)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$  (b)  $(\text{CH}_3)_2\text{CHCl}$   
 (c) Both (a) and (b) (d) Reaction not possible

149. Benzenediazonium chloride when treated with phenols gives an azo dye, to get best result the pH of the medium should be

- (a) around 4 (b) around 8 (c) around 10 (d) 12

150. In the following reaction, the reagent X should be

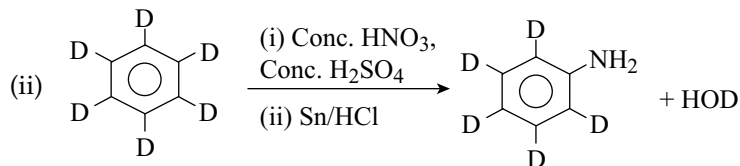
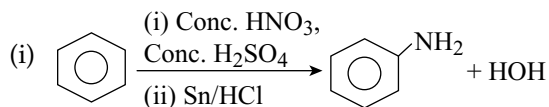


- (a)  $\text{NH}_3$  (b)  $\text{HN}_3$  (c) Either of the two (d) None of the two

151. Which of the following can undergo electrophilic substitution when treated with nitrous acid at  $0^\circ\text{C}$ ?

- (a)  $\text{C}_6\text{H}_5\text{NH}_2$  (b)  $\text{C}_6\text{H}_5\text{NHCH}_3$  (c)  $\text{C}_6\text{H}_5\text{N}(\text{CH}_3)_2$  (d) None of these

152. Which of the two reactions proceed faster?

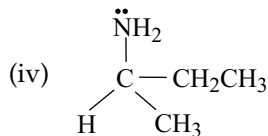
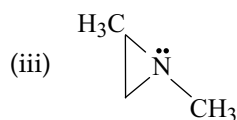
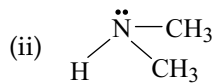
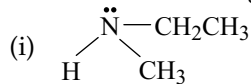


- (a) i (b) ii (c) i = ii (d) Not definite

153. Which of the following does not reduce  $\text{C}_6\text{H}_5\text{NO}_2$  to aniline?

- (a)  $\text{Sn/HCl}$  (b)  $\text{SnCl}_2/\text{HCl}$  (c)  $\text{Zn/HCl}$  (d)  $\text{LiAlH}_4$

154. Which of the following amines can be resolved into two enantiomers?



- (a) i, iv (b) i, ii (c) i, iii, iv (d) iii, iv

155. Which of the following statement is false?

- (a) Dimethyl amine as well as trimethyl amine are soluble in water.  
 (b) Trimethyl amine forms hydrogen bond neither with itself nor with water.  
 (c) Trimethyl amine can act as hydrogen bond acceptor only, while dimethyl amine can serve as both a hydrogen bond donor and acceptor.  
 (d) All the three statements are false.

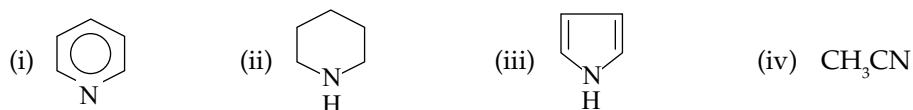
156. Ephedrine is a secondary amine. It is widely used in cold and allergy conditions in the form of its hydrochloride but not as such because

- (a) the amine itself has an unpleasant smell, while its salt is odourless.
- (b) the amine is insoluble in water, while the salt is soluble in water.
- (c) the amine is unstable and easily oxidized by air, while the salt is resistant to atmospheric oxidation.
- (d) of all the above facts

157. Benzamide and benzyl amine can be distinguished by

- (a) cold. dil. NaOH
- (b) cold dil. HCl
- (c) both (a) and (b)
- (d)  $\text{NaNO}_2$ , HCl,  $0^\circ\text{C}$ , then  $\beta$ -naphthol

158. The correct order for the basic character of the compounds i to iv should be

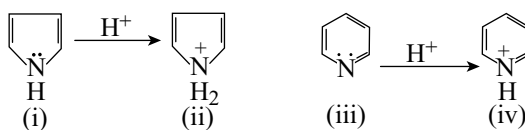


- (a)  $\text{iv} < \text{iii} < \text{i} < \text{ii}$
- (b)  $\text{iv} < \text{i} < \text{iii} < \text{ii}$
- (c)  $\text{iv} < \text{ii} < \text{iii} < \text{i}$
- (d)  $\text{iv} < \text{iii} < \text{ii} < \text{i}$

159. Which of the following is true regarding basic character of pyridine and pyrrole?

- (a) Pyrrole is more basic because its non-bonding electrons occupy  $\text{sp}^3$  orbital.
- (b) Pyridine is more basic because its non-bonding electrons are not part of aromatic sextet.
- (c) Both are equally basic.
- (d) Pyridine is less basic because it is a tertiary amine.

160. Pyrrole and pyridine both are basic and form salts with acids.



Which of the following statement is true regarding the aromatic character of the four species?

- (a) All the four are aromatic
- (b) i, iii and iv are aromatic
- (c) i, ii and iii are aromatic
- (d) i and iii are aromatic

161. Ethylene can be prepared in good yield by

- (a)  $\text{CH}_3\text{CH}_2\text{N}^+(\text{CH}_3)_3\text{I}^- \xrightarrow{\text{Heat}} \text{CH}_2=\text{CH}_2 + (\text{CH}_3)_3\text{N} + \text{HI}$
- (b)  $\text{CH}_3\text{CH}_2\text{N}^+(\text{CH}_3)_3\text{OH}^- \xrightarrow{\text{Heat}} \text{CH}_2=\text{CH}_2 + (\text{CH}_3)_3\text{N} + \text{H}_2\text{O}$
- (c) Both (a) and (b)
- (d)  $\text{CH}_3\text{CH}_2\text{NH}_2 \xrightarrow{\text{Heat}} \text{CH}_2=\text{CH}_2 + \text{NH}_3$

162. Which one of the following is not an oxidation product of a primary amine?

- (a) A hydroxylamine
- (b) A nitroso compound
- (c) A nitro compound
- (d) None of these

163. Which of the following method is used for eliminating nitrogen of an amine present outside the ring?

- (a) Hofmann elimination (b) Cope elimination  
(c) Both (a) and (b) (d) Emde degradation

164. Which of the following does not react with nitrous acid?

- (a)  $C_6H_5NH_2$  (b)  $C_6H_5NHCH_3$  (c)  $C_6H_5N(CH_3)_2$  (d) None of these

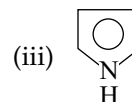
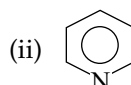
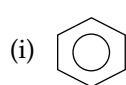
165. Which of the following leads to carbon-carbon double bond?

- (a)  $1^\circ$  amine +  $RCHO \longrightarrow$  (b)  $2^\circ$  Amine +  $R_2CO \longrightarrow$   
(c)  $2^\circ$  amine +  $RCHO \longrightarrow$  (d) Both (b) and (c)

166. Electrophilic aromatic substitution of pyridine resembles with

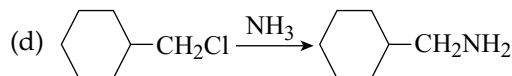
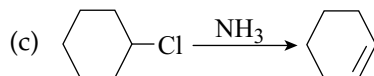
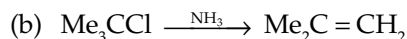
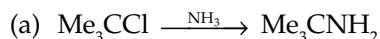
- (a) benzene (b) aniline (c) nitrobenzene (d) none of these

167. Arrange the following compounds in decreasing order of reactivity towards electrophilic substitution.

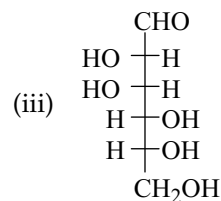
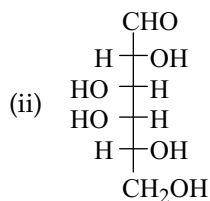
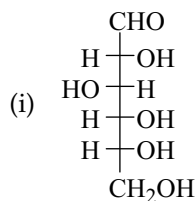


- (a)  $i > ii > iii$  (b)  $i > ii = iii$  (c)  $iii > ii > i$  (d)  $iii > i > ii$

168. Which reaction seems to be incorrect?



169. Which of the statement regarding following structure is true?



- (a) (i) and (ii) are epimers (b) (i) and (iii) are epimers  
(c) Both (a) and (b) are true (d) All the three are epimers

170. Which of the following pair represents an example of diastereoisomers

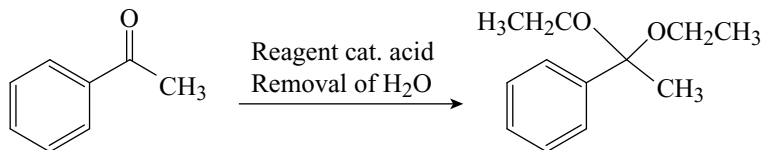
- (i) (+)-Tartaric acid and meso-tartaric acid  
(ii) Maleic acid and fumaric acid  
(iii) D(+)-Galactose and D(+)-mannose  
(iv) (+)-Lactic acid and (-)-Lactic acid

- (a) i and iii (b) i, iii and iv (c) i, ii and iii (d) iv

## LEVEL 2

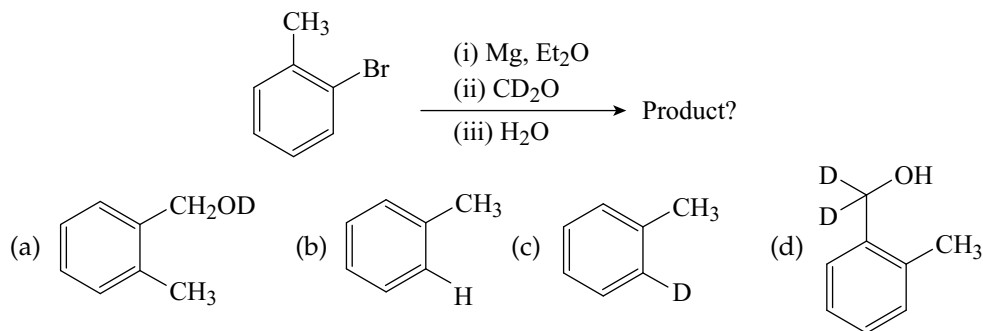
### Single and Multiple-choice Type

1. What could be the reagent for the following reaction?

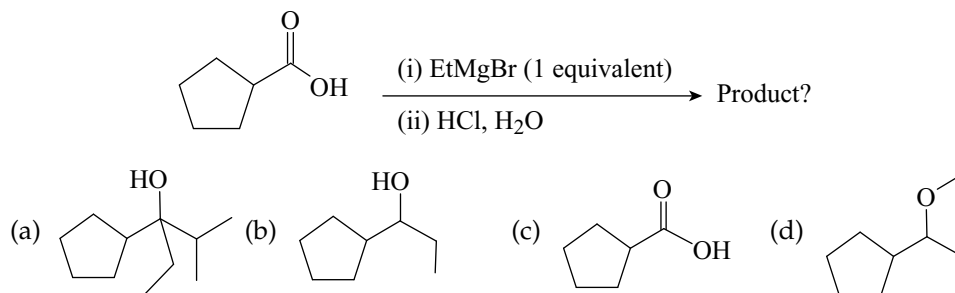


- (a) CH3COCH3    (b) CH3OH    (c) CH3CH2OH    (d) HOCH2CH2OH

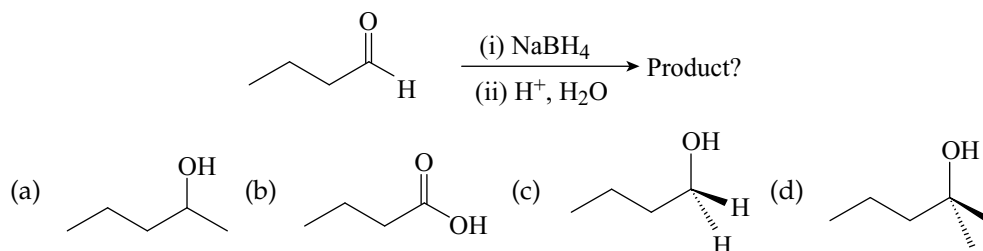
2. What could be the product for the following reaction?



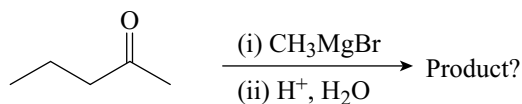
3. What could be the major product for the following reaction?

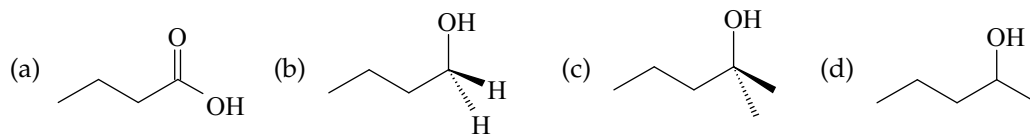


4. What could be the product for the following reaction?

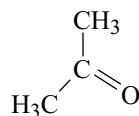


5. What could be the product for the following reaction?



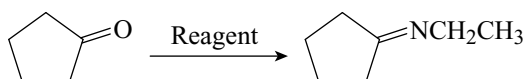


6. What is not the name for the following compound?



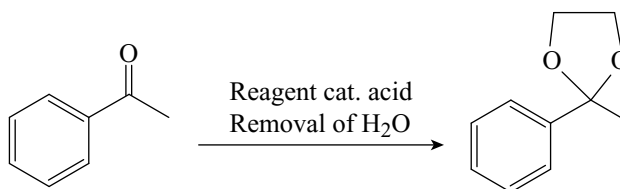
- (a) 2-Acetaldehyde (b) propanone (c) acetone (d) dimethyl ketone

7. What could be the reagent for the following reaction?

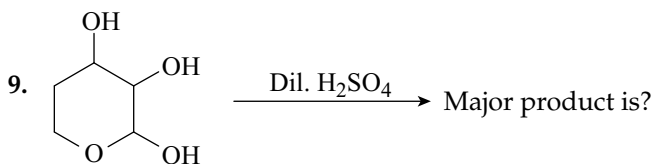


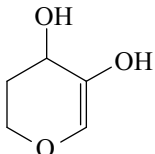
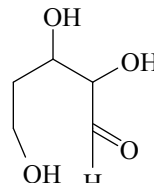
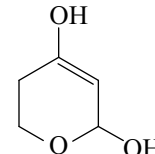
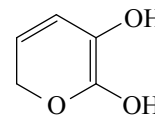
- (a)  $\text{H}_2\text{N-Ph}$ , removal of water  
 (b)  $\text{H}_2\text{NCH}_2\text{CH}_3$ ,  $\text{CH}_3\text{CO}_2\text{H}$ , removal of water  
 (c)  $\text{H}_2\text{NCH}_3$ ,  $\text{H}_2\text{O}$ , removal of water  
 (d)  $\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_3$ ,  $\text{CH}_3\text{CO}_2\text{H}$ , removal of water

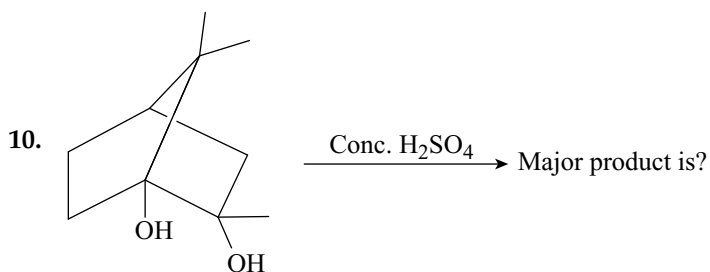
8. What could be the reagent for the following reaction?

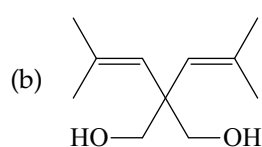
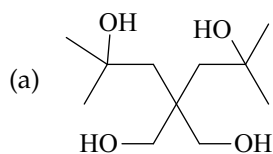
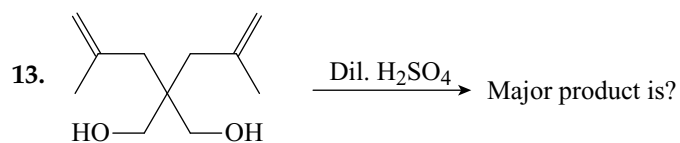
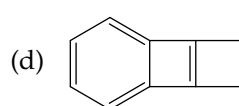
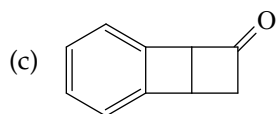
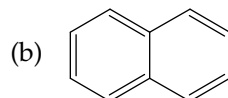
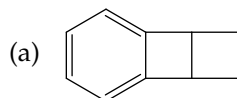
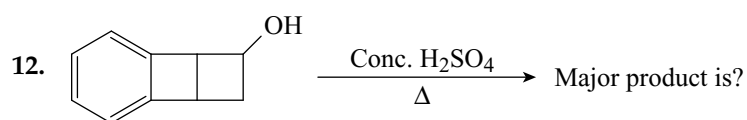
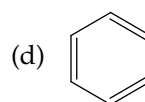
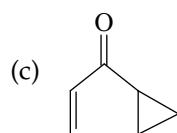
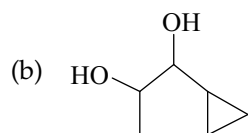
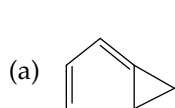
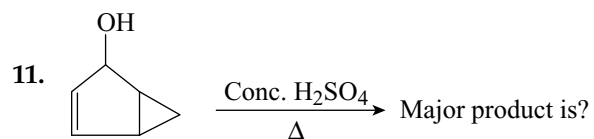
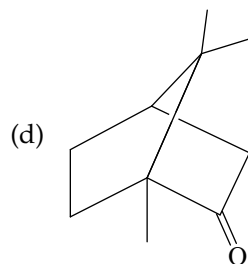
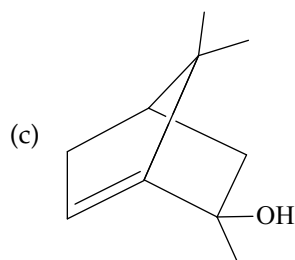
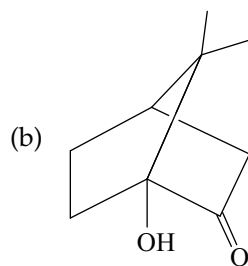
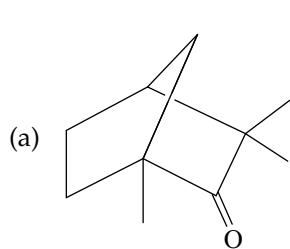


