

國立清華大學 104 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系乙組（化學組）

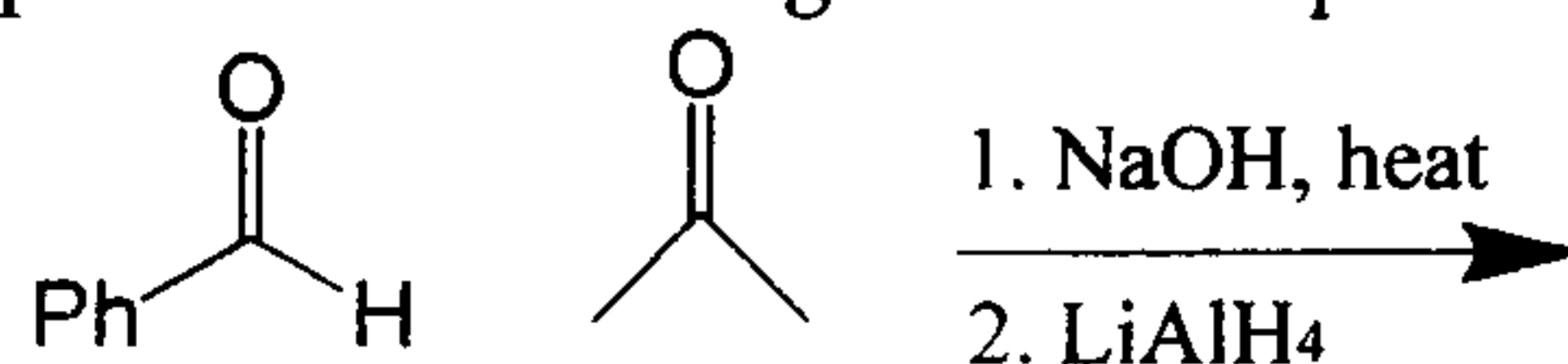
考試科目（代碼）：有機化學 2304

共 5 頁，第 1 頁

*請在【答案卷】作答

一、問答題（每題 2.5 分共 40 分）

1. What would be the final product of following reaction sequence?



- (A) $\text{PhCH}_2\text{CH}_2\text{C}(\text{OH})\text{Me}$ (B) $\text{PhCH}(\text{OH})\text{CH}_2\text{C}(\text{OH})\text{Me}$
(C) $\text{PhCH}_2\text{CH}_2\text{CH}_2\text{Me}$ (D) $\text{PhCH}=\text{CHCH}(\text{OH})\text{Me}$
(E) None of these

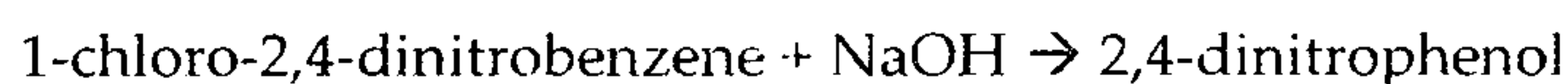
2. Which description about the frontier molecular orbital theory is False?

- (A) HOMO is an acronym for highest occupied molecular orbital.
(B) Antibonding molecular orbitals are higher in energy than the isolated atomic orbitals from which they made.
(C) The LUMO of 1,3-butadiene has one node.
(D) The HOMO of allyl anion has one node.
(E) The thermal [2+2] cycloaddition of two ethylenes to give cyclobutane is a symmetry-forbidden reaction.

3. Which pair listed below is a Lewis acid-base pair?

- (A) 2,6-di-*tert*-butylpyridine + HCl
(B) BF_3 + ether
(C) Benzoic acid + NaOH
(D) *tert*-butyl chloride + benzene
(E) acetone + H_2SO_4

4. Which statement is correct for the reaction shown below?



- (A) This reaction is an electrophilic aromatic substitution.
(B) This reaction is a $\text{S}_{\text{N}}2$ substitution.
(C) This reaction is a nucleophilic aromatic substitution.
(D) Substituted benzyne is the reaction intermediate.

5. Assuming the ionization energy of a hydrogen atom is E , estimate the 4f orbital energy for a Li^{2+} cation:

- (A) $3E/4$
(B) $-3E/4$
(C) $9E/16$
(D) $-9E/16$
(E) $E/4$

6. Please indicate which type of compounds are not derivatives of the nucleophilic acyl substitution reactions.

- (A) Ester
(B) Amides
(C) Acid anhydrides

(D) Amines

7. Which of the following compounds is a suitable base to prepare ester enolate of ethyl acetate?

- (A) Lithium diisopropylamide
- (B) Pyridine
- (C) Diisopropyl amine
- (D) Pyrrolidine

8. Which of following addition reactions of alkenes occur specifically in an anti- fashion:

- (A) Dihydroxylation using OsO_4 , H_2O_2
- (B) Addition of Br_2
- (C) Hydroboration-oxidation
- (D) Hydrogenation using H_2 -Pt

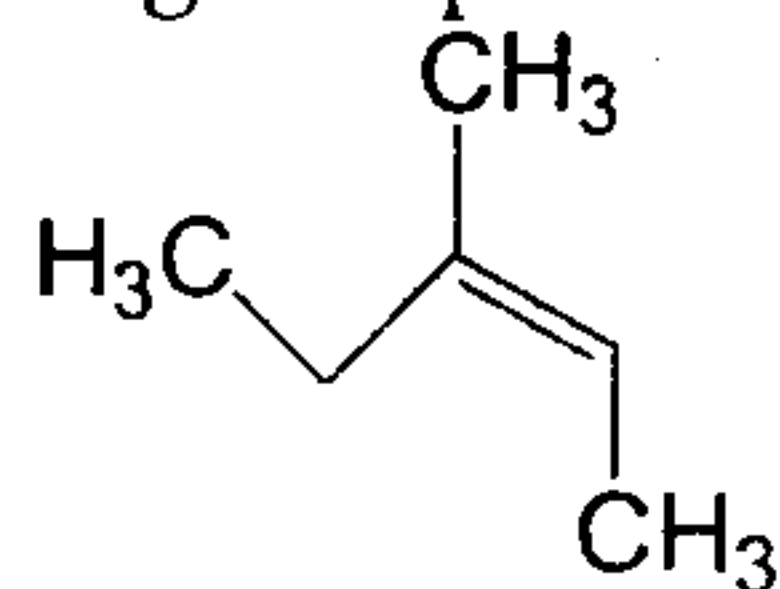
9. The conversion of 2-pentanone to butanoic acid is best accomplished with:

- (A) I_2 , NaOH
- (B) NaBH_4
- (C) CrO_3
- (D) Ag_2O

10. A molecule has three degrees of unsaturation. In this molecule there would be

- (A) three rings
- (B) three double bonds
- (C) two rings and one double bond
- (D) one ring and two double bonds
- (E) any of the above

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



- (A) (E)-3-methylpent-3-ene
- (B) (Z)-3-methylpent-3-ene
- (C) (E)-3-methylpent-2-ene
- (D) (Z)-3-methylpent-2-ene

12. Which of the following amines is most basic?

- (A) aniline
- (B) N-ethylaniline
- (C) N,N-diethylaniline
- (D) piperidine
- (E) pyrrole

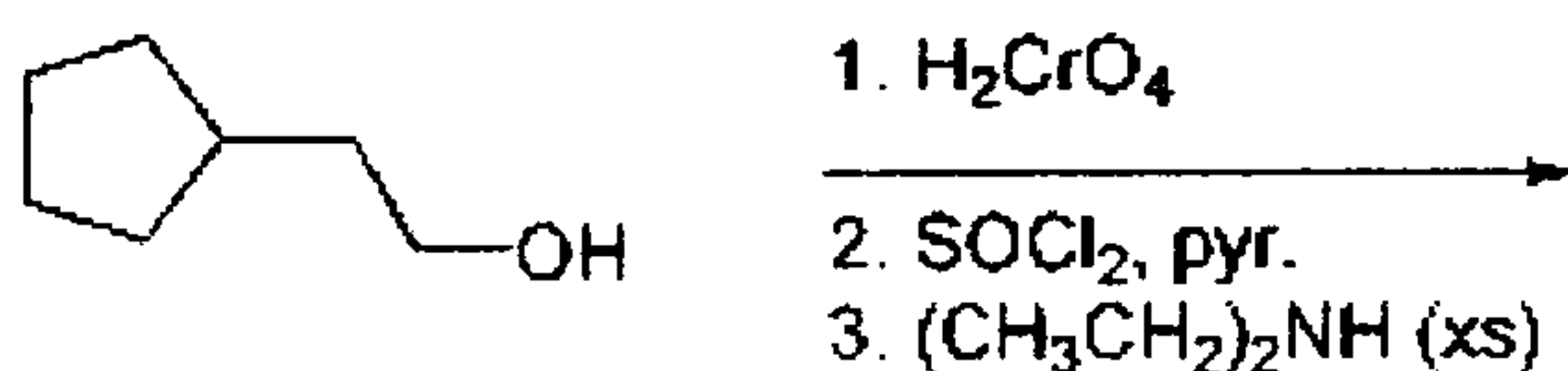
13. In a solution of aspartic acid ($\text{pK}_a=7.4$) adjusted to a pH of 2.74,