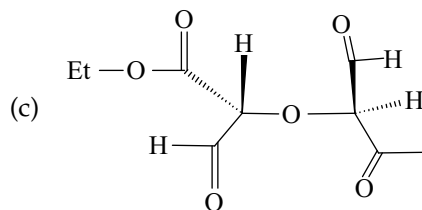
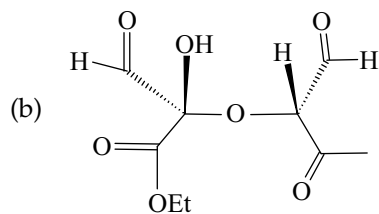
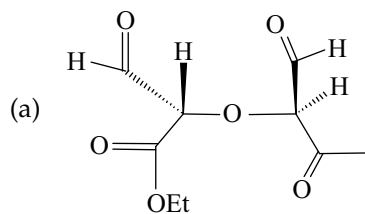
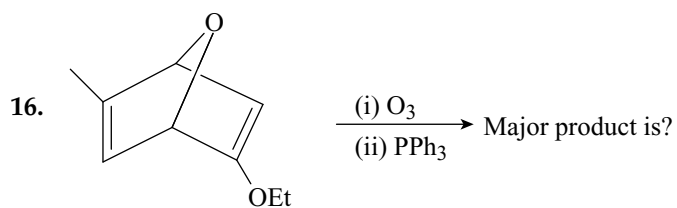
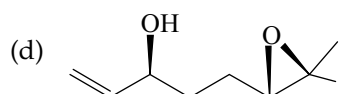
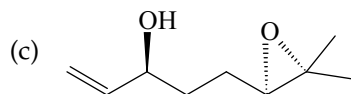
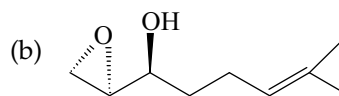
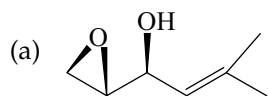
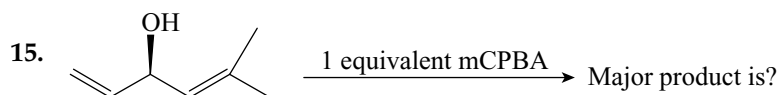
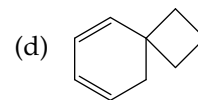
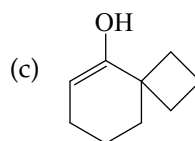
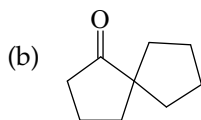
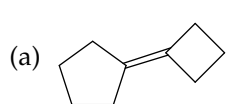
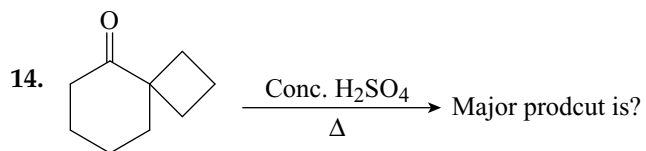
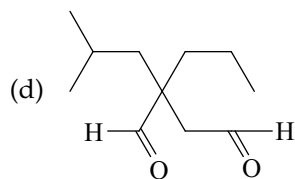
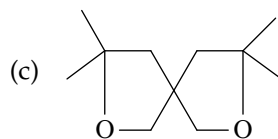
- (a)  $\text{CH}_3\text{COCH}_3$  (b)  $\text{HOCH}_2\text{CH}_2\text{OH}$  (c)  $\text{CH}_3\text{CH}_2\text{OH}$  (d)  $\text{CH}_3\text{OH}$



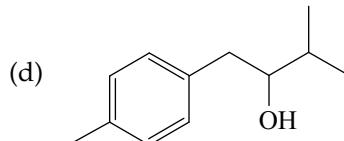
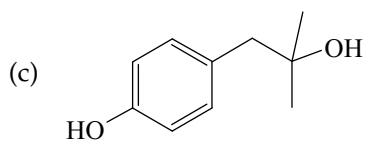
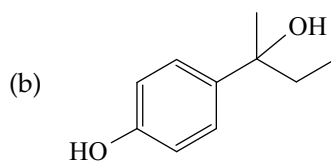
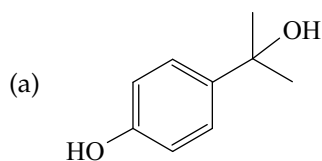
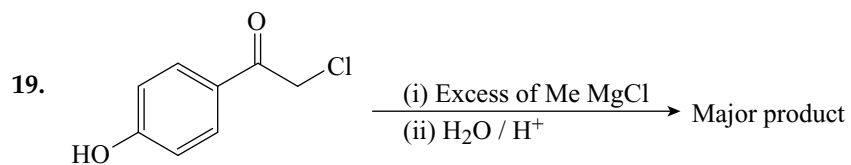
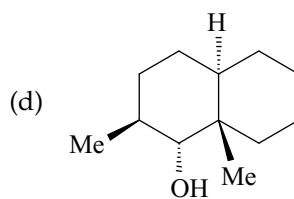
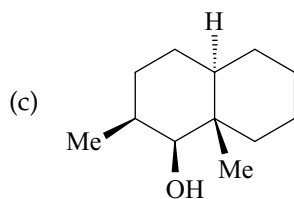
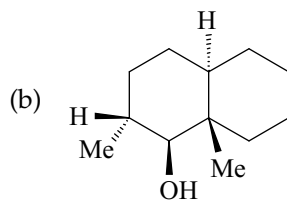
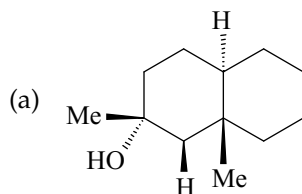
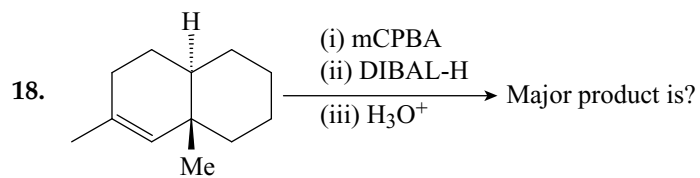
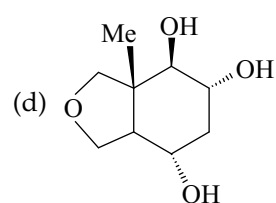
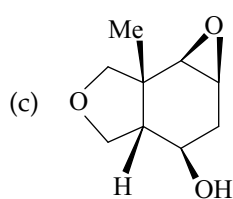
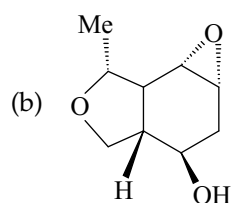
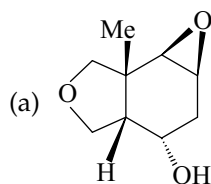
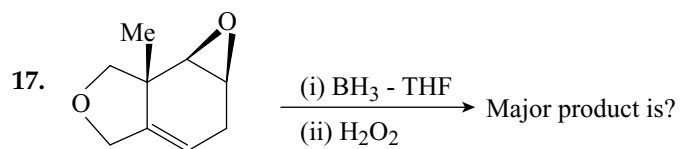
- (a)  (b)  (c)  (d) 

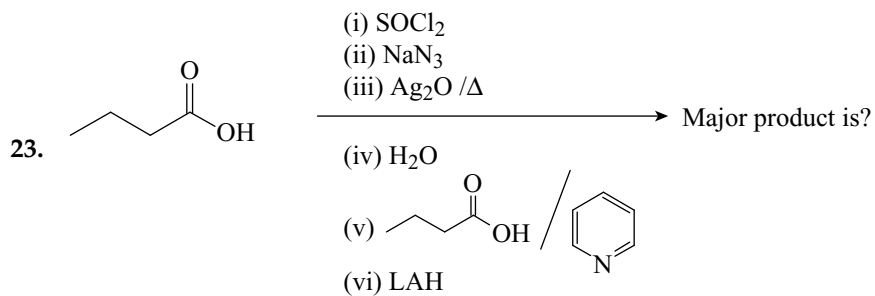
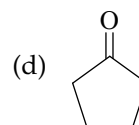
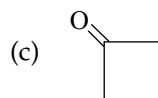
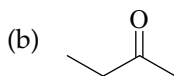
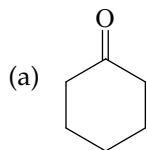
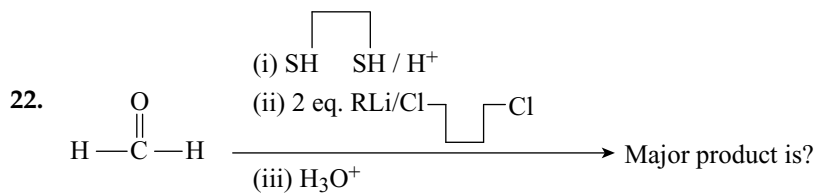
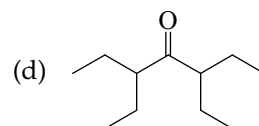
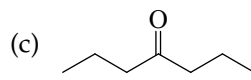
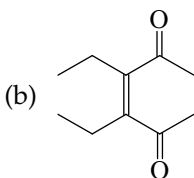
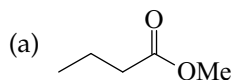
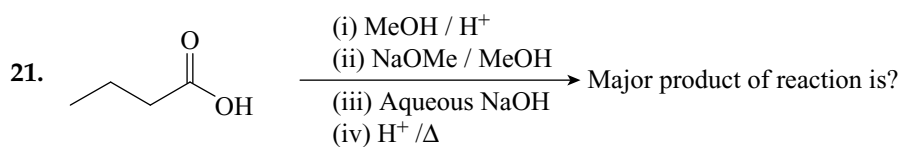
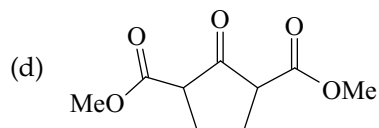
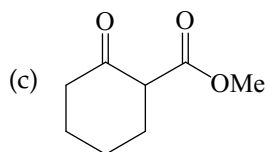
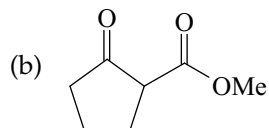
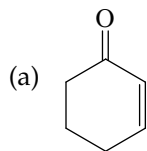
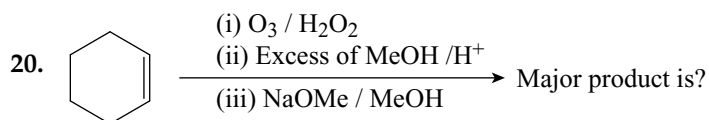


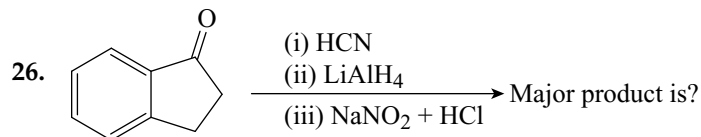
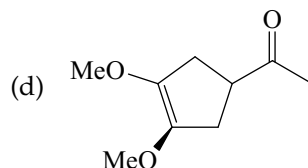
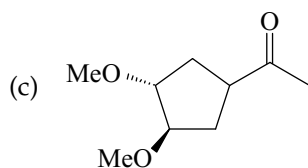
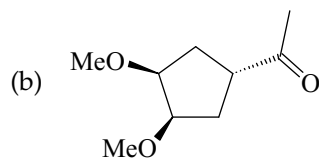
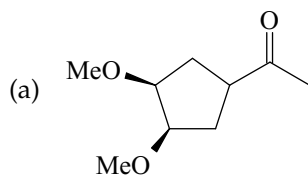
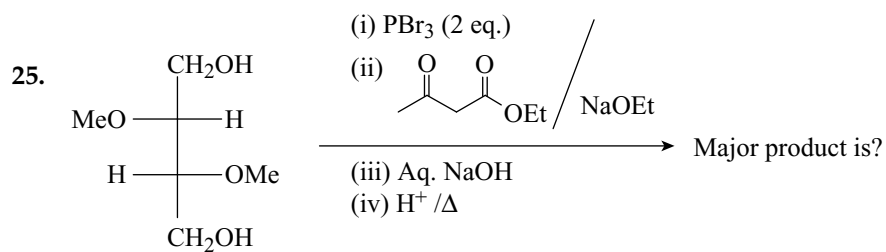
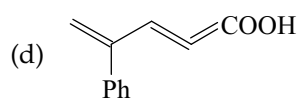
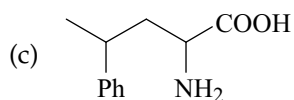
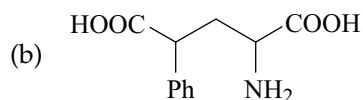
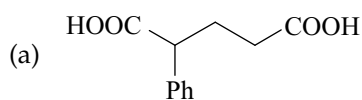
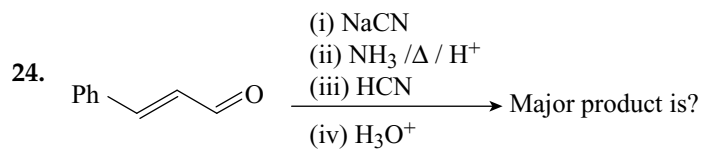
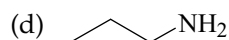
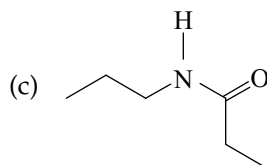
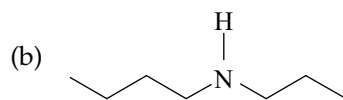
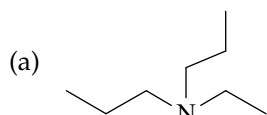


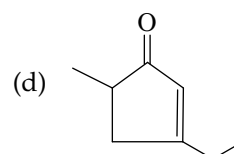
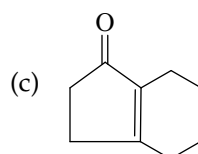
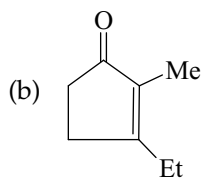
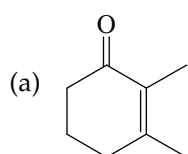
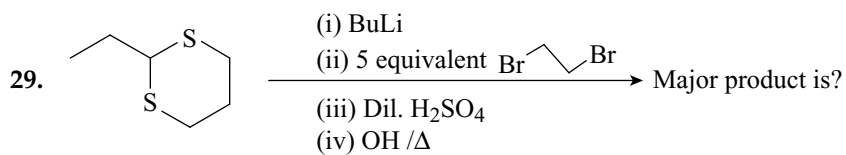
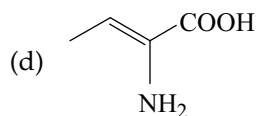
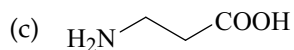
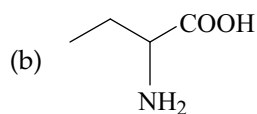
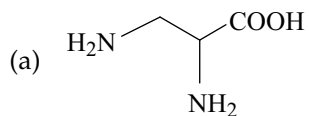
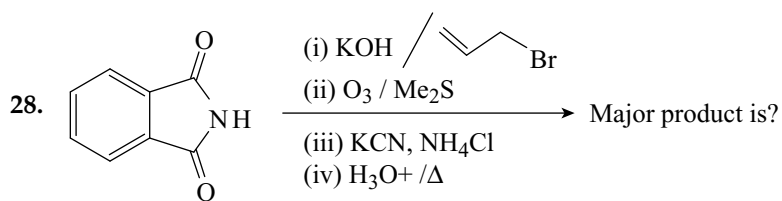
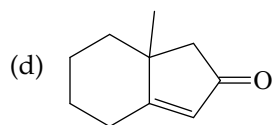
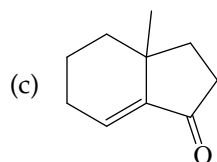
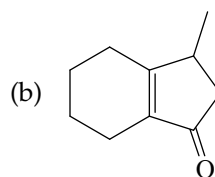
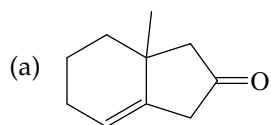
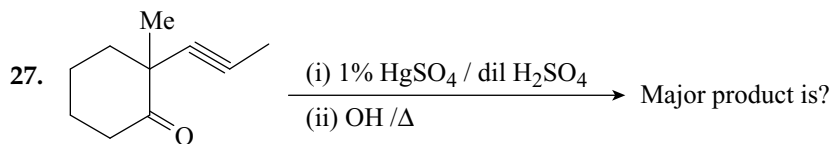
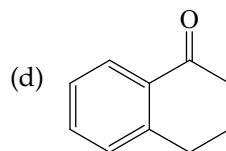
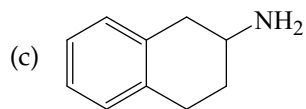
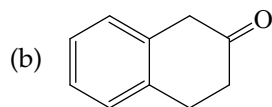
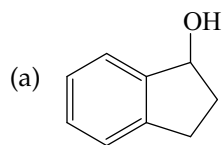


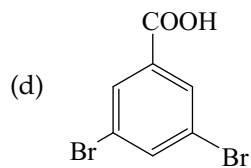
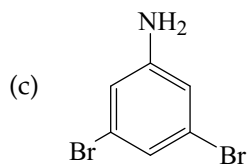
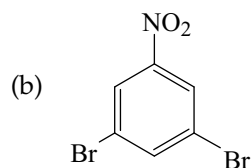
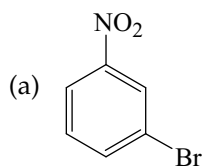
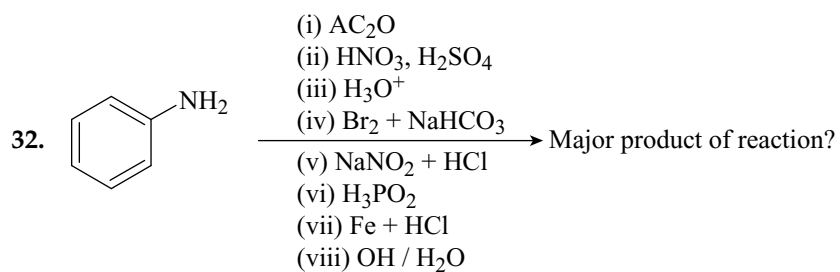
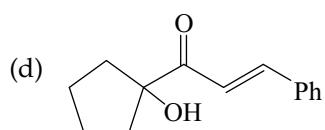
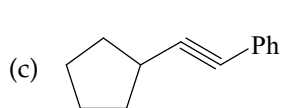
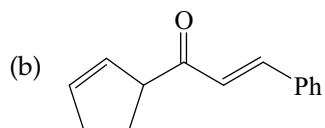
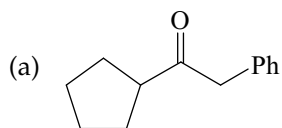
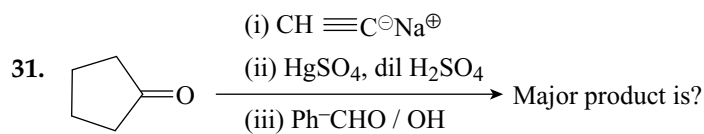
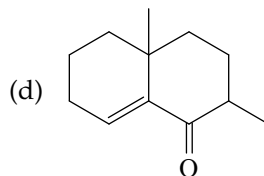
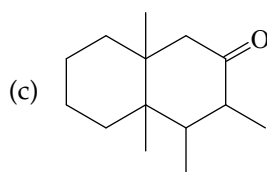
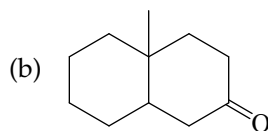
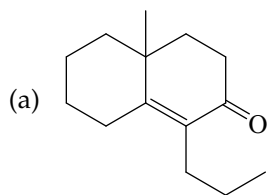
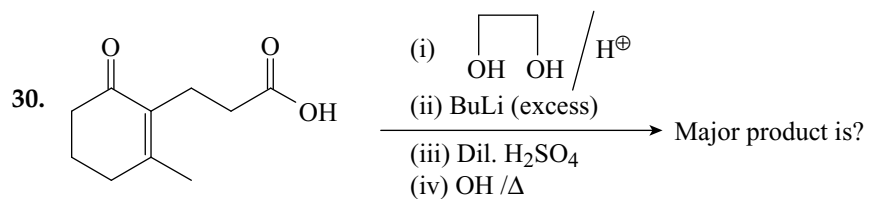
(d) None of these

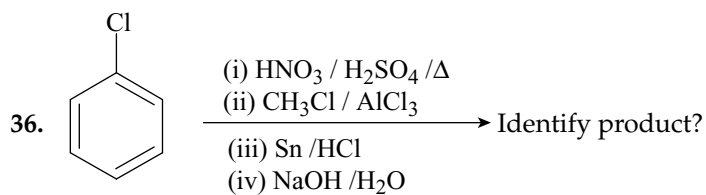
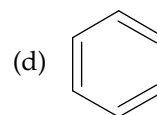
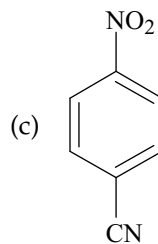
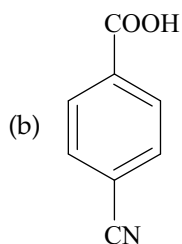
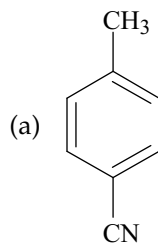
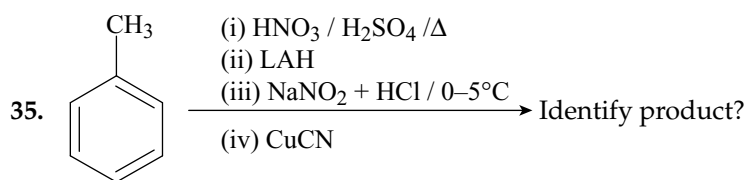
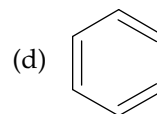
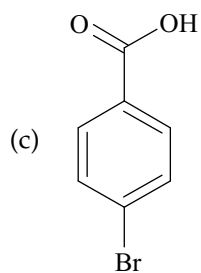
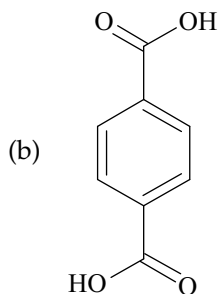
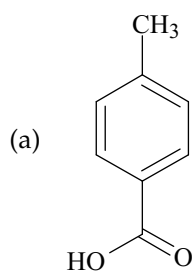
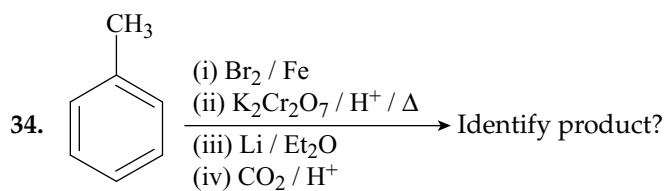
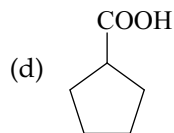
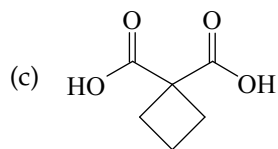
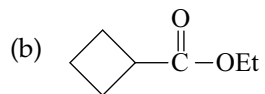
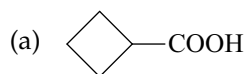
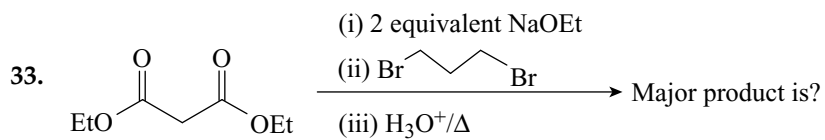


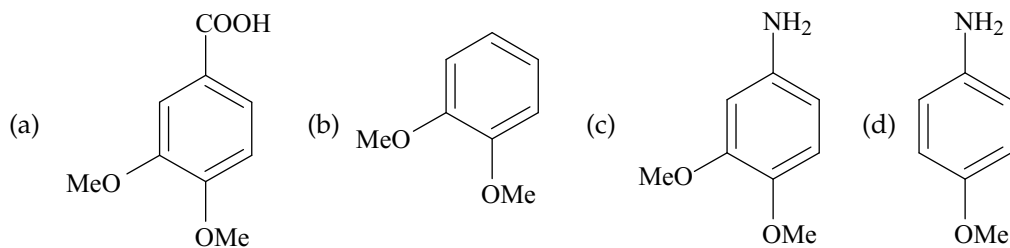
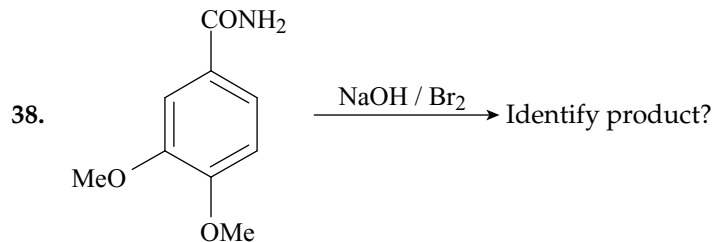
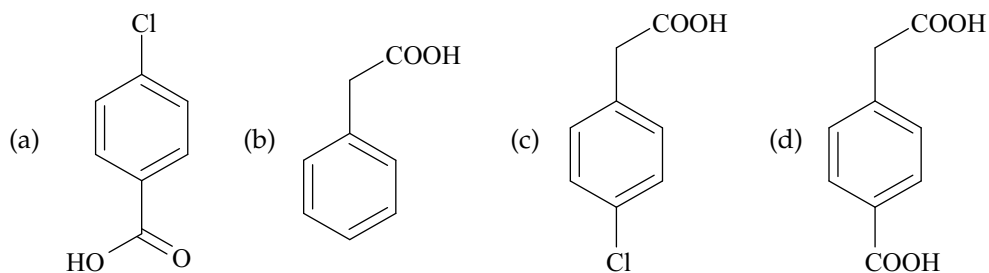
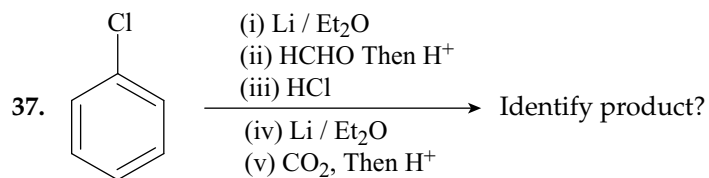
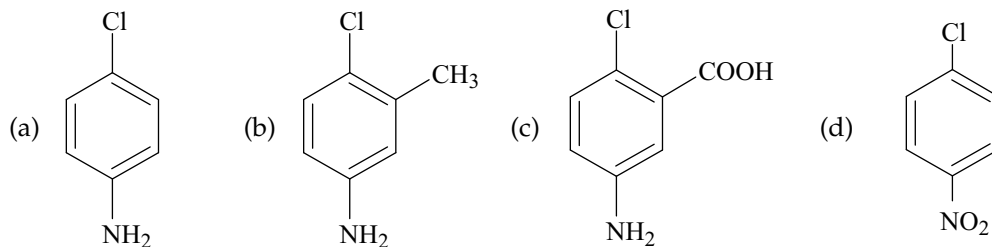




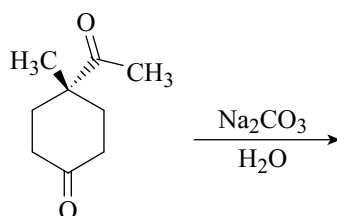




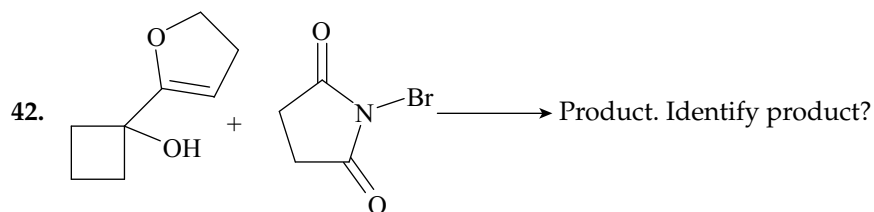
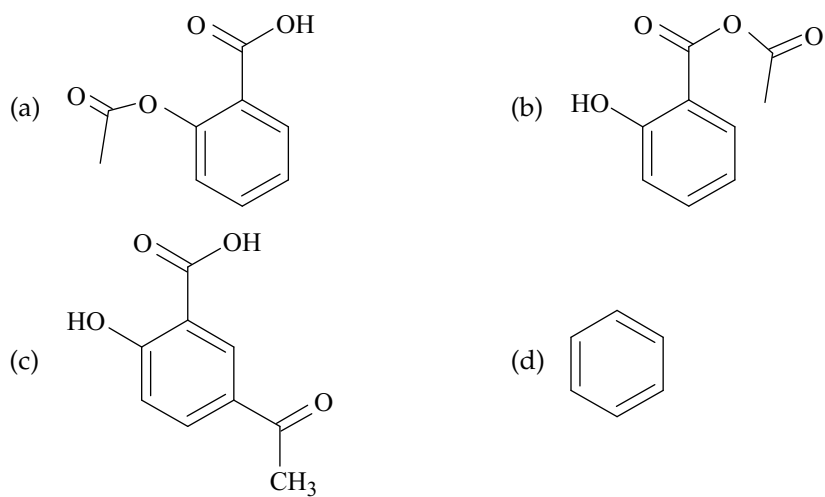
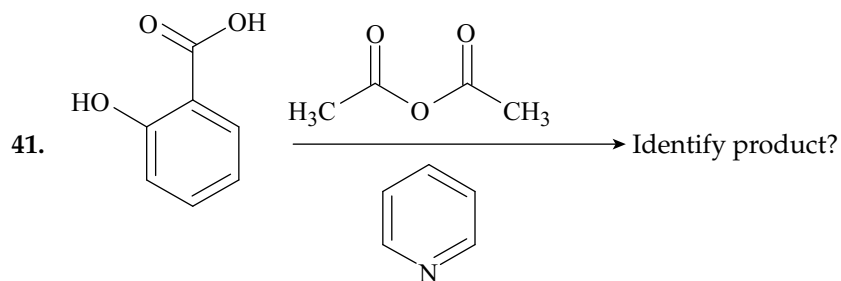
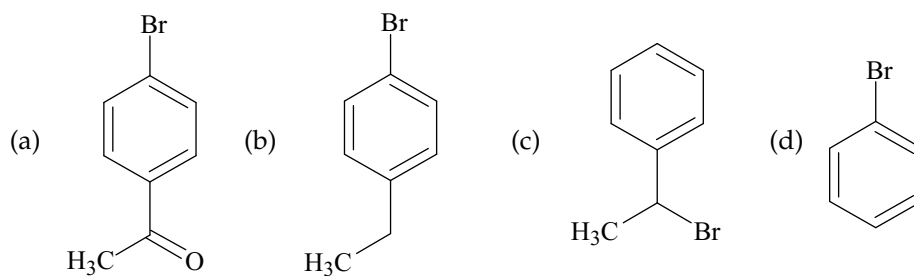
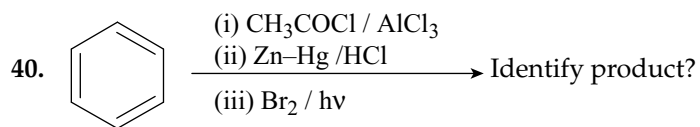
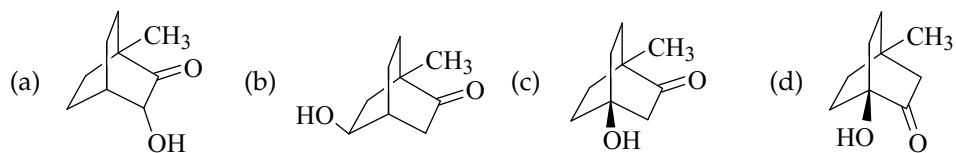


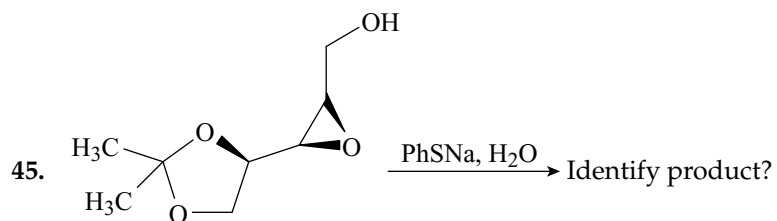
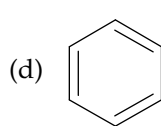
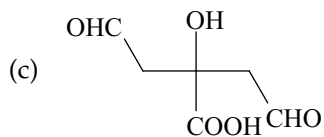
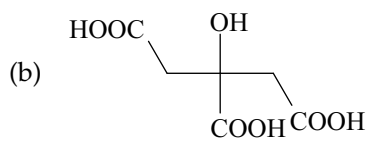
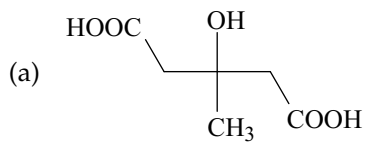
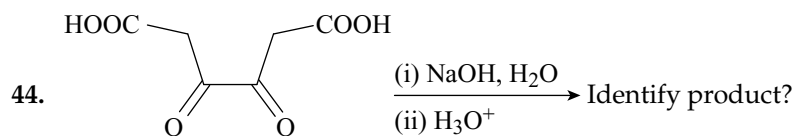
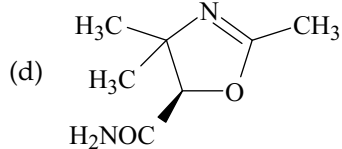
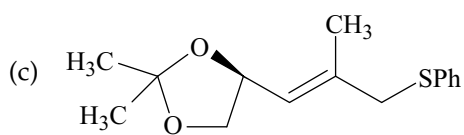
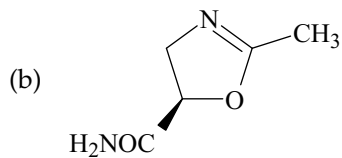
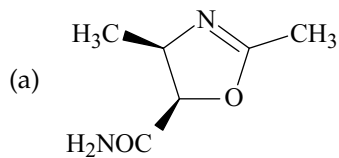
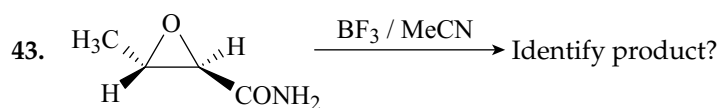
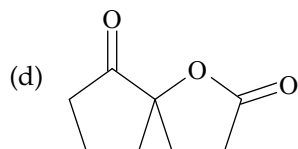
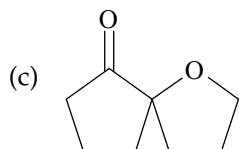
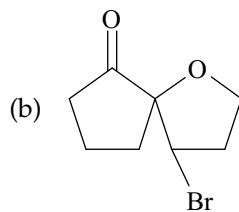
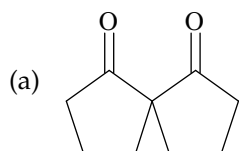


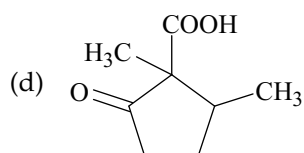
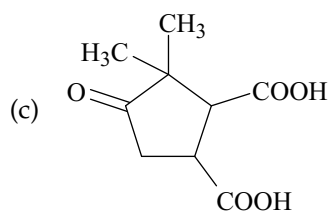
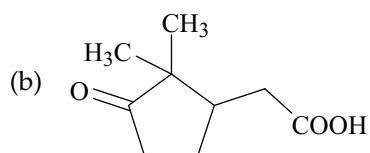
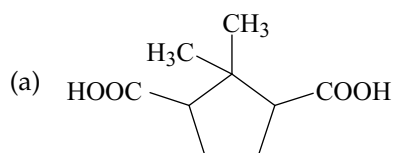
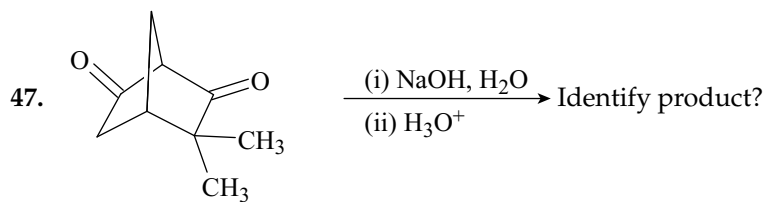
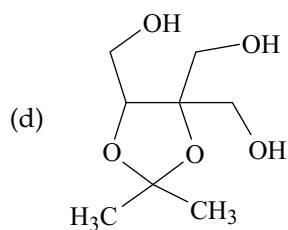
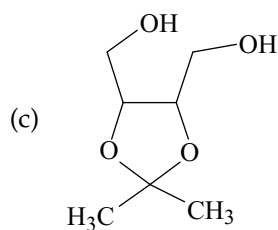
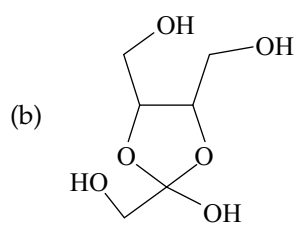
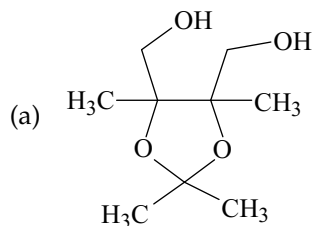
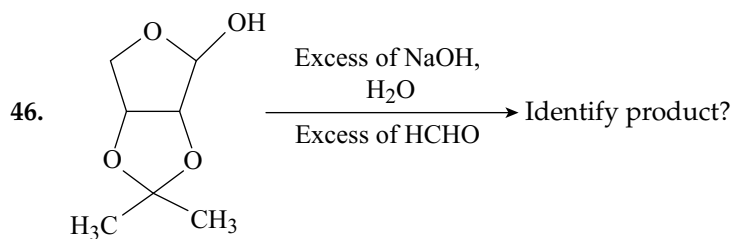
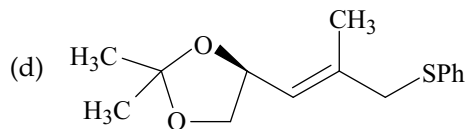
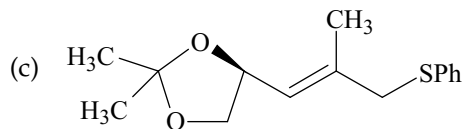
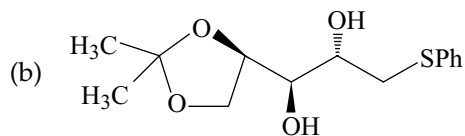
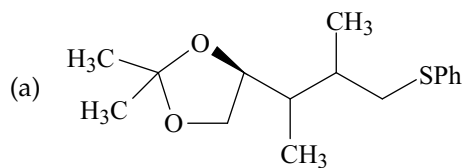
39. In the presence of a base, the compound below cyclizes to give a compound Y.