- (A) the ration of aspartate to aspartic acid is 10 to 1.
- (B) the ration of aspartate to aspartic acid is 100 to 1.
- (C) the ration of aspartate to aspartic acid is 1000 to 1.
- (D) the ration of aspartate to aspartic acid is 1 to 10.
- (E) the ration of aspartate to aspartic acid is 1 to 100.

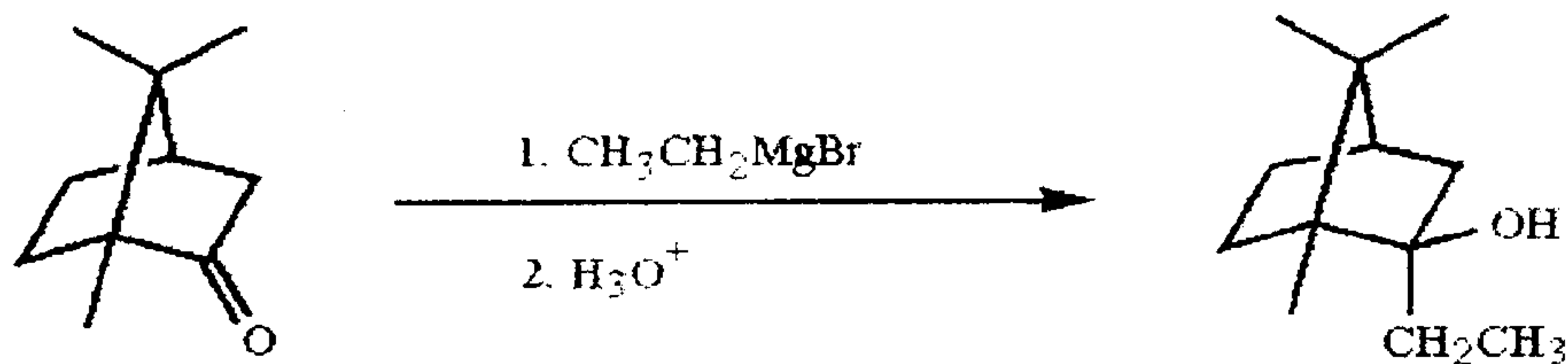
14. Addition of Br₂ to (E)-hex-3-ene produces ____.
- (A) A meso dibromide.
 (B) A mixture of enantiomeric dibromides which is optically active.
 (C) A mixture of enantiomeric dibromides which is optically inactive.
 (D) (Z)-3,4-dibromo-3-hexene.
 (E) (E)-3,4-dibromo-3-hexene.
15. Reaction of 2-butyne with Na in liquid NH₃ gives:
- (A) 2-aminobutane
 (B) 2,3-diaminobutane
 (C) (E)-2-butene
 (D) (Z)-2-butene
16. Which reagent is used to convert benzene to bromobenzene?
- (A) HBr
 (B) PBr₃
 (C) Br₂/NaOH
 (D) Br₂/FeBr₃