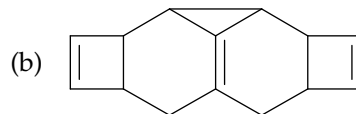
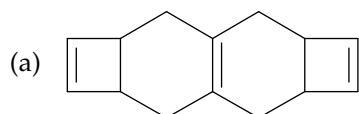
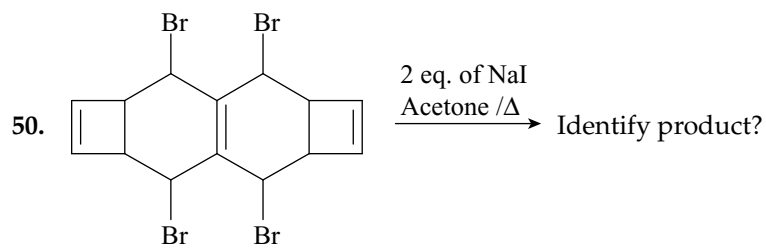
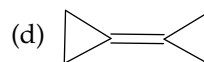
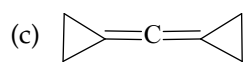
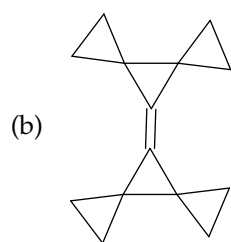
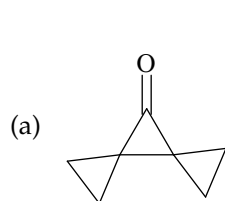
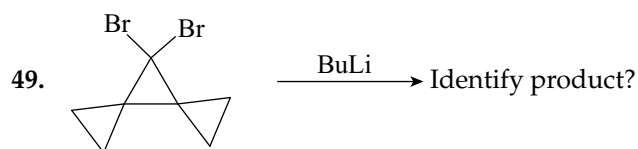
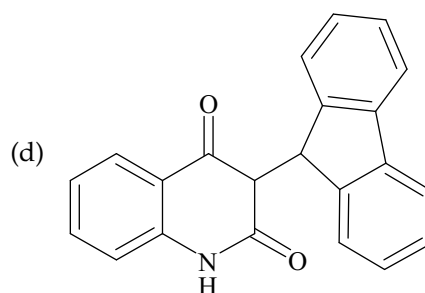
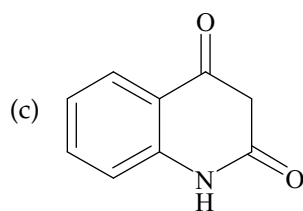
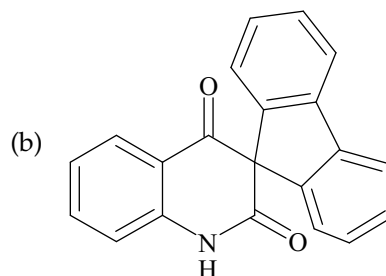
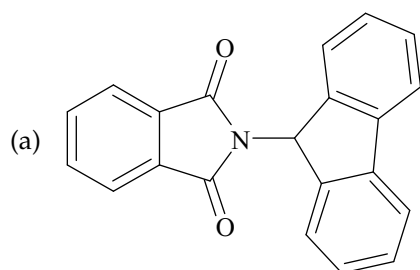
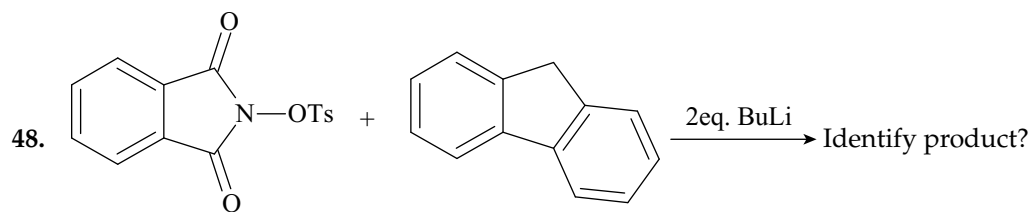


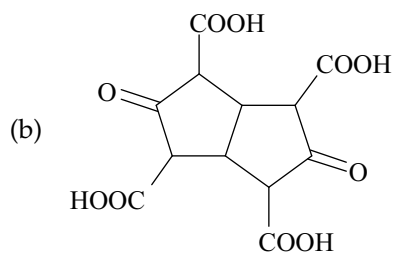
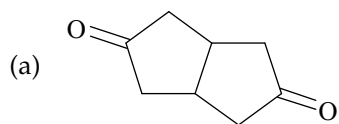
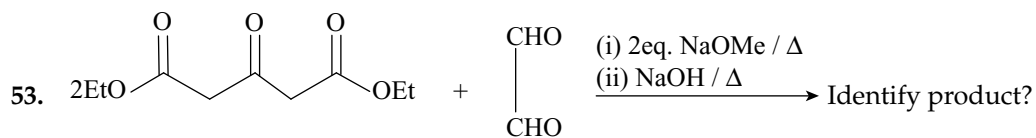
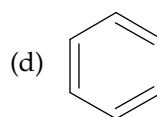
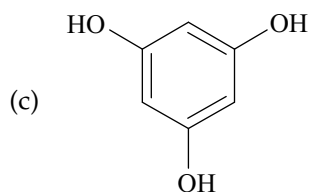
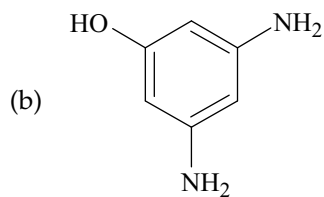
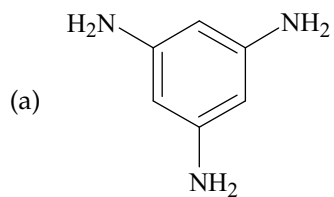
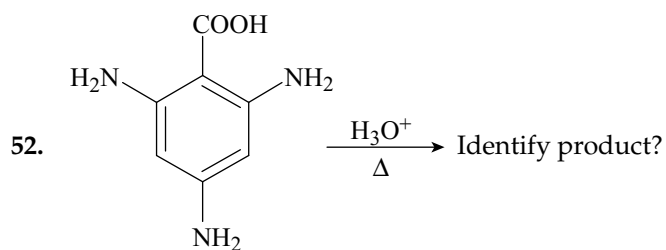
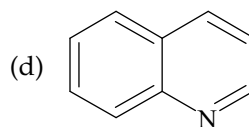
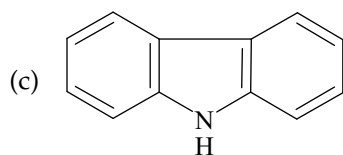
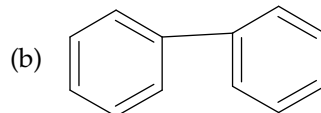
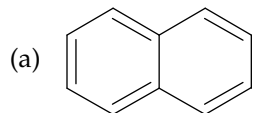
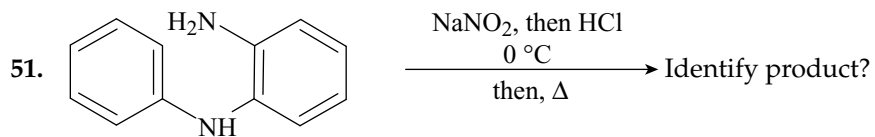
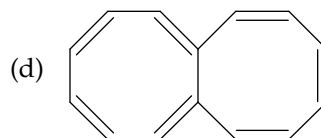
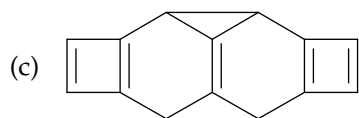
Identify the structure of compound Y.

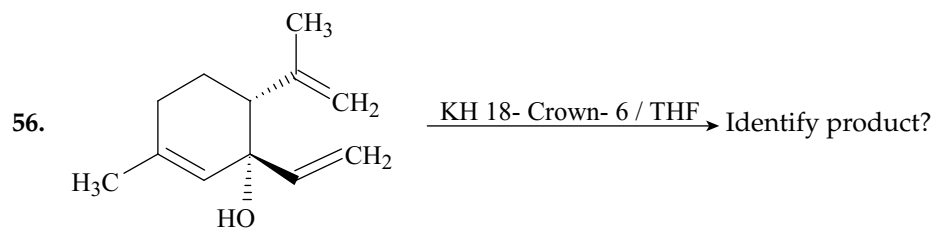
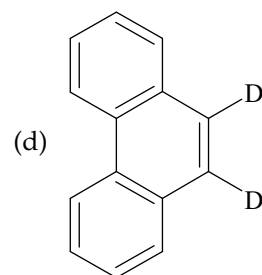
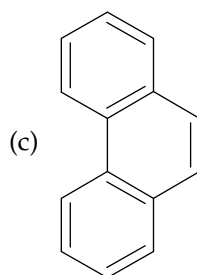
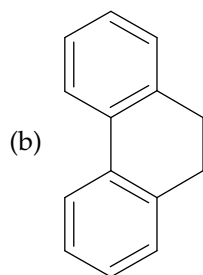
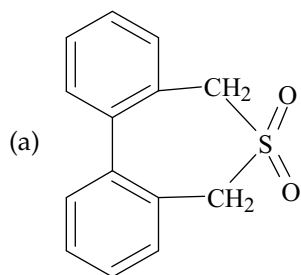
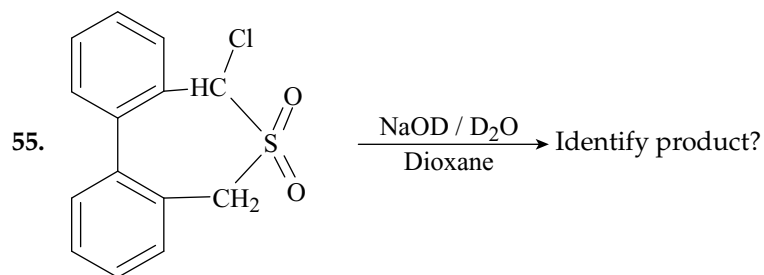
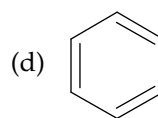
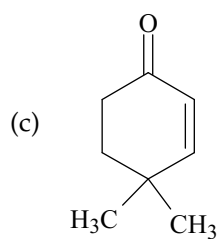
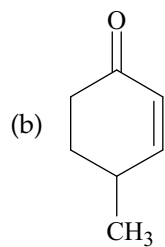
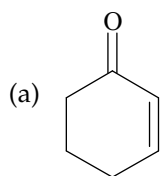
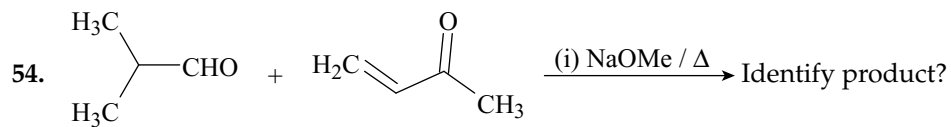
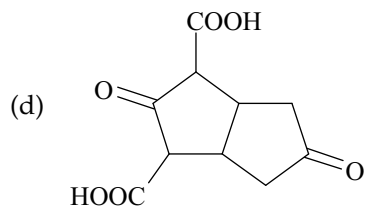
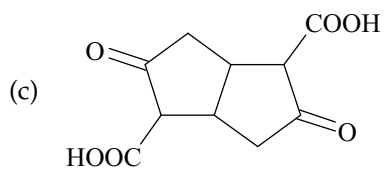


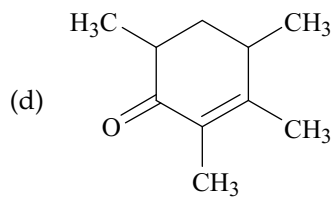
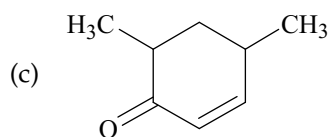
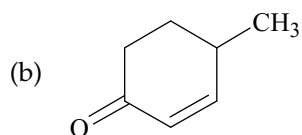
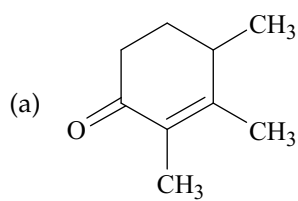
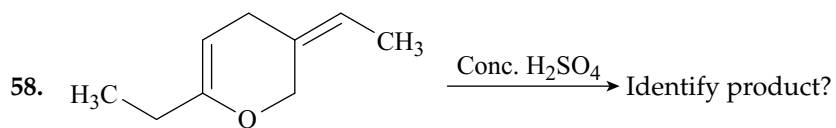
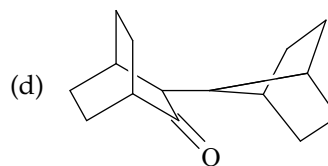
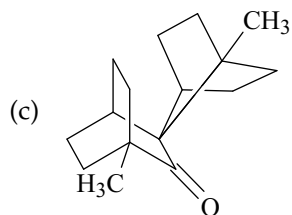
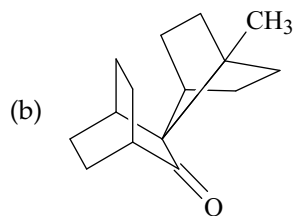
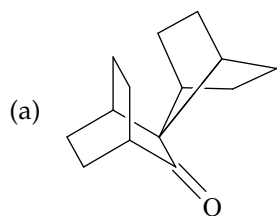
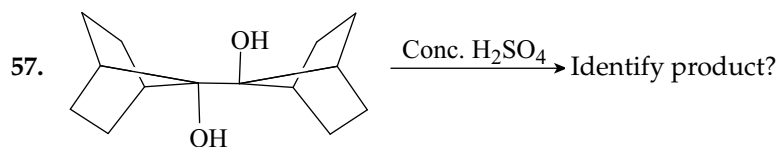
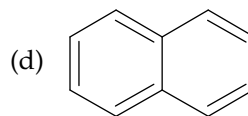
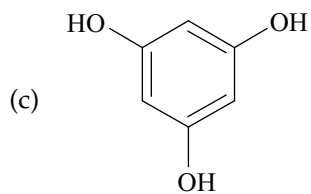
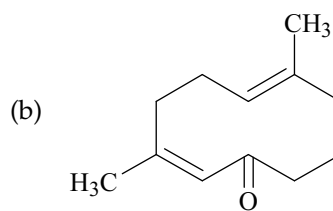
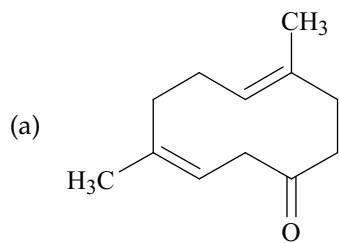


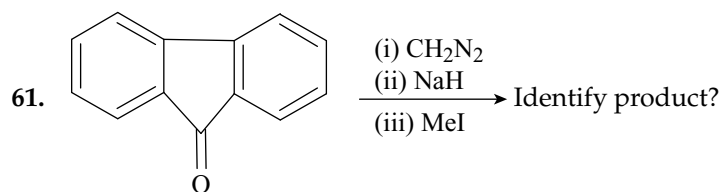
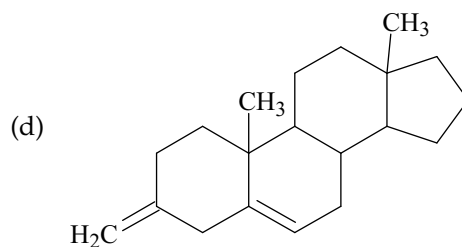
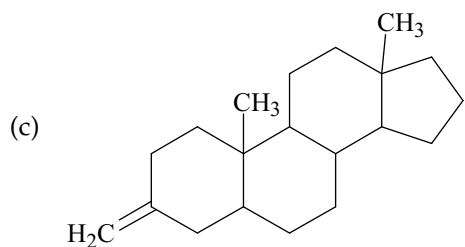
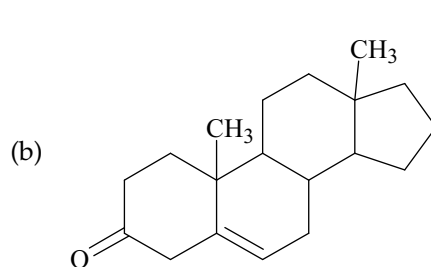
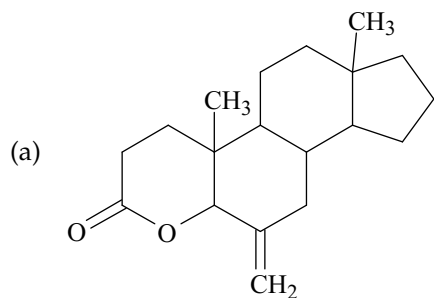
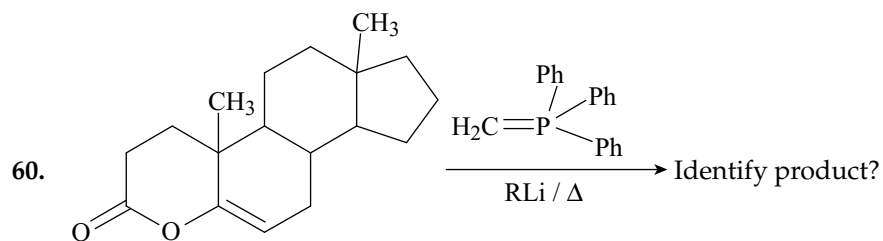
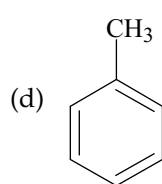
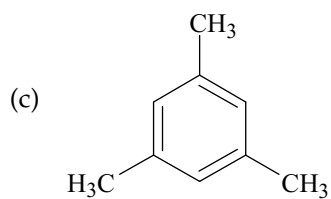
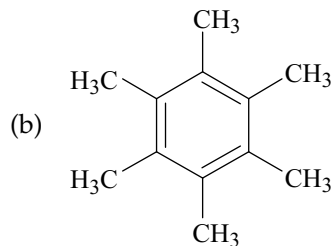
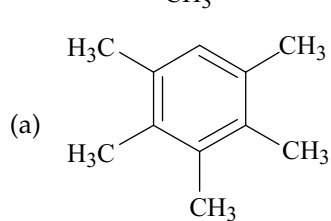
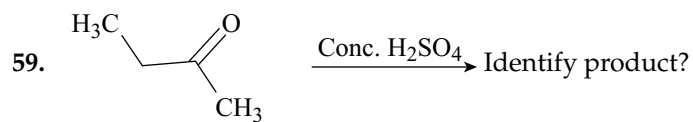


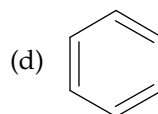
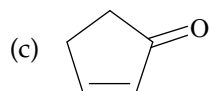
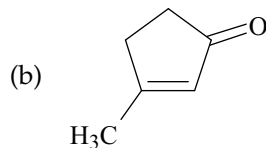
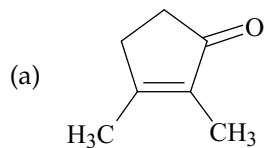
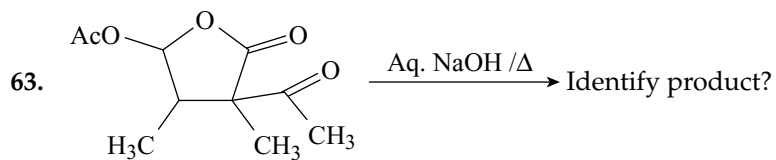
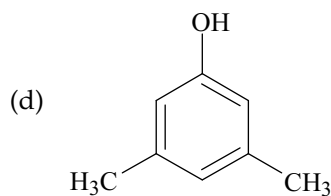
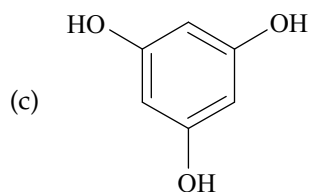
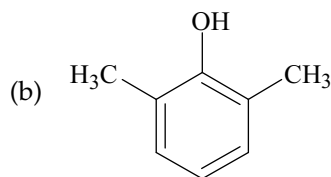
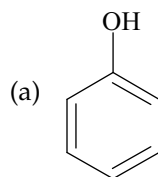
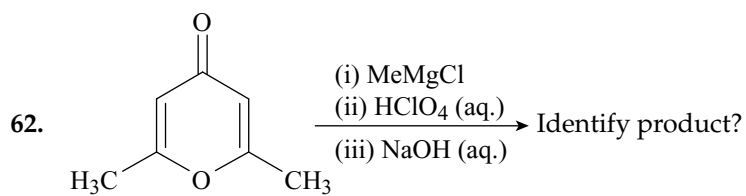
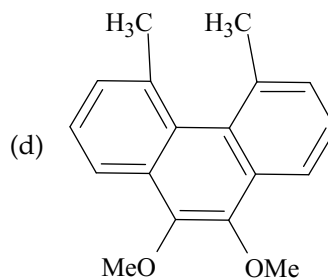
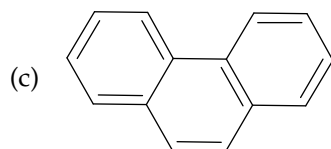
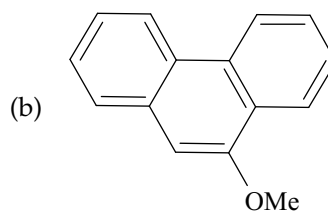
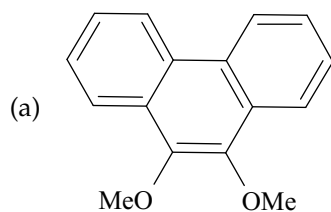