二、問答題（每題 3 分共 60 分）

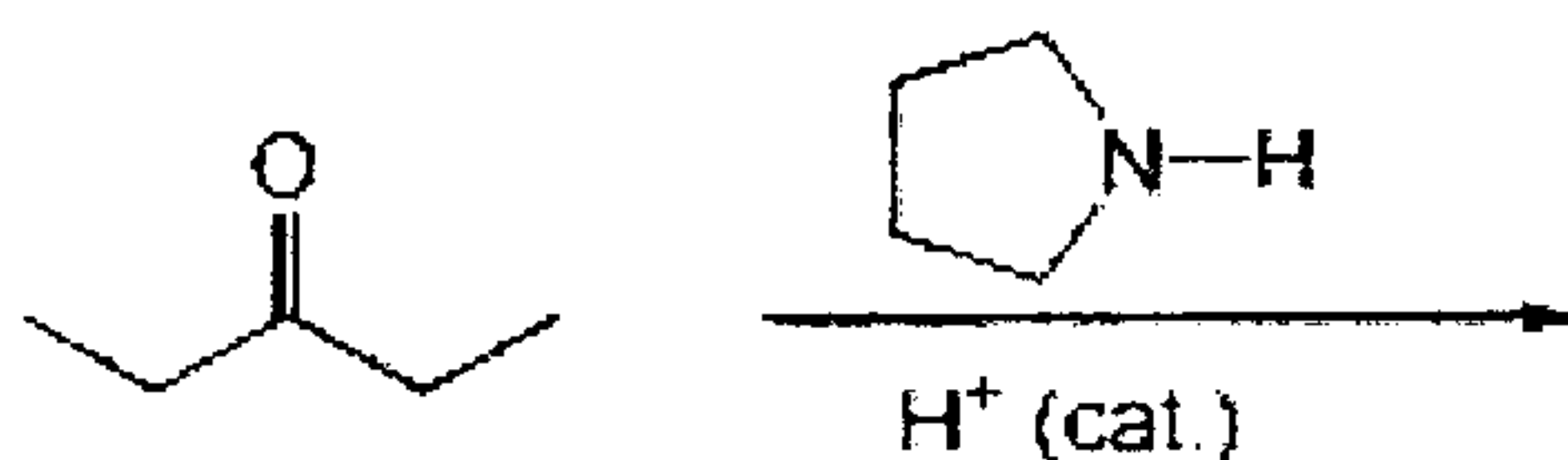
- Provide a detailed, stepwise mechanism for the reaction of acetyl chloride with methanol to produce methyl acetate and HCl.
- Provide the major organic product of the reaction below.