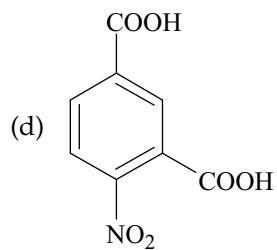
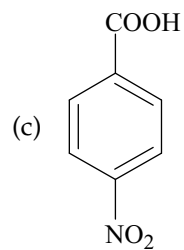
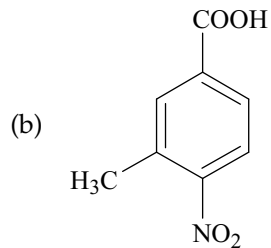
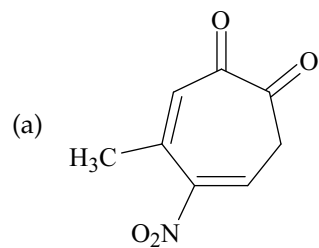
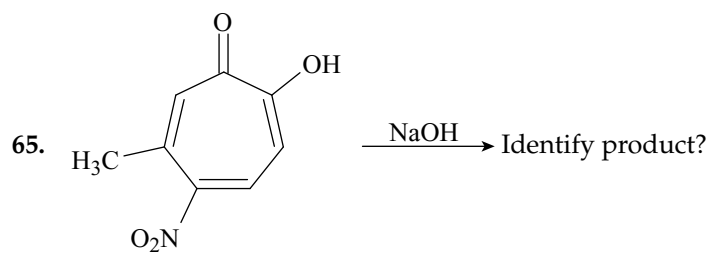
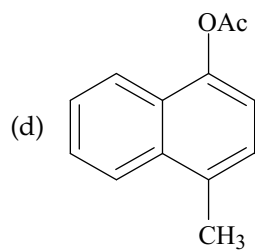
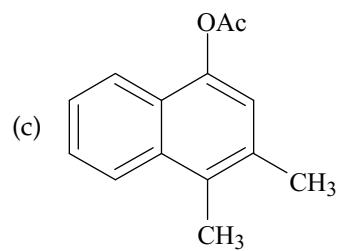
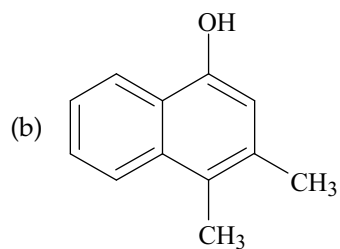
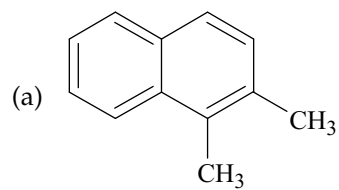
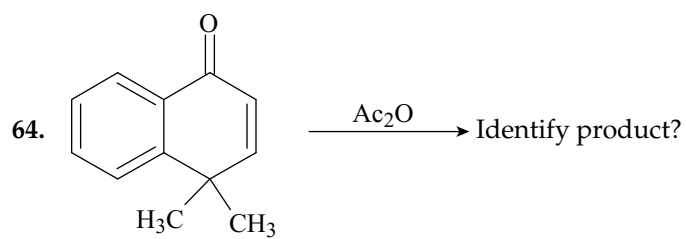


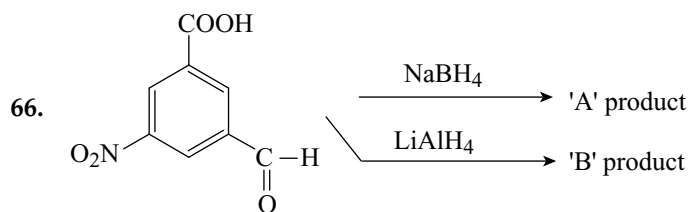




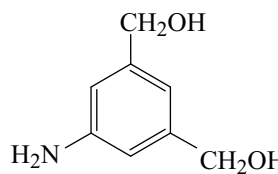
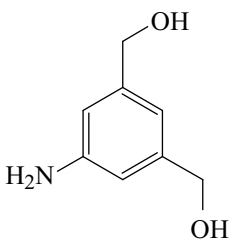
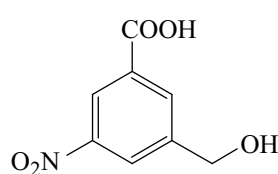
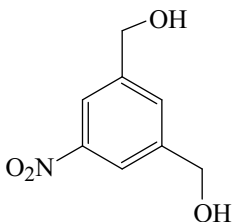


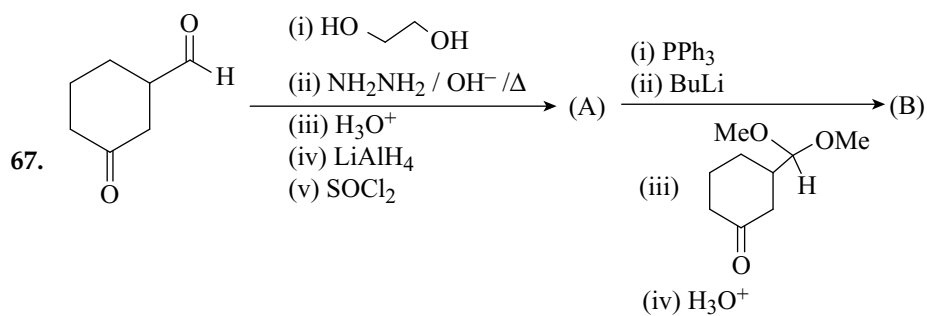




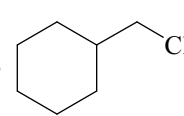
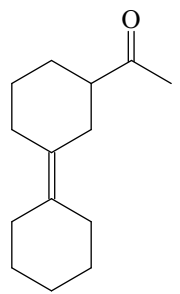
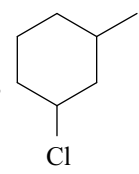
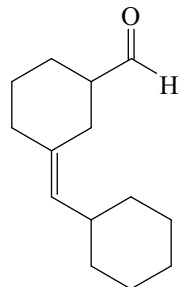


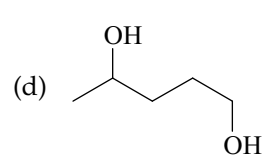
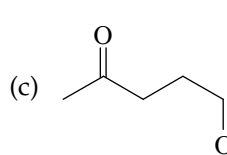
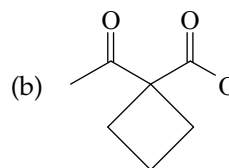
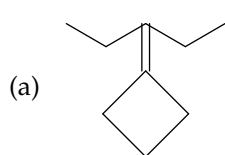
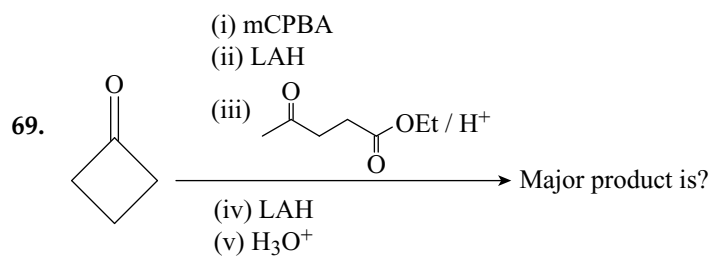
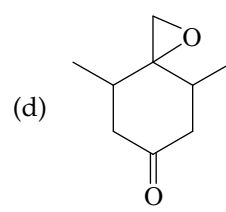
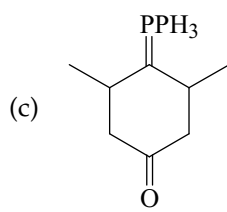
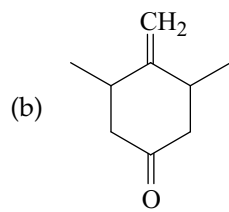
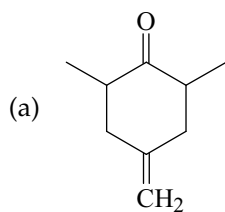
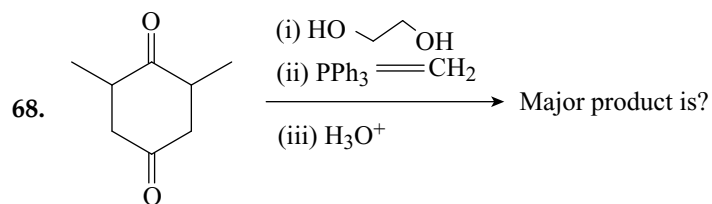
Identify true statement for A and B products.

- (a) 'A' is 
- (b) 'B' is 
- (c) 'A' is 
- (d) 'B' is 

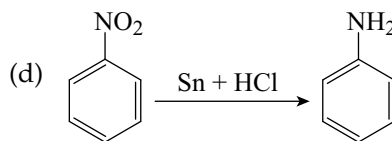
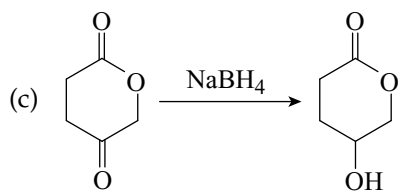
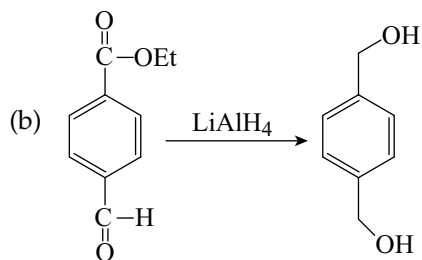
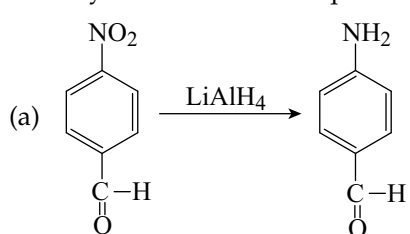


Identify correct statement for (A) and (B) products.

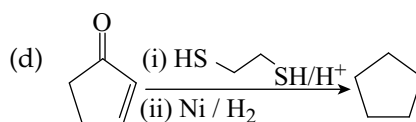
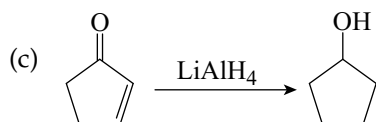
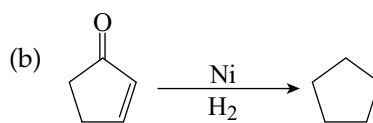
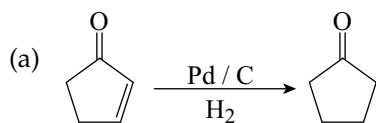
- (a) Structure of 'A' is 
- (b) Structure of 'B' is 
- (c) Structure of 'A' is 
- (d) Structure of 'B' is 



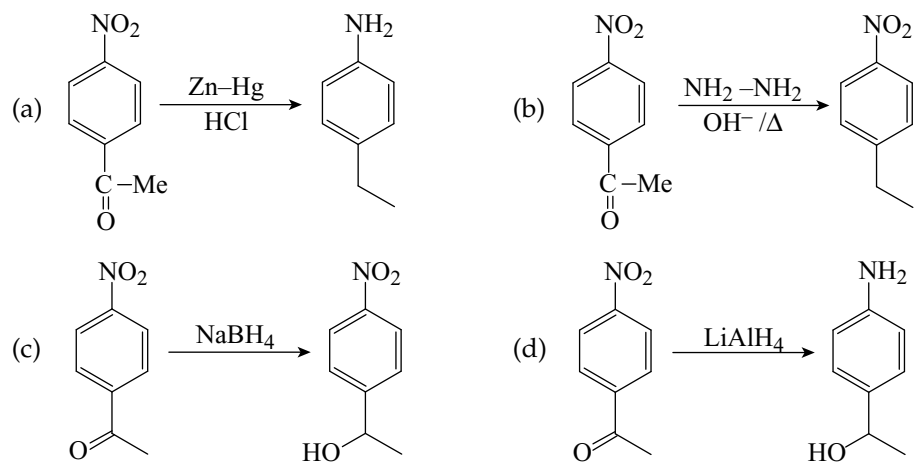
70. Identify correct reaction sequence



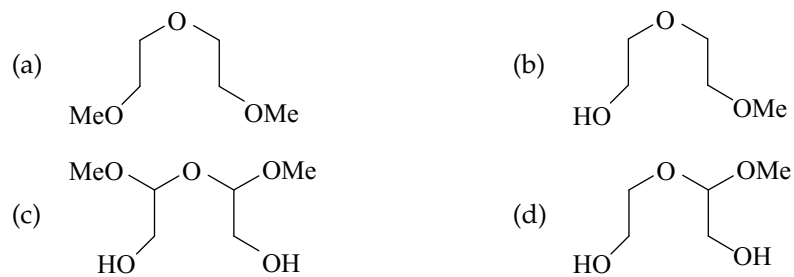
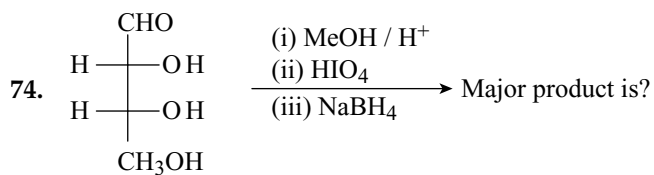
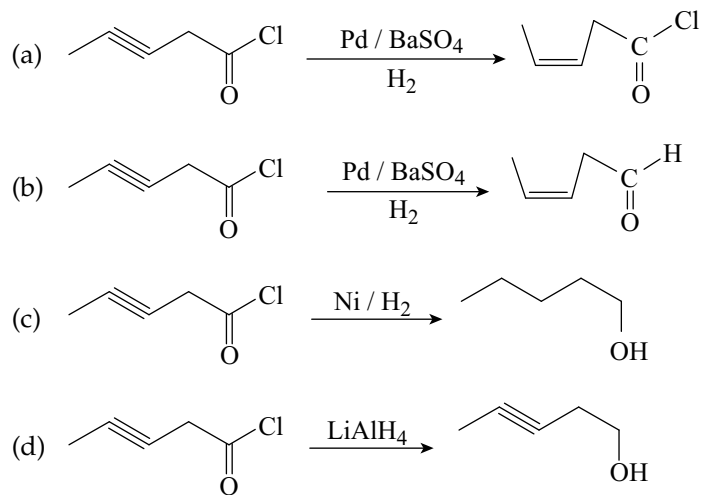
71. Identify correct reaction sequence

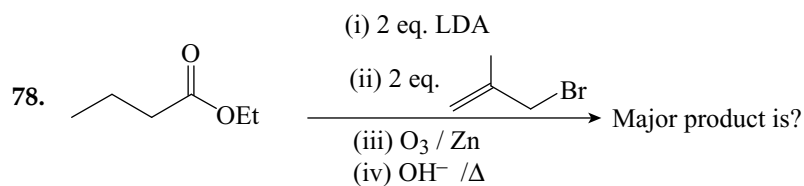
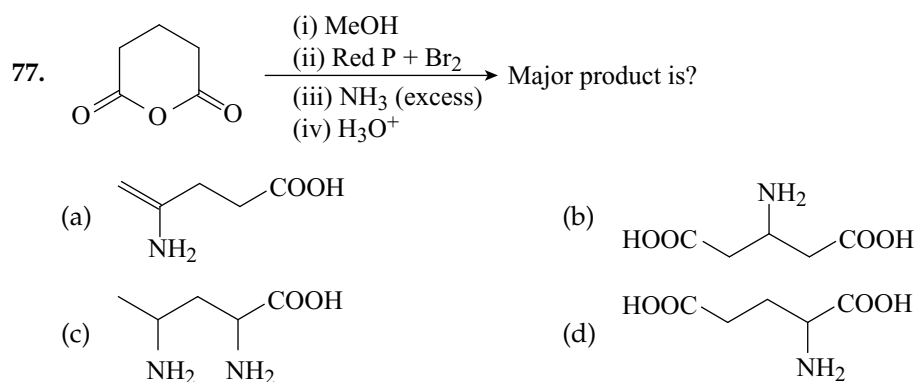
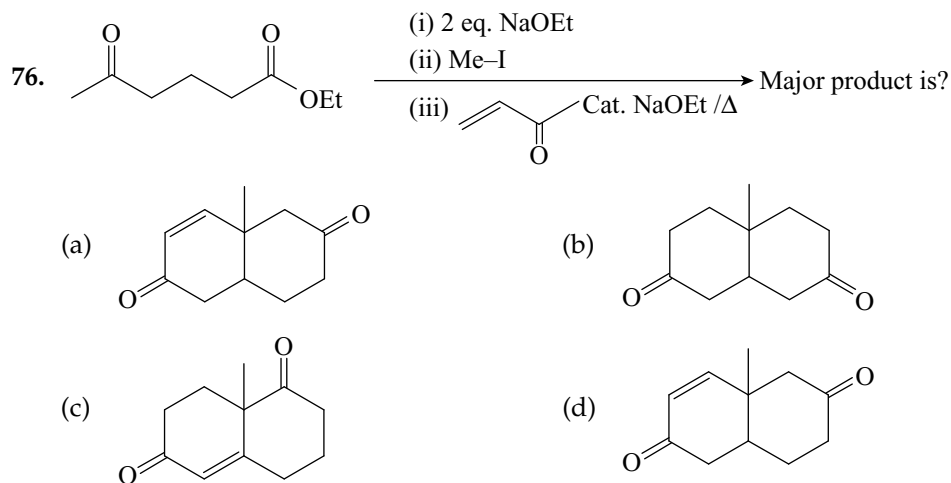
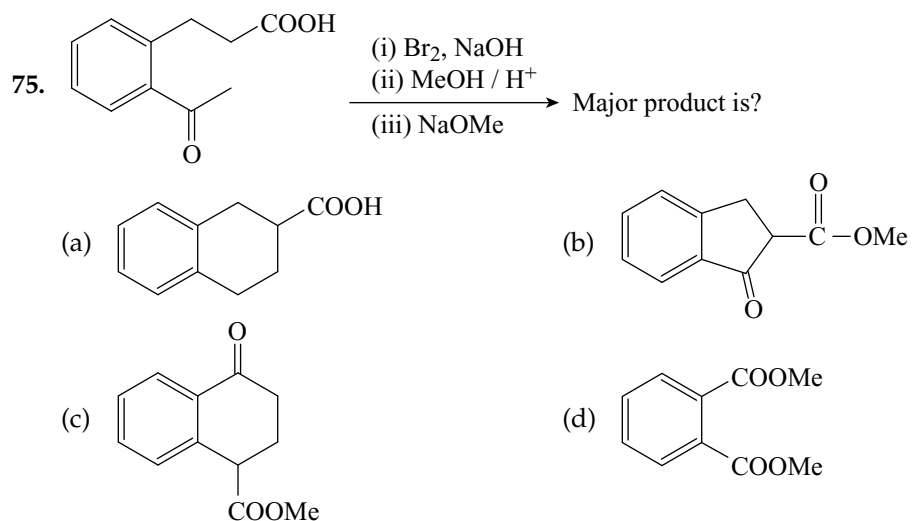


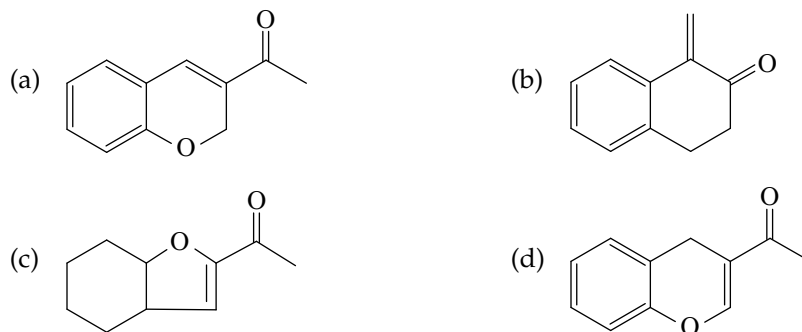
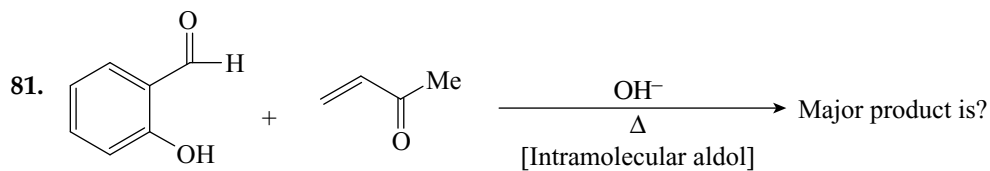
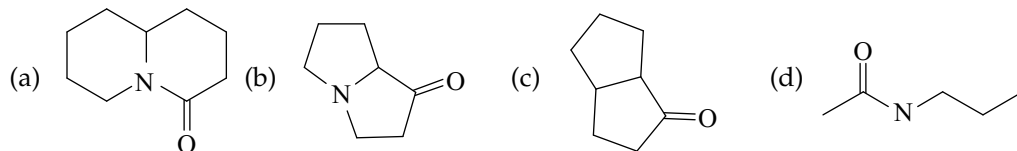
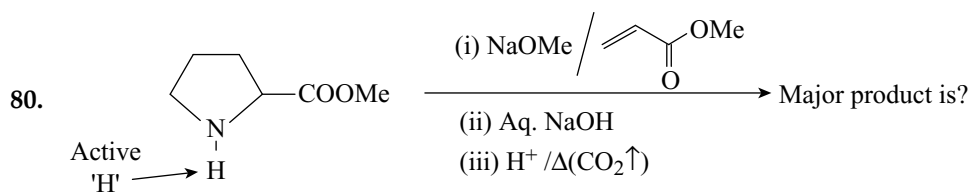
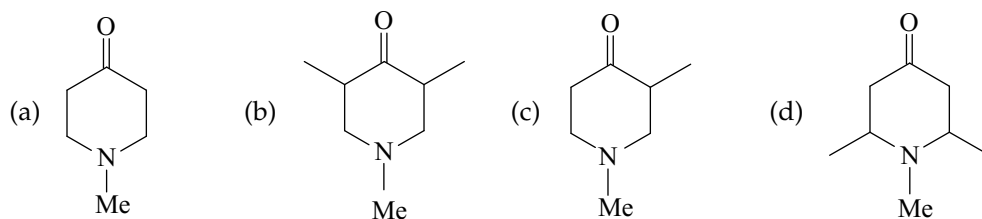
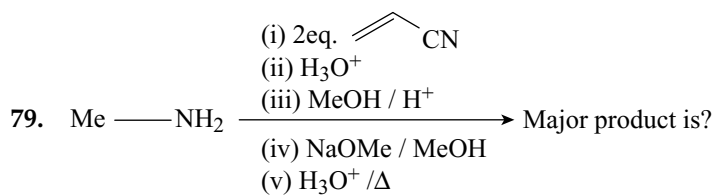
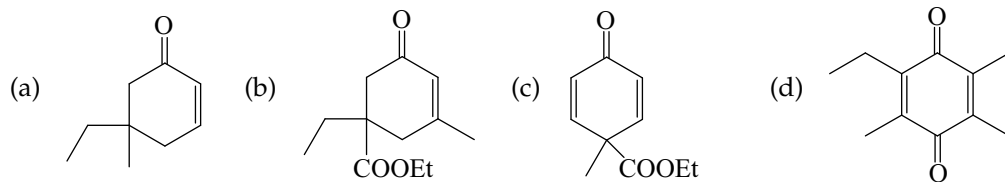
72. Identify correct reaction sequence

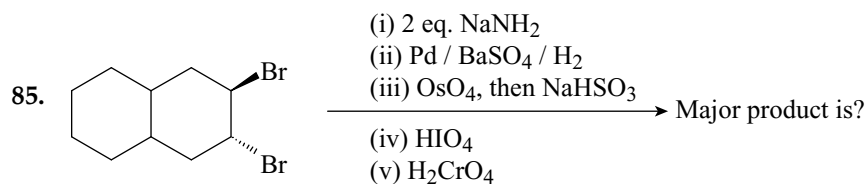
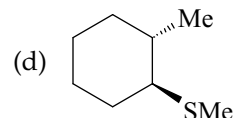
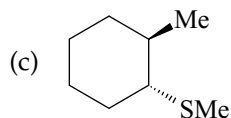
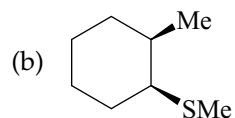
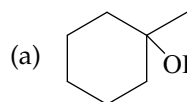
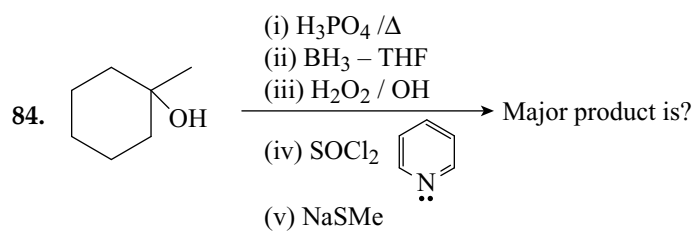
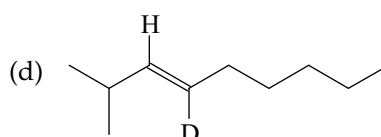
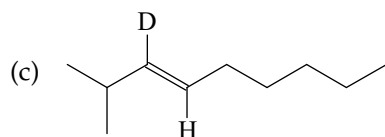
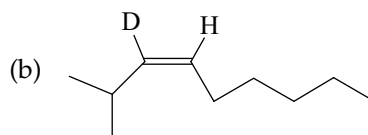
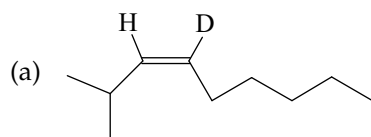
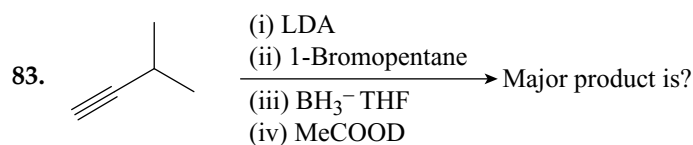
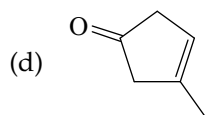
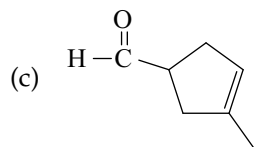
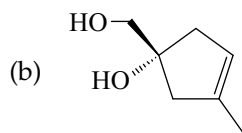
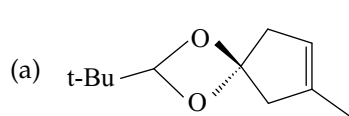
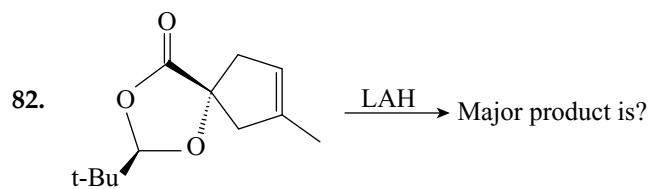


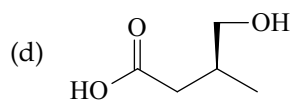
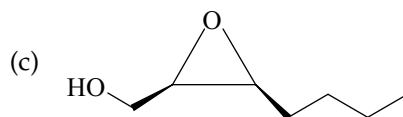
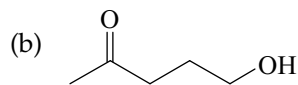
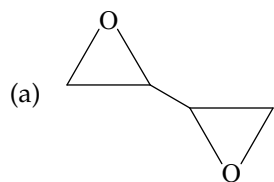
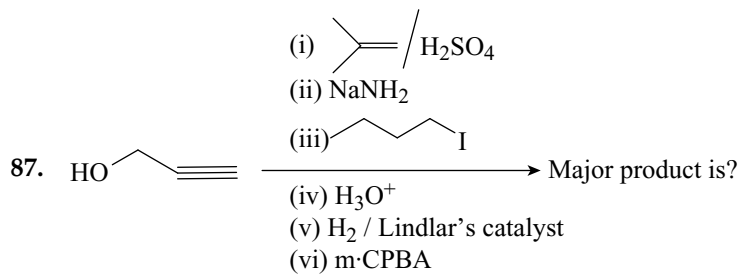
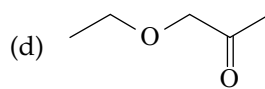
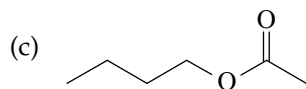
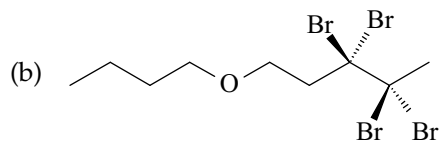
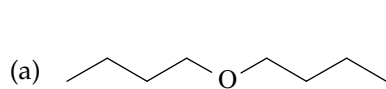
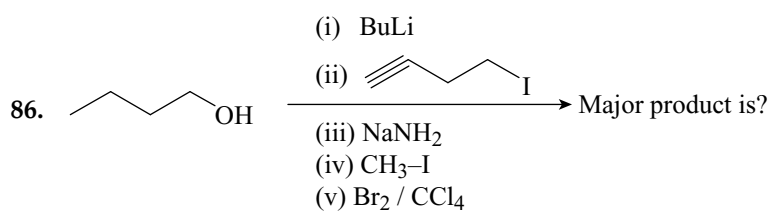
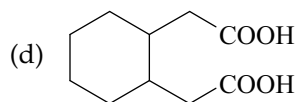
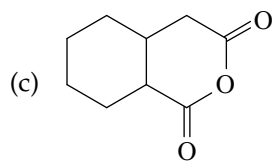
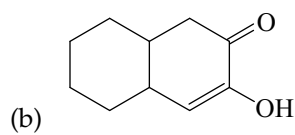
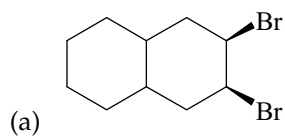
73. Identify correct reaction sequence

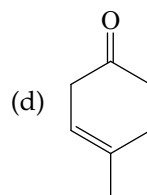
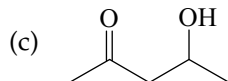
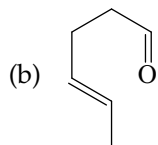
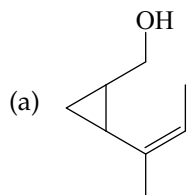
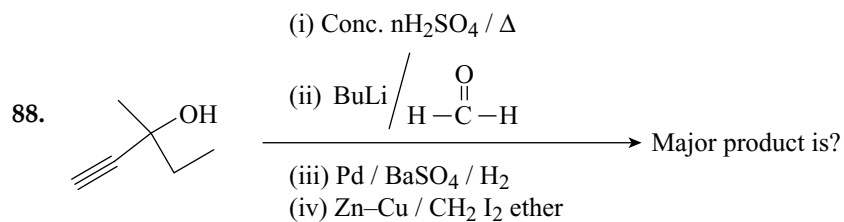




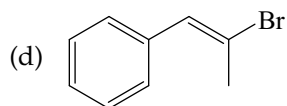
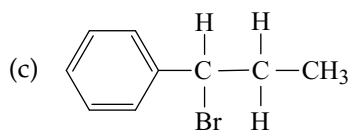
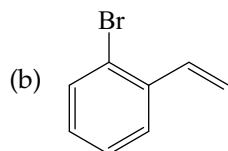
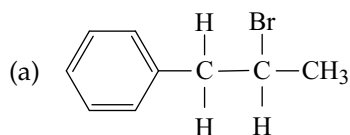
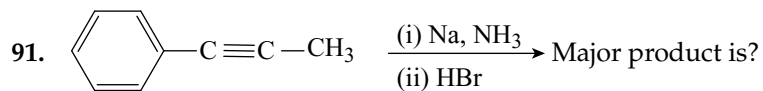
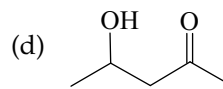
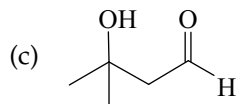
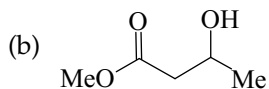
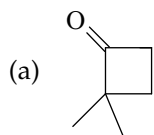
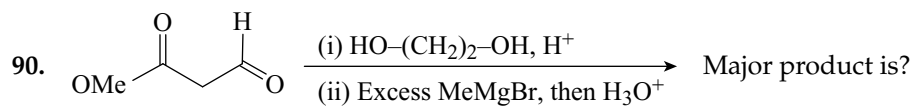
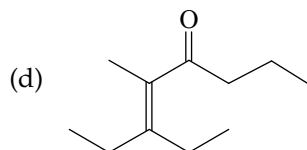
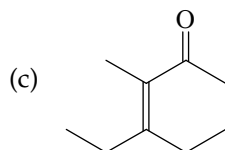
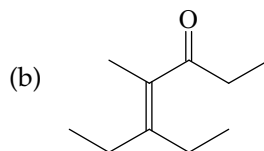
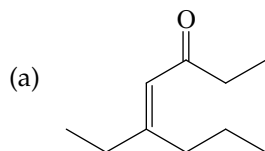


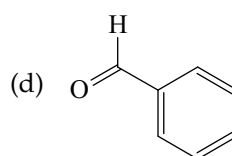
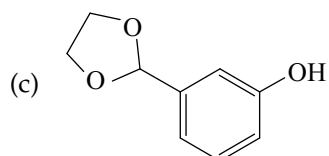
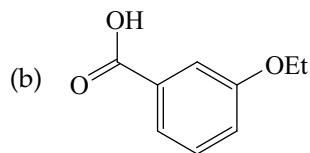
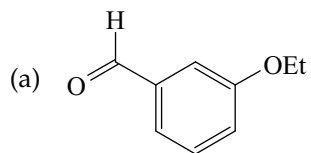
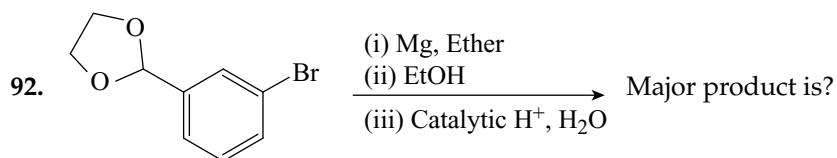






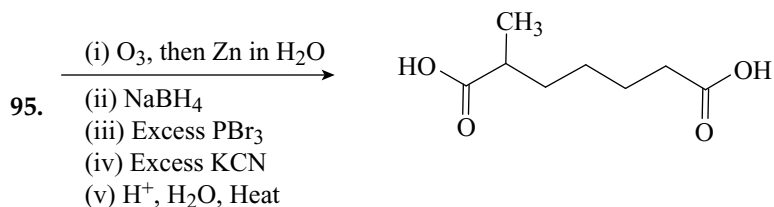
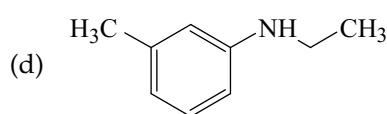
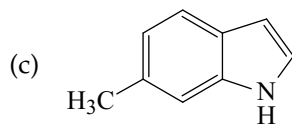
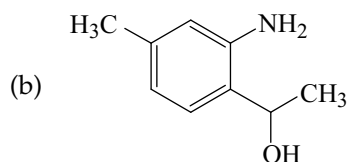
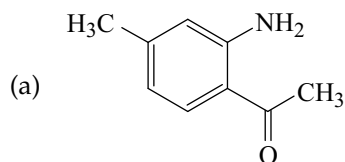
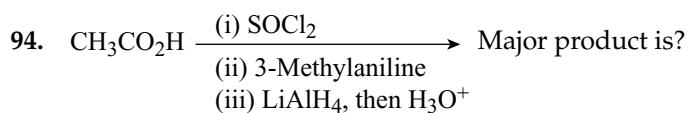
89. Which of the following structures is the product from the self-condensation of two molecules of pentan-3-one?



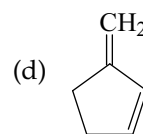
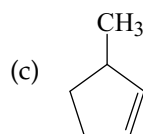
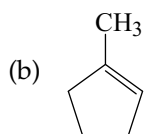
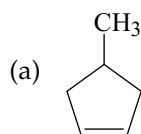


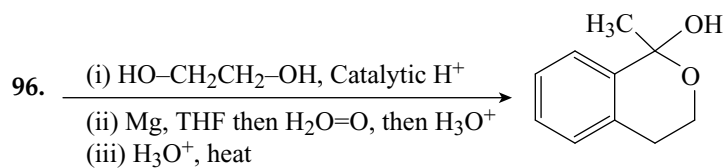
93. Select all of the following statements about the cross Aldol experiment that are true:

- (a) The ketone was added to a solution containing the aldehyde and base.
- (b) The reaction can be catalyzed by an acid.
- (c) The electrophile is the enolate ion.
- (d) The aldehyde is used in excess.

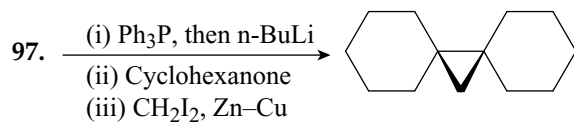
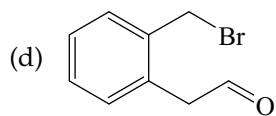
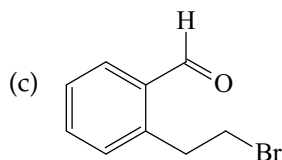
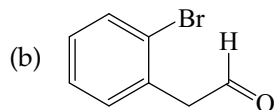
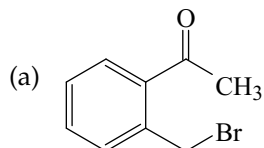


Identify reactant?

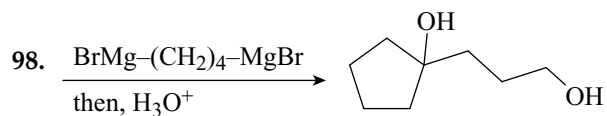
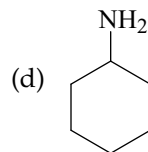
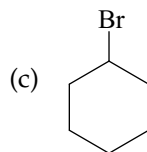
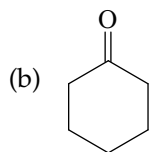
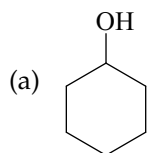




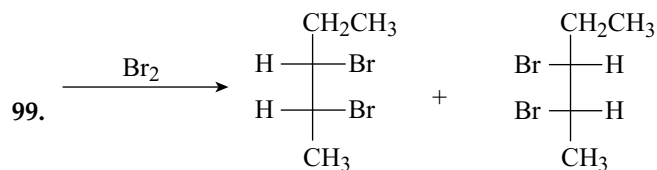
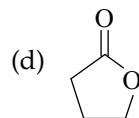
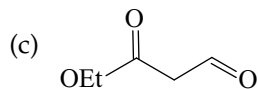
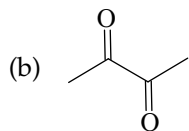
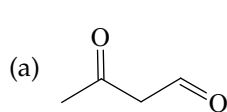
Identify reactant?



Identify reactant?

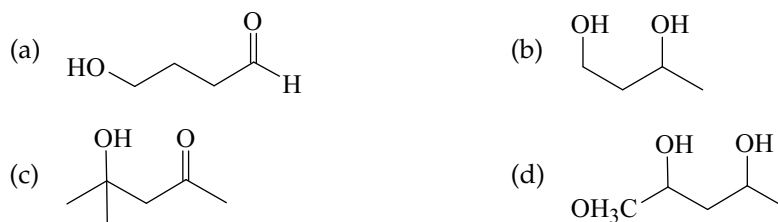
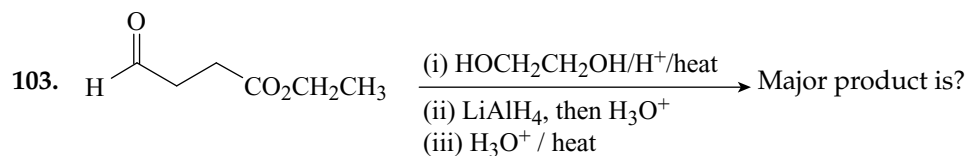
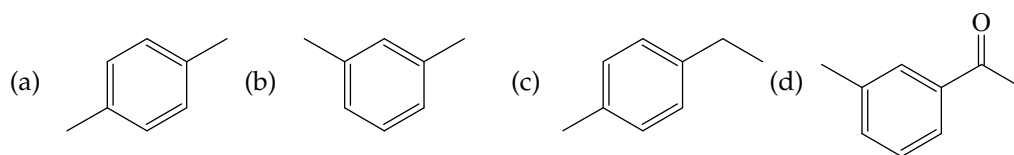
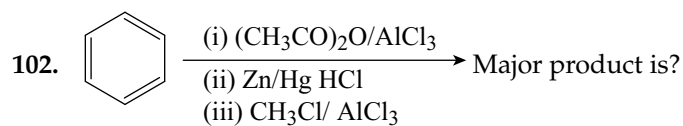
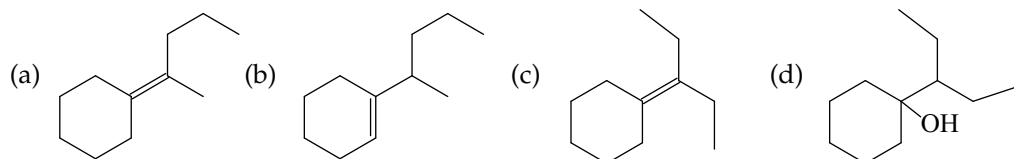
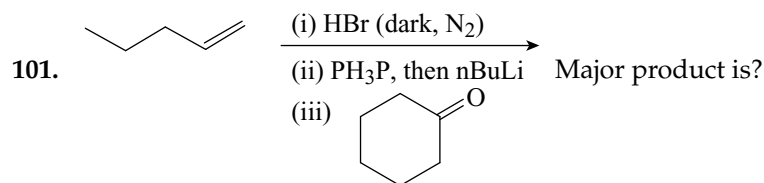
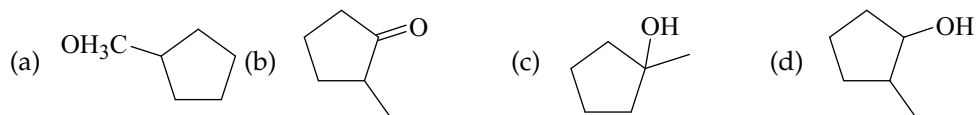
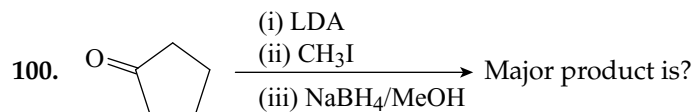
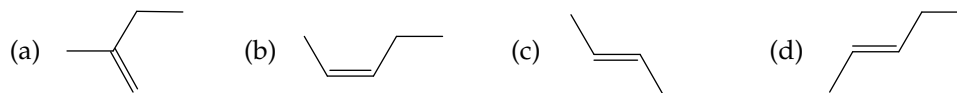


Identify reactant?