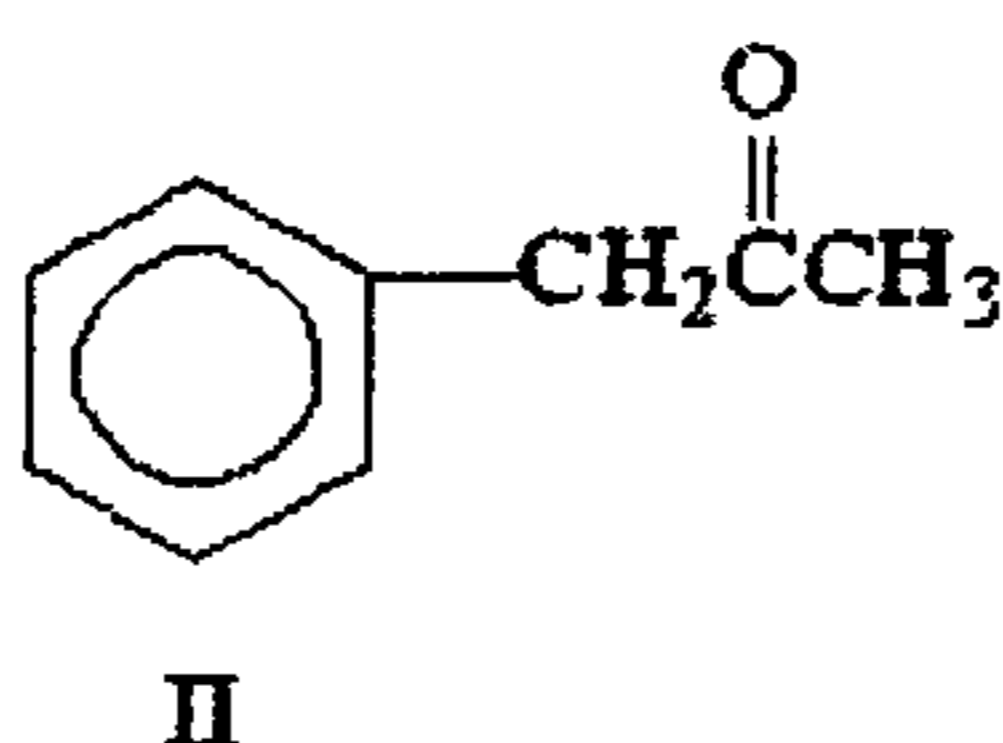
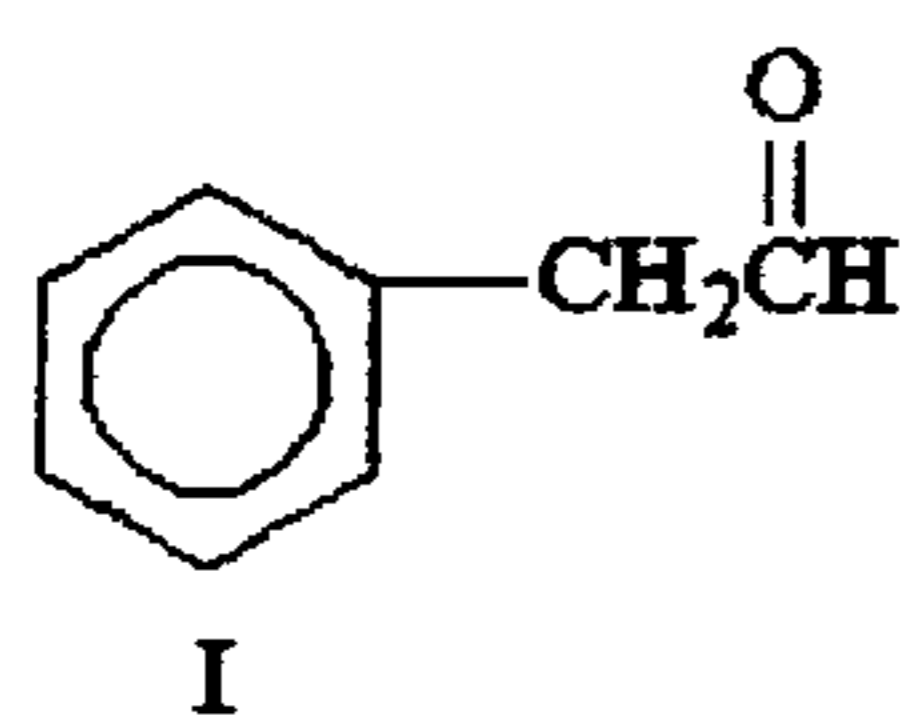
- Provide a detailed, stepwise mechanism for the acid-catalyzed transesterification of ethyl acetate with *n*-propanol.
- What reagents are used to dehydrate amides to nitriles?
- Would you expect the carbonyl carbon of benzaldehyde to be more or less electrophilic than that of acetaldehyde? Explain using resonance structures.
- When camphor undergoes nucleophilic attack by CH₃CH₂MgBr, the major product is the one in which the Grignard reagent has added *endo*. Explain the stereoselectivity observed. Which face of the carbonyl carbon, *re* or *si*, was attacked?



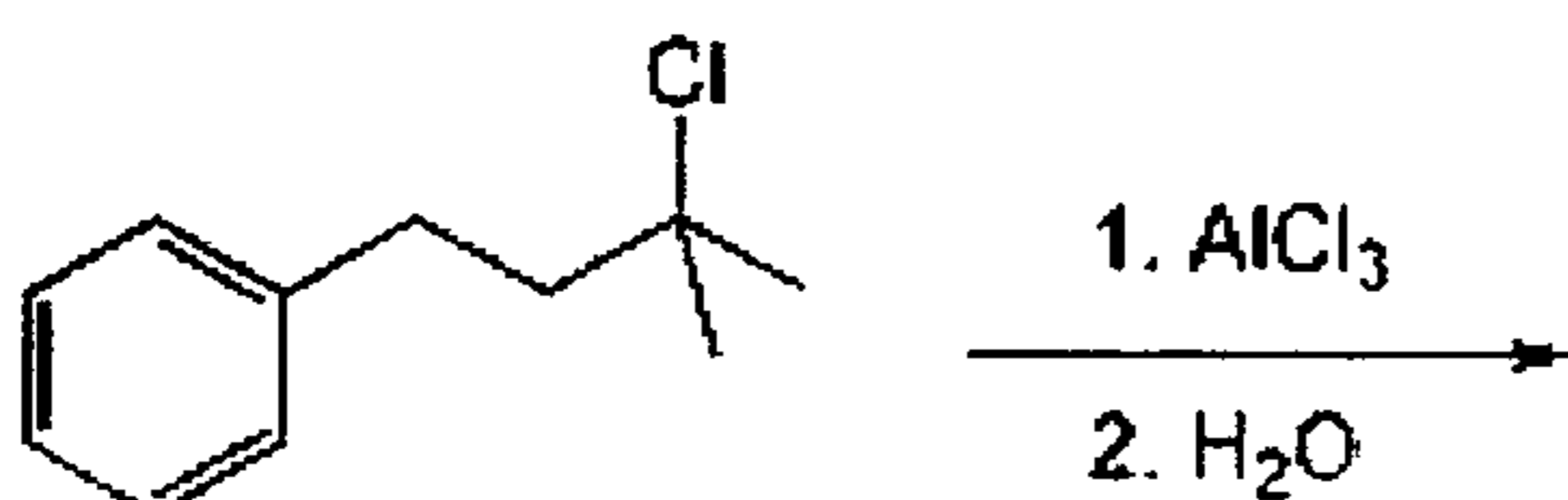
- Provide the major organic product(s) of the reaction below.



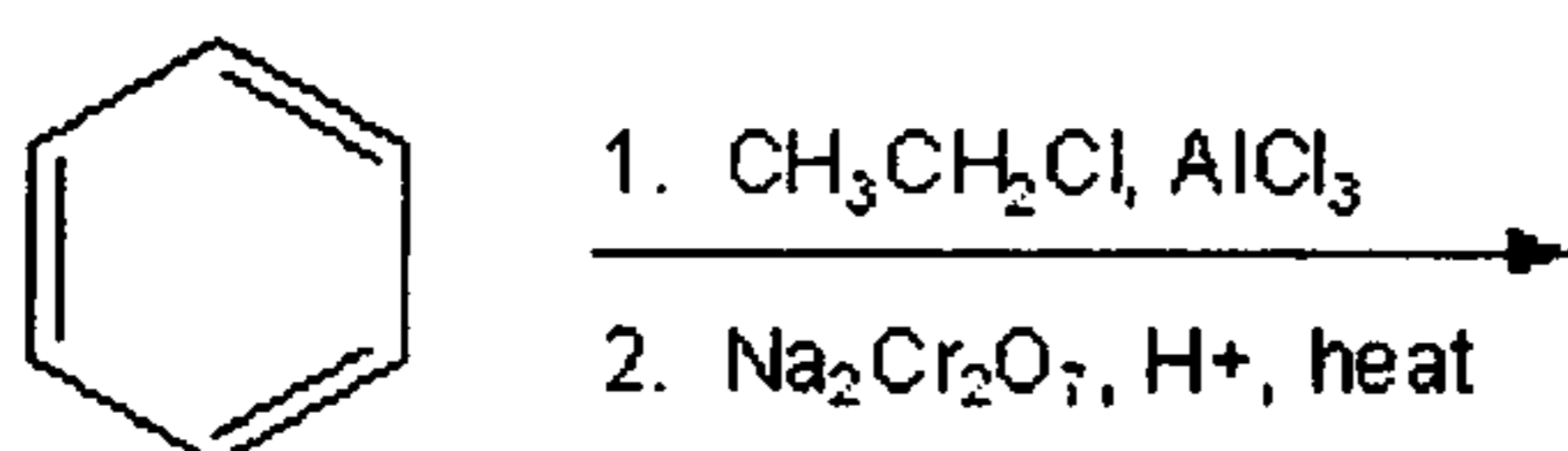
8. Propose an IR frequency that would distinguish between the following compounds:



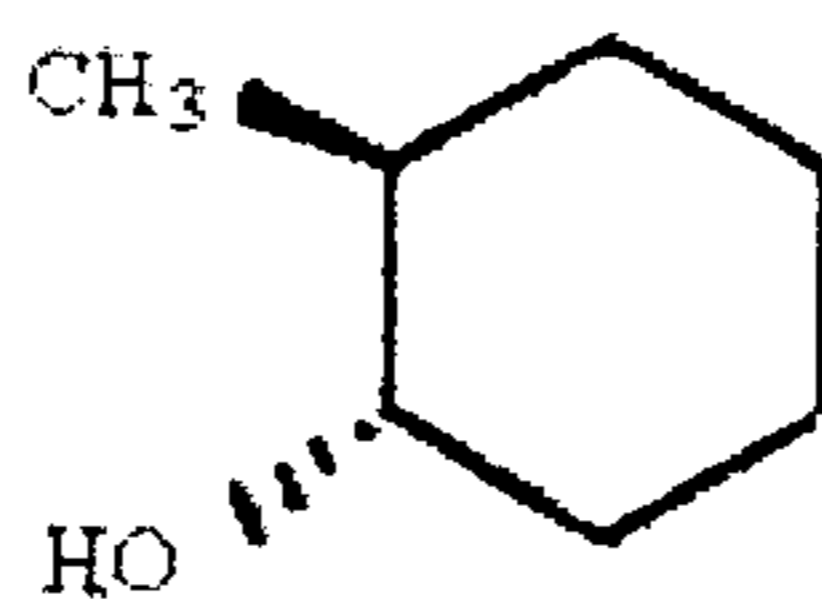
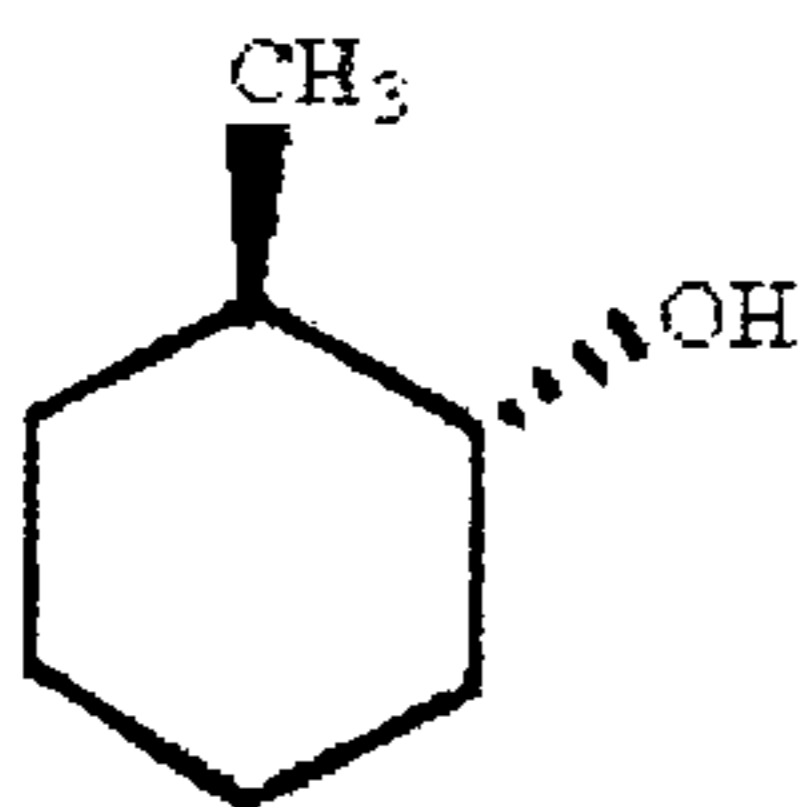
9. Provide the structure of anisole.
 10. Provide the major organic product of the reaction shown below.



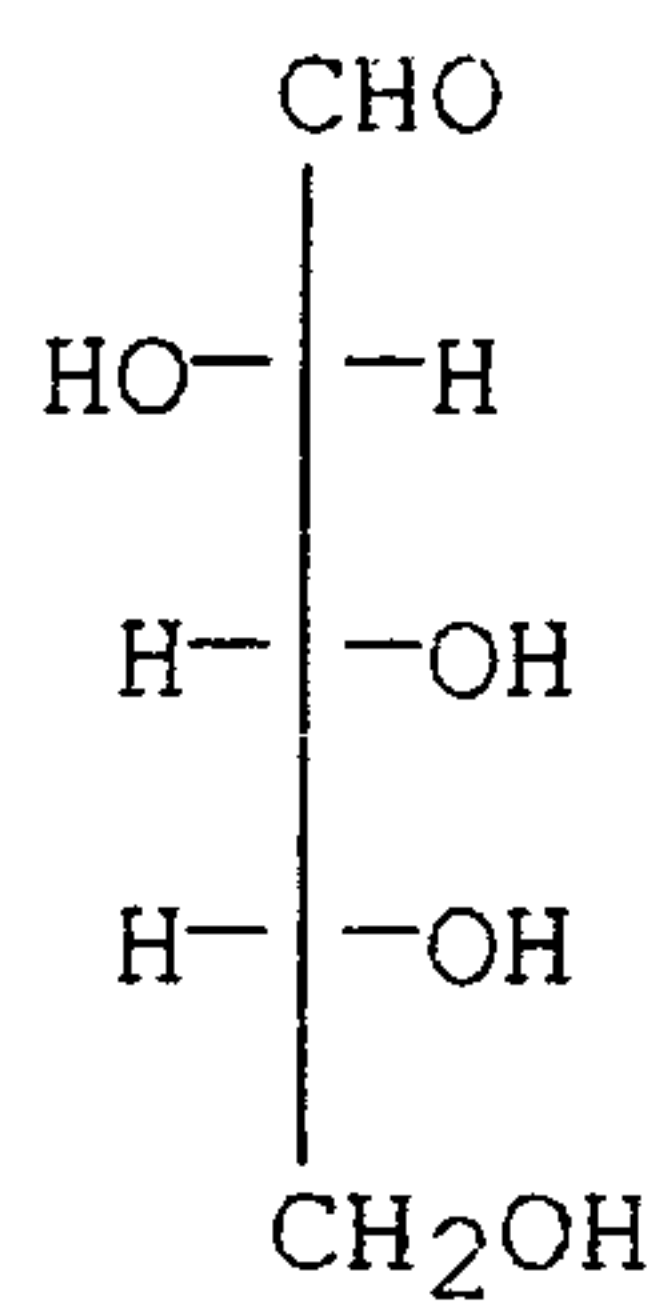
11. Give the best product for the following reaction.



12. What sequence of reagents can be used to make *p*-butylbenzenesulfonic acid from benzene?
13. Deduce the identity of the following compound from the spectral data given.
 $C_9H_{10}O_2$: ^{13}C NMR, δ 18.06 (quartet), 45.40 (doublet), 127.32 (doublet), 127.55 (doublet), 128.61 (doublet), 139.70 (singlet), 180.98 (singlet); IR, broad 3500-2800, 1708 cm^{-1}
14. Deduce the identity of the compound from the data provided.
 $C_{10}H_{14}O$: IR (cm^{-1}): 3200-3500 (broad), 3050, 2950, 1610
 1H NMR(δ): 1.0 (s, 6H), 2.0 (s, 3H), 2.8 (broad s, 1H), 7.3 (d, 2H), 7.6 (d, 2H)
15. Deduce the identity of the following compound from the 1H NMR spectral data given.
 $C_3H_3Cl_5$: δ 4.5 (1H, triplet), 6.1 (2H, doublet) (ppm)
16. Draw the stereoisomers of 1,3-dichlorocyclopentane.
17. Which of the following terms best describes the pair of compounds shown: enantiomers, diastereomers, or the same compound?



18. Label each asymmetrical carbon in the compound below as R or S.



19. HCN has a $\text{pK}_a = 9.1$. What form of the compound, HCN or CN^- , will predominate in a solution of $\text{pH} = 7.0$

20. Draw the major organic product generated in the reaction below.