(50:50 of these enantiomers)

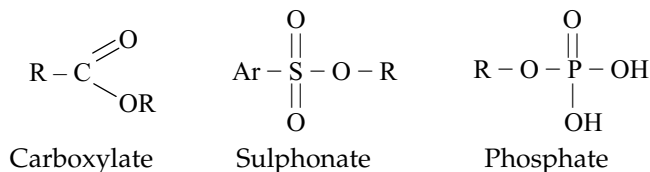
Identify reactant?



## Comprehension Type

### Passage 1

When the following three different types of esters are hydrolyzed in a basic medium,



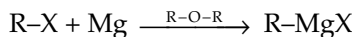
the hydroxide anion attacks the acyl carbon in carboxylates while it attacks the alkyl carbon in sulphonates leading to a difference in the site of cleavage. More interestingly, phosphate esters lie somewhat in between carboxylates and sulphonates in that cleavage can occur in either direction.

In an acidic solution, all the three types of phosphates (monoalkyl, dialkyl and trialkyl) are hydrolyzed to phosphoric acid, while in a basic solution only trialkyl phosphates undergo hydrolysis and only one alkoxy group is removed.

104. Which of the following factor explains the difference in attack of the nucleophile,  $\text{OH}^-$  on carboxylates and sulphonates?
- Sulphonate anions are weakly basic and hence good leaving groups.
  - Carboxylate anions are strongly basic and hence poor leaving groups.
  - Both (a) and (b)
  - None of the these
105. Competition between phosphorus and alkyl carbon to nucleophilic attack is due to the fact that
- Phosphorus can accept an additional pair of electrons.
  - Phosphoric acid lies between carboxylic acid and sulphonic acid.
  - Both (a) and (b)
  - None of the these
106. The rate of hydrolysis of monoalkyl phosphates tends to ..... with increase in pH.
- Decrease
  - Increase
  - Remains unaffected
  - None of these
107. In an aqueous solution, a monoalkylphosphate ester can exist as
- A neutral ester
  - A monoanion and dianion
  - A monoanion, dianion and protonated ester
  - A monoanion, dianion, protonated ester and neutral ester

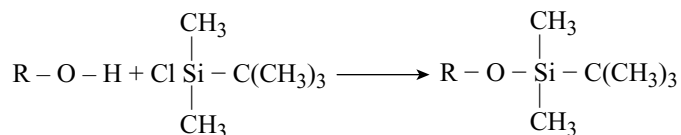
## Passage 2

Grignard reagents ( $\text{RMgX}$ ) are prepared by the reaction of an organic halide and magnesium metal in ether solvent.

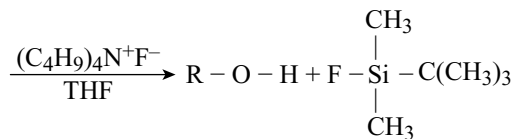


The solvent (usually diethyl ether or tetrahydrofuran) plays a crucial role in the formation of a Grignard reagent. Alkyl halides are more reactive than aryl and vinyl halides. Indeed, aryl and vinyl chlorides do not form Grignard reagent in diethyl ether.

However, an alkyl halide containing an alcoholic  $-\text{OH}$  group can be converted to Grignard reagent by first protecting the  $-\text{OH}$  group to tert-butyldimethylsilyl ether which is inert to Grignard reagent. The protecting group is finally liberated by treatment with fluoride ion.

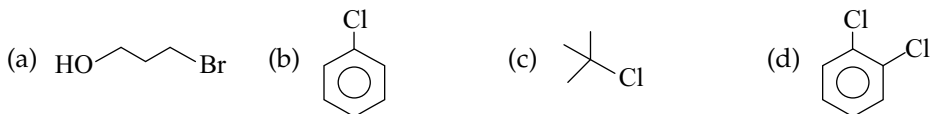


tert-butylchlorodimethylsilane



108. Grignard reactions generally occur in dry ether because
- The stronger acid diethyl ether will displace the weaker  $\text{RH}$  acid from its salt.
  - The stronger acid  $\text{H}_2\text{O}$  will displace the weaker acid  $\text{RH}$  from its salt.
  - Water slows down the reaction.
  - Water mixes with ether preventing ether to perform its function.

109. Grignard reagent cannot be prepared from



110.  $\text{H}_2\text{N}(\text{CH}_2)_3\text{Br}$  cannot be converted into corresponding Grignard reagent because of

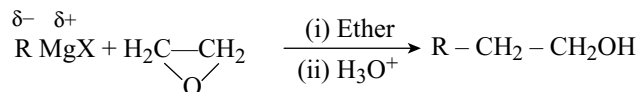
- Reaction between  $-\text{NH}_2$  and  $-\text{Br}$  groups present in the same molecule
- Strong nucleophilic character of the Grignard reagent
- Strong basic nature of the Grignard reagent
- All the three factors

111. The function of tetrahydrofuran in the preparation of Grignard reagent is that it

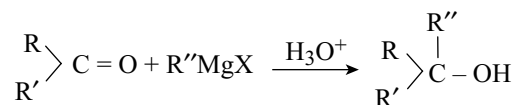
- Acts as a solvent
- Helps in maintaining the reactivity of magnesium
- Both (a) and (b)
- None of the these

### Passage 3

Grignard reagents are powerful nucleophiles and strong bases. They act as nucleophiles by attacking a variety of compounds including saturated and unsaturated carbon atoms. Examples of reaction on saturated carbon include oxiranes (epoxides) which form alcohols as the final product.



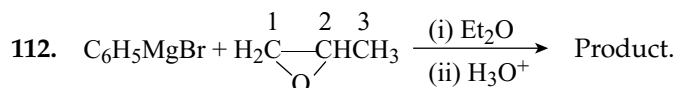
Examples of reaction on unsaturated carbon are attack on  $\text{>C}=\text{O}$ ,  $-\text{C}\equiv\text{N}$ ,  $\text{>C}=\text{S}$ , etc.



When R and R' = H, product is 1° alcohol.

When R and R' = Alkyl group, product is 3° alcohol.

When one R or R' is alkyl, product is 2° alcohol.



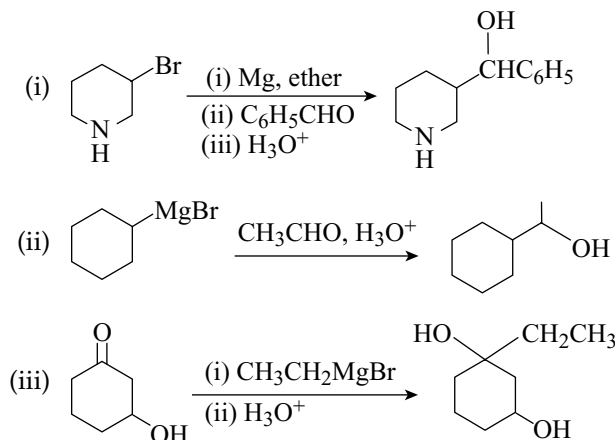
Here, the nucleophile  $\text{C}_6\text{H}_5^-$  attacks

- (a)  $\text{C}_1$                       (b)  $\text{C}_2$                       (c)  $\text{C}_3$                       (d) Any of the three

113. Epoxides react with Grignard reagent to form

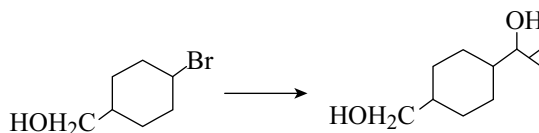
- (a) Primary alcohols                      (b) Secondary alcohols  
(c) Tertiary alcohols                      (d) Any of the three

114. On the basis of the above two passages, predict which of the reaction is feasible.



- (a) Only ii                      (b) i and ii                      (c) All the three                      (d) None of three

115. On the basis of the above two passages, steps involved in the following conversion are



- (a) Protection of the  $\text{-OH}$  group, followed by reaction with  $\text{H}_2\text{C}=\text{CHCH}_3$   
 (b) Protection of the  $\text{-OH}$  group, followed by reaction with  $\text{CH}_3\text{CH}_2\text{CHO}$   
 (c) Protection of the  $\text{-OH}$  group, followed by reaction with  $(\text{CH}_3)_2\text{CHCHO}$   
 (d) Reaction is not feasible to give quantitative yield

#### Passage 4

Alkyl halides and alcohols easily undergo nucleophilic substitution either through  $\text{S}_{\text{N}}1$  or  $\text{S}_{\text{N}}2$  mechanism. The relative ease of these two processes depends upon the nature of the substrate (alkyl group as well as leaving group), nature of nucleophile and also upon the nature of solvent.

$\text{S}_{\text{N}}1$  mechanism involves the formation of carbocation as intermediate while  $\text{S}_{\text{N}}2$  mechanism involves the formation of a transition pentavalent state.  $\text{S}_{\text{N}}1$  is the main mechanism in  $3^\circ$  alkyl halides and alcohols, while  $\text{S}_{\text{N}}2$  mechanism is the path adopted by most of the  $1^\circ$  alkyl halides and  $2^\circ$  alkyl halides may follow  $\text{S}_{\text{N}}1$  as well as  $\text{S}_{\text{N}}2$ .

116. Which of the following solvent will give maximum yield for an alkyl halide undergoing  $\text{S}_{\text{N}}1$  mechanism?  
 (a) Water (b) Ethanol (c) Diethyl ether (d) n-hexane
117. Rearrangement of alkyl groups occur when hydrogen halides react with alcohols except with most primary alcohols. The best explanation is that  
 (a) The  $1^\circ$  carbocations are unstable and hence are not formed.  
 (b) The  $1^\circ$  carbocations are unable to undergo rearrangement.  
 (c) Both (a) and (b) are true  
 (d) Both (a) and (b) are false
118. Neopentyl alcohol,  $\text{Me}_3\text{CCH}_2\text{OH}$ , reacts with  $\text{HX}$  according to  
 (a)  $\text{S}_{\text{N}}1$  mechanism (b)  $\text{S}_{\text{N}}2$  mechanism  
 (c) Both (a) and (b) (d) None

#### Passage 5

119. A chemist treated a compound X with  $\text{NaOH}$  in presence of acetone as solvent. However, he recovered the starting material as such, and instead isolated a small amount of the product A. The product A was shown to have C, H and O and it had a molecular weight of 116g/mol. It gave a positive iodoform test and was found to be identical with a compound obtained by the aldol self-condensation of acetone.

Although the product A did not discharge colour of bromine in  $\text{CCl}_4$ , its dehydration product B with hot sulphuric acid discharged bromine dissolved in  $\text{CCl}_4$ .

120. What is the molecular weight of a compound that undergoes an aldol self-condensation reaction and whose dehydrated product has a molecular weight of 70?

- (a) 35                      (b) 44                      (c) 49                      (d) 58

121. The aldol self-condensation of acetone is in equilibrium that favours acetone over its corresponding product. Which of the following conditions is most likely to shift the position of equilibrium toward product A?

- (a) By using a catalytic amount of NaOH.  
(b) By using only a catalytic amount of acetone.  
(c) By removing product A as soon as it is formed.  
(d) By increasing reaction temperature.

122. Which of the following compounds will give a positive iodoform test?

- (a) Only compound A                      (b) Only compound B  
(c) Both (a) and (b)                      (d) None of these

123. The compound X can be

- (a)  $\text{CH}_3\overset{\text{O}}{\parallel}\text{CH}$                       (b)  $\text{CH}_3-\overset{\text{O}}{\parallel}\text{C}-\text{CH}_3$   
(c) HCHO                      (d)  $\text{n-CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$

### Passage 6

Amides undergo hydrolysis to yield carboxylic acid plus amine on heating in either aqueous acid or aqueous base. The conditions required for amide hydrolysis are more severe than those required for the hydrolysis of esters, anhydrides or acid chlorides, but the mechanism is similar (nucleophilic acyl substitution). Nucleophilic acyl substitutions involve a tetrahedral intermediate, hence these are quite different from alkyl substitution ( $\text{RCH}_2\text{Br} \xrightarrow{\text{NaCN}} \text{RCH}_2\text{CN}$ ) which involves a pentavalent intermediate or transition state.

One of the important reactions of esters is their reaction with two equivalent of a Grignard reagent to give tertiary alcohols.

124. The mechanism involved during the hydrolysis of acid derivatives is

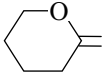
- (a) elimination-addition                      (b) addition-elimination  
(c) nucleophilic addition-elimination                      (d) electrophilic addition-elimination

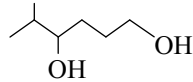
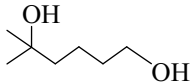
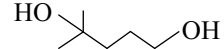
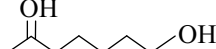
125. Which of the following constitutes the best substrate during the acidic hydrolysis of amides?

- (a)  $\text{R}-\overset{\text{O}}{\parallel}\text{C}-\text{NH}_2$                       (b)  $\text{R}-\overset{\text{O}}{\parallel}\text{C}-\overset{+}{\text{N}}\text{H}_3$                       (c)  $\text{R}-\overset{\text{OH}^+}{\parallel}\text{C}-\text{NH}_2$                       (d)  $\text{R}-\overset{\text{OH}^+}{\parallel}\text{C}-\overset{+}{\text{N}}\text{H}_3$

126. For which functional derivative of carboxylic acids, acidic hydrolysis is avoided?

- (a) Acid chlorides                      (b) Acid amides  
(c) Acid anhydrides                      (d) Esters

127. When  is treated with two equivalent of methyl magnesium iodide, the product that acidified the final product will be

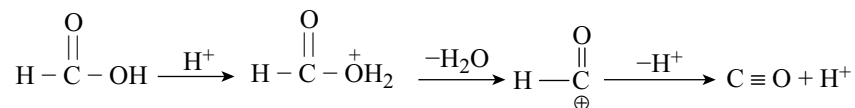
- (a)  (b)   
 (c)  (d) 

128. Which of the following methods is more general for preparing nitriles?

- (a)  $\text{RCH}_2\text{Br} + \text{NaCN} \longrightarrow \text{RCH}_2\text{CN} + \text{NaBr}$   
 (b)  $\text{RCH}_2\text{CH}_2\text{CONH}_2 \xrightarrow{\text{P}_4\text{O}_{10}} \text{RCH}_2\text{CH}_2\text{CN}$   
 (c) Both (a) and (b)  
 (d) None of these

### Passage 7

Methanoic acid, the first member of carboxylic acid series, when warmed with concentrated sulphuric acid decompose in the following way and evolve carbon monoxide



The driving force for this reaction lies in the fact that the  $\text{HC} \equiv \text{O}^+$  ion is very unstable acid and thus easily loses  $\text{H}^+$ .

129. Formic acid on heating with conc.  $\text{H}_2\text{SO}_4$  gives

- (a)  $\text{CO}_2 + \text{H}_2$  (b)  $\text{CO} + \text{H}_2\text{O}$  (c)  $\text{CO}$  (d)  $\text{H}_2\text{O}$

130. What happens when acetic acid is treated with conc.  $\text{H}_2\text{SO}_4$ ?

- (a)  $\text{CO} + \text{H}_2\text{O}$  (b)  $\text{CH}_4 + \text{CO}_2$  (c)  $\text{CO} + \text{CH}_4$  (d) No reaction

131. If acetic acid is replaced by triphenylacetic acid, the product formed will be

- (a)  $(\text{C}_6\text{H}_5)_3\text{CH} + \text{CO}$  (b)  $(\text{C}_6\text{H}_5)_3\text{CH} + \text{CO}_2$   
 (c)  $(\text{C}_6\text{H}_5)_3\text{COH} + \text{CO}$  (d) No reaction

132. If formic acid is replaced by benzoylformic acid,  $\text{C}_6\text{H}_5\text{COCOOH}$ , the product formed will be

- (a)  $\text{C}_6\text{H}_5\text{COOH} + \text{CO} + \text{CO}_2$  (b)  $\text{C}_6\text{H}_5\text{COOH} + \text{CO}_2$   
 (c)  $\text{C}_6\text{H}_5\text{COOH} + \text{CO}$  (d)  $\text{C}_6\text{H}_5\text{CHO} + \text{CO}_2$

# Answer Keys

## LEVEL 1

|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  |
| d   | a   | c   | d   | b   | b   | a   | d   | d   | d   | d   | a   | c   | a   | a   | a   | b   | b   | d   | a   |
| 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  |
| c   | b   | d   | b   | a   | d   | c   | b   | d   | b   | b   | b   | b   | c   | d   | c   | a   | d   | b   | c   |
| 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  |
| c   | c   | d   | d   | b   | b   | c   | c   | c   | d   | c   | c   | d   | d   | c   | c   | c   | c   | b   | b   |
| 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  |
| c   | a   | a   | c   | b   | c   | d   | b   | c   | a   | c   | c   | c   | b   | d   | c   | c   | b   | c   | c   |
| 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  | 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 |
| c   | d   | b   | d   | c   | b   | a   | c   | c   | b   | a   | d   | b   | d   | a   | b   | d   | b   | b   | d   |
| 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 |
| c   | a   | a   | c   | b   | d   | b   | b   | a   | d   | d   | a   | a   | d   | b   | d   | c   | c   | d   | c   |
| 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 |
| d   | a   | b   | d   | b   | d   | b   | c   | c   | d   | b   | d   | d   | c   | a   | a   | c   | a   | d   | a   |
| 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 |
| a   | d   | b   | d   | c   | a   | d   | c   | b   | b   | c   | c   | d   | d   | b   | d   | b   | a   | b   | b   |
| 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 |     |     |     |     |     |     |     |     |     |     |
| b   | d   | b   | d   | d   | c   | d   | a   | c   | c   |     |     |     |     |     |     |     |     |     |     |

## LEVEL 2

|     |      |     |      |     |     |     |     |     |     |      |      |      |      |     |
|-----|------|-----|------|-----|-----|-----|-----|-----|-----|------|------|------|------|-----|
| 1   | 2    | 3   | 4    | 5   | 6   | 7   | 8   | 9   | 10  | 11   | 12   | 13   | 14   | 15  |
| c   | d    | c   | c    | c   | a   | b   | b   | b   | a   | d    | b    | c    | b    | a   |
| 16  | 17   | 18  | 19   | 20  | 21  | 22  | 23  | 24  | 25  | 26   | 27   | 28   | 29   | 30  |
| a   | c    | d   | c    | b   | c   | d   | b   | b   | c   | b    | d    | a    | b    | a   |
| 31  | 32   | 33  | 34   | 35  | 36  | 37  | 38  | 39  | 40  | 41   | 42   | 43   | 44   | 45  |
| d   | c    | a   | b    | a   | b   | b   | c   | c   | c   | a    | b    | a    | b    | b   |
| 46  | 47   | 48  | 49   | 50  | 51  | 52  | 53  | 54  | 55  | 56   | 57   | 58   | 59   | 60  |
| d   | b    | b   | c    | d   | c   | a   | a   | c   | d   | b    | a    | a    | b    | b   |
| 61  | 62   | 63  | 64   | 65  | 66  | 67  | 68  | 69  | 70  | 71   | 72   | 73   | 74   | 75  |
| b   | d    | a   | c    | b   | bc  | ad  | b   | c   | bcd | ad   | abcd | bcd  | d    | b   |
| 76  | 77   | 78  | 79   | 80  | 81  | 82  | 83  | 84  | 85  | 86   | 87   | 88   | 89   | 90  |
| c   | d    | b   | a    | b   | a   | b   | a   | cd  | d   | b    | c    | a    | b    | c   |
| 91  | 92   | 93  | 94   | 95  | 96  | 97  | 98  | 99  | 100 | 1 01 | 1 02 | 1 03 | 1 04 | 105 |
| c   | d    | abd | d    | b   | a   | c   | d   | d   | d   | a    | c    | a    | c    | a   |
| 106 | 1 07 | 108 | 1 09 | 110 | 111 | 112 | 113 | 114 | 115 | 116  | 117  | 118  | 119  | 120 |
| a   | d    | b   | a    | c   | c   | a   | d   | d   | d   | a    | d    | a    | b    | c   |
| 121 | 1 22 | 123 | 124  | 125 | 126 | 127 | 128 | 129 | 130 | 131  | 132  |      |      |     |
| c   | d    | c   | c    | c   | b   | b   | b   | b   | c   | c    | c    |      |      |     |

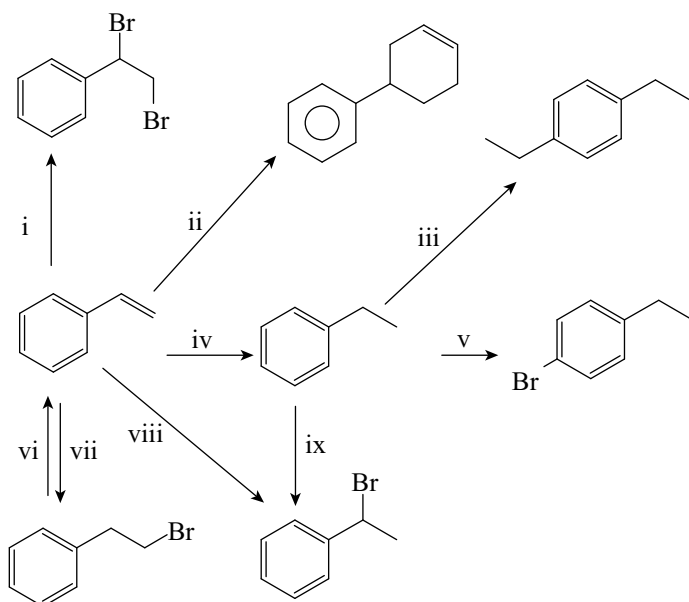
# WORKBOOK EXERCISES

## EXERCISE 1

### Matrix Type

Identify reagents (1 to 9) used in the following conversion from reagent present in the second Column II (A to L).

Column I (Conversion)



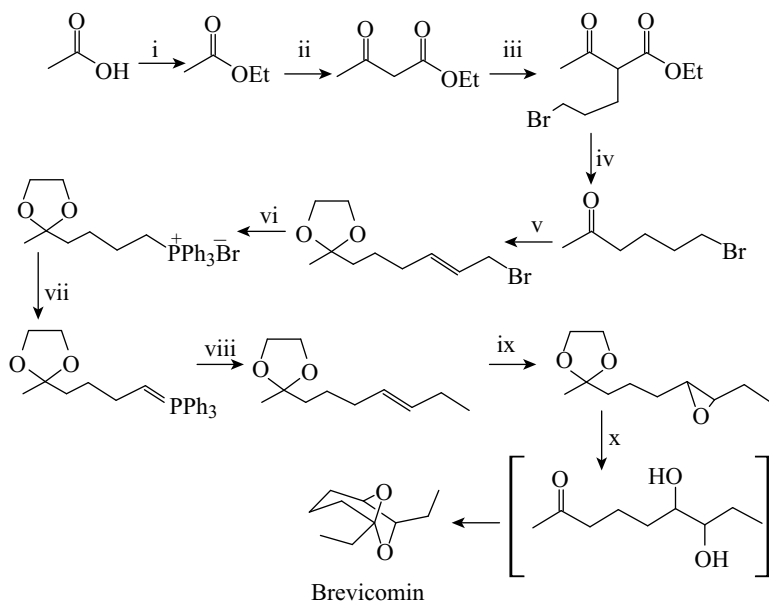
Column II (Reagent)

- (A)  $\text{Br}_2$
- (B)  $\text{NaBr}$  / acetone
- (C)  $\text{Br}_2$  / UV light
- (D)  $\text{Br}_2$  /  $\text{FeBr}_3$
- (E)  $\text{HBr}$  / dark
- (F)  $\text{HBr}$  / light
- (G)  $\text{EtBr}$
- (H)  $\text{EtBr}$  /  $\text{AlCl}_3$
- (I)  $\text{KOH}$  /  $\text{EtOH}$  /  $\Delta$
- (J)  $\text{CH}_2\text{CHCHCH}_2$  /  $\Delta$
- (K)  $\text{H}_2\text{SO}_4$
- (L)  $\text{H}_2$  /  $\text{Pd}$

## EXERCISE 2

**Identify reagents (1 to 10) used in the following conversion  
from reagent present in the second Column II (A to P).**

**Column I (Conversion)**



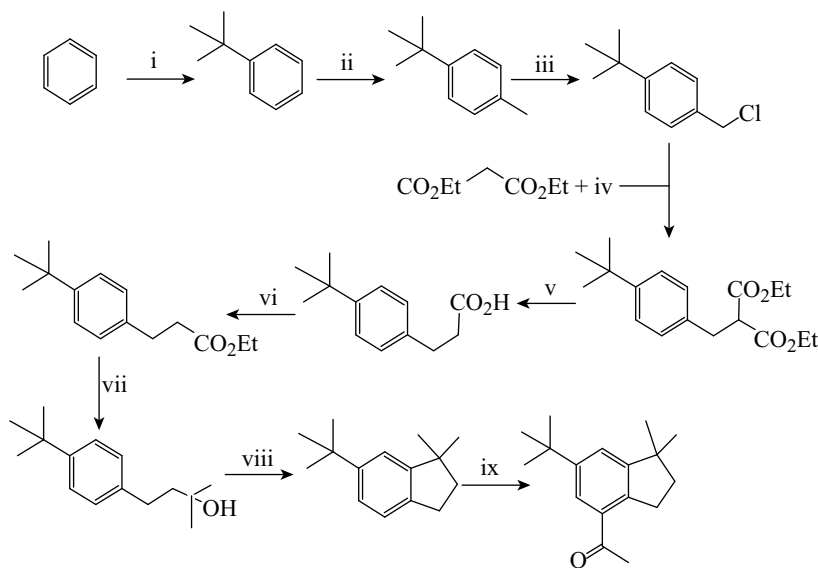
**Column II (Reagent)**

- (A)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Li} / \text{THF}$
- (B)  $\text{CH}_3\text{CH}=\text{CH}_2$
- (C)  $\text{CH}_3\text{CO}_2\text{H}$
- (D)  $\text{CH}_3\text{CO}_3\text{H}$
- (E)  $(\text{CH}_3)_2\text{C}=\text{O} / \text{H}^+$
- (F)  $\text{CH}_3\text{CH}_2\text{CHO}$
- (G)  $\text{PBr}_3 / \text{Et}_3\text{N}$
- (H)  $\text{PPh}_3$
- (I)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{MgBr} / \text{THF, then } \text{H}_3\text{O}^+$
- (J)  $\text{H}_3\text{O}^+ / \Delta$
- (K)  $\text{Conc. H}_2\text{SO}_4 / \Delta$
- (L)  $\text{NaOEt, then Br}(\text{CH}_2)_3\text{Br}$
- (M)  $\text{NaOEt} / \text{EtOH}$
- (N)  $\text{LiAlH}_4, \text{ then } \text{H}_3\text{O}^+$
- (O)  $\text{HOCH}_2\text{CH}_2\text{OH} / \text{H}^+$
- (P)  $\text{EtOH} / \text{H}^+ / \text{heat}$

## EXERCISE 3

**Identify reagents (1 to 9) used in the following conversion from reagent present in the second Column II (A to S).**

**Column I (Conversion)**



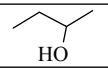
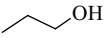
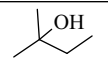
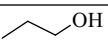
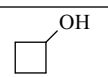
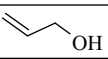
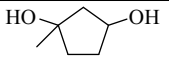
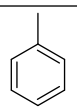
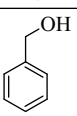
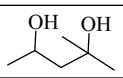
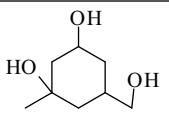
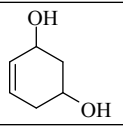
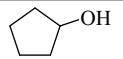
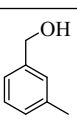
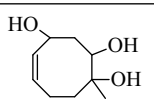
**Column II (Reagent)**

- (A)  $\text{KOH} / \text{H}_2\text{O} / \text{H}_3\text{O}^+ / \Delta$
- (B)  $\text{NaOEt} / \text{EtOH}$
- (C)  $\text{CH}_3\text{ONa} / \text{CH}_3\text{OH}$
- (D)  $\text{CH}_3\text{CH}_2\text{OH} / \text{H}^+$
- (E)  $\text{CH}_3\text{OH} / \text{H}^+$
- (F) Excess  $\text{CH}_3\text{I}$
- (G) Conc.  $\text{H}_2\text{SO}_4$
- (H)  $\text{BH}_3$ , then aq.  $\text{NaOH} / \text{H}_2\text{O}_2$
- (I)  $\text{CH}_3\text{Cl} / \text{AlCl}_3$
- (J)  $\text{CH}_3\text{COCl} / \text{AlCl}_3$
- (K) Excess  $\text{CH}_3\text{MgI}$ , then  $\text{H}_3\text{O}^+$
- (L) Conc.  $\text{HCl}$
- (M)  $\text{NCS}$  or  $\text{Cl}_2$
- (N)  $\text{LiAlH}_4$ , then  $\text{H}_3\text{O}^+$
- (O)  $\text{NaBH}_4$
- (P)  $\text{Ph}_3\text{P}=\text{CH}_2$
- (Q)  $\text{tBuOH} / \text{H}^+$
- (R)  $\text{tBuCl} / \text{KOH}$
- (S)  $\text{H}_2\text{O} / \text{HgSO}_4 / \text{H}_2\text{SO}_4$

## EXERCISE 4

Identify products in the following matrix.

Reagents →

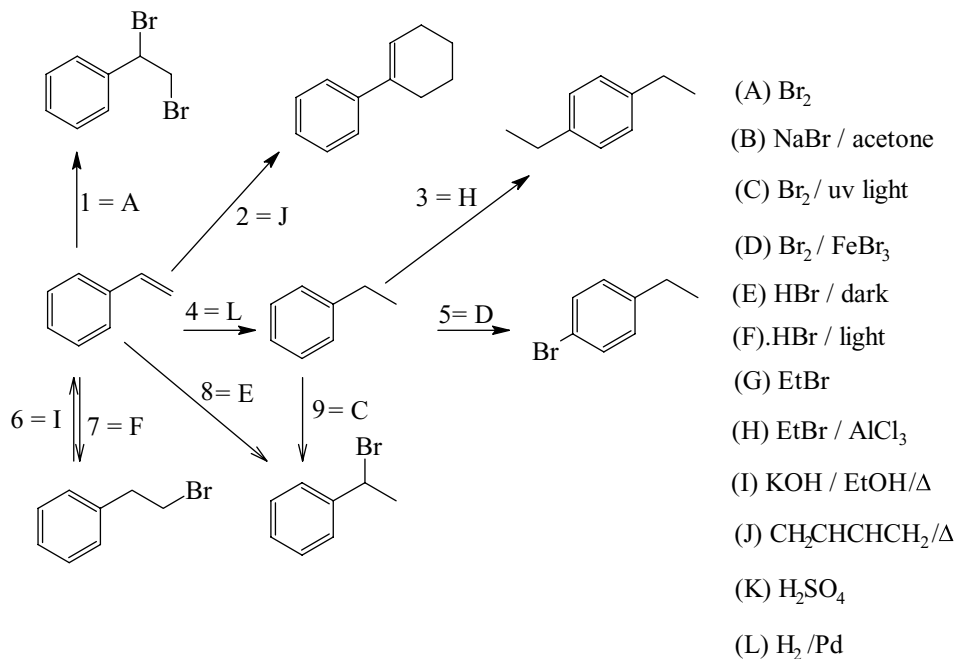
| Compounds                                                                           | PCC | K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> | NaH/Mel | MnO <sub>2</sub> | Conc. KMnO <sub>4</sub> |
|-------------------------------------------------------------------------------------|-----|-----------------------------------------------|---------|------------------|-------------------------|
|    |     |                                               |         |                  |                         |
|    |     |                                               |         |                  |                         |
|    |     |                                               |         |                  |                         |
|    |     |                                               |         |                  |                         |
|    |     |                                               |         |                  |                         |
|    |     |                                               |         |                  |                         |
|    |     |                                               |         |                  |                         |
|    |     |                                               |         |                  |                         |
|   |     |                                               |         |                  |                         |
|  |     |                                               |         |                  |                         |
|  |     |                                               |         |                  |                         |
|  |     |                                               |         |                  |                         |
|  |     |                                               |         |                  |                         |
|  |     |                                               |         |                  |                         |
|  |     |                                               |         |                  |                         |
|  |     |                                               |         |                  |                         |

# SOLUTION FOR WORKBOOK EXERCISES

## EXERCISE 1

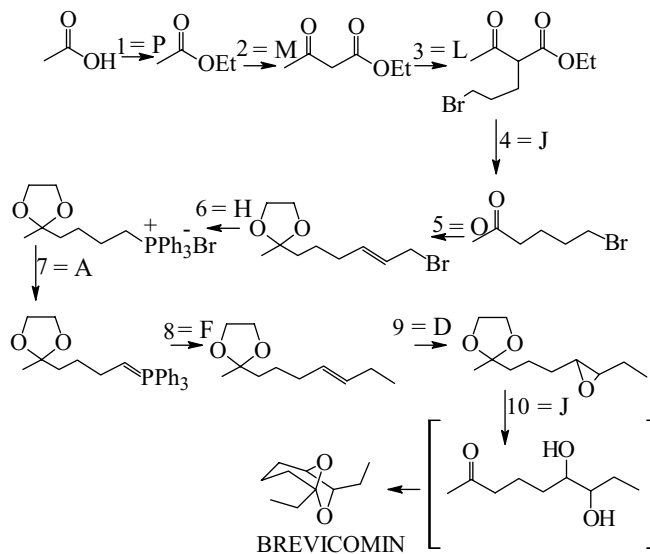
Column I (Conversion)

Column II (Reagent)



## EXERCISE 2

### Column I (Conversion)

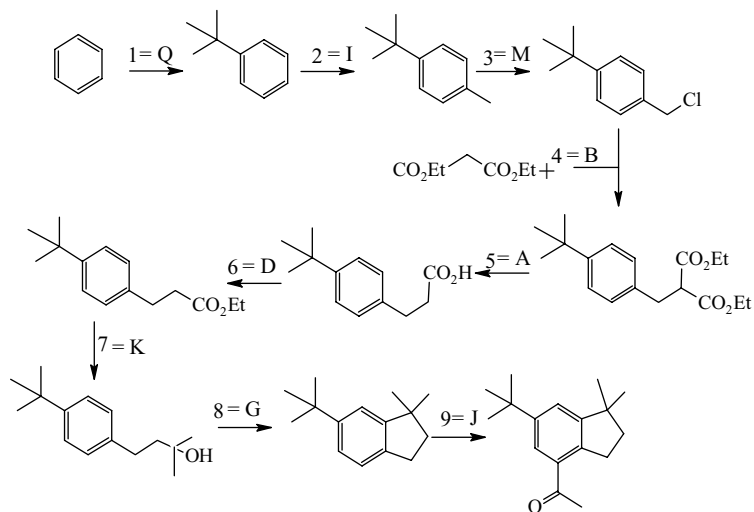


### Column II (Reagent)

- (A)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Li} / \text{THF}$
- (B)  $\text{CH}_3\text{CH}=\text{CH}_2$
- (C)  $\text{CH}_3\text{CO}_2\text{H}$
- (D)  $\text{CH}_3\text{CO}_3\text{H}$
- (E)  $(\text{CH}_3)_2\text{C}=\text{O} / \text{H}^+$
- (F)  $\text{CH}_3\text{CH}_2\text{CHO}$
- (G)  $\text{PBr}_3 / \text{Et}_3\text{N}$
- (H)  $\text{PPh}_3$
- (I)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{MgBr} / \text{THF}$  then  $\text{H}_3\text{O}^+$
- (J)  $\text{H}_3\text{O}^+ / \text{D}$
- (K)  $\text{Conc. H}_2\text{SO}_4 / \text{D}$
- (L)  $\text{NaOEt}$  then  $\text{Br}(\text{CH}_2)_3\text{Br}$
- (M)  $\text{NaOEt} / \text{EtOH}$
- (N)  $\text{LiAlH}_4$  then  $\text{H}_3\text{O}^+$
- (O)  $\text{HOCH}_2\text{CH}_2\text{OH} / \text{H}^+$
- (P)  $\text{EtOH} / \text{H}^+ / \text{heat}$

## EXERCISE 3

### Column I (Conversion)



### Column II (Reagent)

- (A) KOH / H<sub>2</sub>O / Δ
- (B) NaOEt / EtOH
- (C) CH<sub>3</sub>ONa / CH<sub>3</sub>OH
- (D) CH<sub>3</sub>CH<sub>2</sub>OH / H<sup>+</sup>
- (E) CH<sub>3</sub>OH / H<sup>+</sup>
- (F) Excess CH<sub>3</sub>I
- (G) conc. H<sub>2</sub>SO<sub>4</sub>
- (H). BH<sub>3</sub> then aq. NaOH / H<sub>2</sub>O<sub>2</sub>
- (I) CH<sub>3</sub>Cl / AlCl<sub>3</sub>
- (J) CH<sub>3</sub>COCl / AlCl<sub>3</sub>
- (K) excess CH<sub>3</sub>MgI then H<sub>3</sub>O<sup>+</sup>
- (L) conc. HCl
- (M) NCS or Cl<sub>2</sub>
- (N) LiAlH<sub>4</sub> then H<sub>3</sub>O<sup>+</sup>
- (O) NaBH<sub>4</sub>
- (P) Ph<sub>3</sub>P=CH<sub>2</sub>
- (Q) tBuOH / H<sup>+</sup>
- (R) tBuCl / KOH
- (S) H<sub>2</sub>O / HgSO<sub>4</sub> / H<sub>2</sub>SO<sub>4</sub>

# EXERCISE 4

| Compounds                                                                           | Reagents $\longrightarrow$                                                          |                                                                                     |                                                                                     |                                                                                      |                                                                                       |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                                                                     | PCC                                                                                 | $K_2Cr_2O_7$                                                                        | NaH/MeI                                                                             | $MnO_2$                                                                              | Conc. $KMnO_4$                                                                        |
|    |    |    |    |    |    |
|    |    |    |    |    |    |
|    |    |    |    |    |    |
|    |    |    |    |    |    |
|    |    |    |    |    |    |
|    |    |    |    |    |    |
|    |    |    |    |    |    |
|    |    |    |    |    |    |
|   |   |   |   |   |   |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |