

Practice Final Exam A - FULL LENGTH

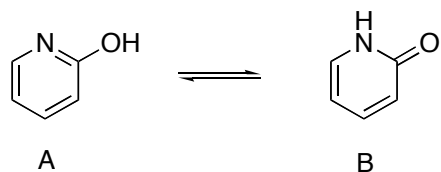
The following practice exam contains questions from past final exams as well as new questions. You will get the most out of this practice test if you complete it under EXAM CONDITIONS - that is, without distractions and within a 2.5 hour time limit.

It is not possible to match the actual exam length exactly, but it is close. This test contains items that sample from the learning objectives in the course, but does not test everything. The difficulty level is also similar to the actual final exam. However, since the questions sample from the course, the actual exam may feel more or less difficult to you, depending on how well you know the various topics.

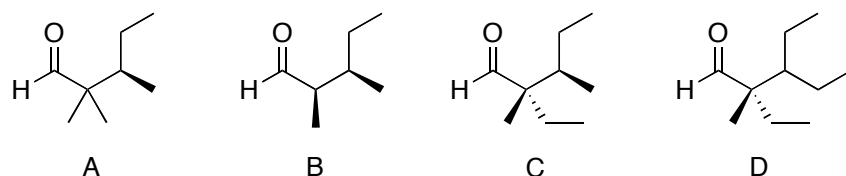
GOOD LUCK!

Part 1. Multiple Choice.

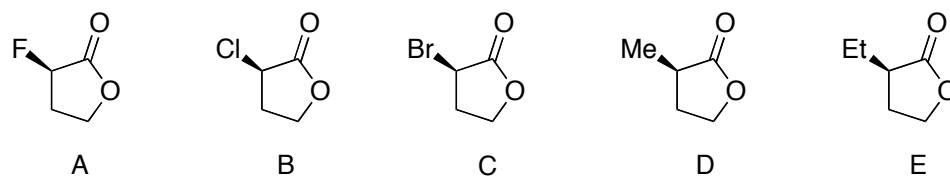
1. Which isomer is favoured in the following equilibrium?



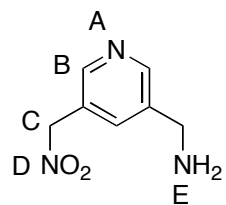
2. Which structure(s) will maintain optical activity upon treatment with sodium methoxide in methanol?



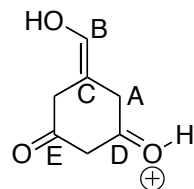
3. Which structure will react most rapidly with ethoxide?



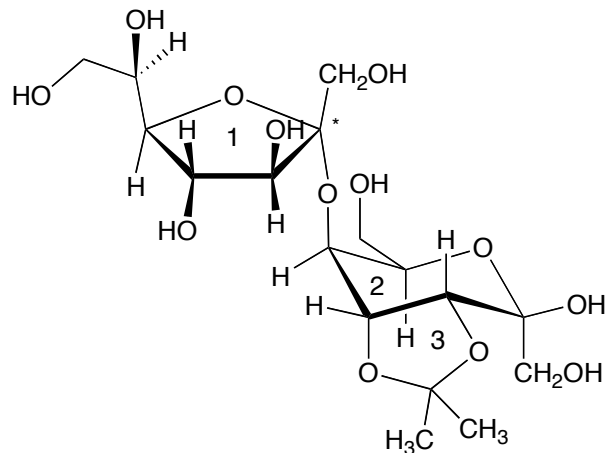
4. Of the ones labeled, which is the most nucleophilic atom in the following structure?



5. Of the ones labeled, which is the most electrophilic carbon atom in the following structure?



Use the structure of the following carbohydrate derivative to answer questions 6 to 12.



6. Which of the following describes the three rings labeled 1, 2, and 3?

Answer choice	Ring 1	Ring 2	Ring 3
A	Pyranose	Pyranose	Pyranose
B	Furanose	Furanose	Furanose
C	Pyranose	Furanose	Pyranose
D	Furanose	Pyranose	Furanose
E	Pyranose	Pyranose	Furanose
F	Furanose	Furanose	Pyranose
G	Pyranose	Furanose	Neither
H	Furanose	Pyranose	Neither
I	Neither	Pyranose	Neither
J	Furanose	Neither	Neither

6. How many monosaccharides in this structure are based on ketoses?

- A. 0
- B. 1
- C. 2
- D. 3

7. Will this structure give a positive Tollen's test result?

- A. Yes
- B. No

8. Can this structure undergo mutarotation?

- A. Yes
- B. No

9. To what functional group does the carbon atom labeled * belong?

- A. aldehyde
- B. ketone
- C. hemiacetal
- D. hemiketal
- E. acetal
- F. ketal
- G. alcohol
- H. ether

10. Is ring 2 in its alpha or beta form?

- A. alpha
- B. beta
- C. It's not possible to determine this.

11. Is ring 1 a D or L sugar?

- A. D
- B. L
- C. It's not possible to determine this.

12. How many equivalents of $\text{Ac}_2\text{O}/\text{CH}_3\text{I}$ would be needed to fully react with this structure?

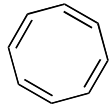
- A. 1
- B. 2
- C. 3
- D. 4
- E. 5
- F. 6
- G. 7
- H. 8
- I. 9
- J. 10

For questions 13 to 18, classify the following structures as aromatic or not aromatic.

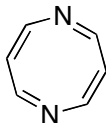
Question 13
A. aromatic
B. not aromatic



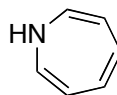
Question 14
A. aromatic
B. not aromatic



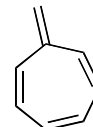
Question 15
A. aromatic
B. not aromatic



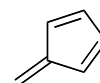
Question 16
A. aromatic
B. not aromatic



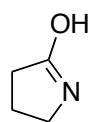
Question 17
A. aromatic
B. not aromatic



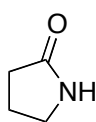
Question 18
A. aromatic
B. not aromatic



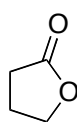
For questions 19 to 21, classify each transformation as a formal reduction, oxidation, or neither.



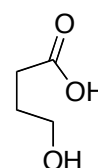
Question 19
A. oxidation
B. reduction
C. neither



Question 20
A. oxidation
B. reduction
C. neither



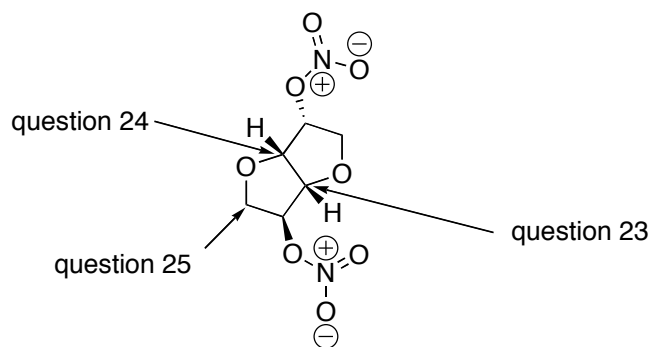
Question 21
A. oxidation
B. reduction
C. neither



22. Which of the following bases would largely deprotonate 2-propanol?

- | | |
|---------------------------------------|-----------------------|
| A. NaH | E. NaNH ₂ |
| B. LDA | F. NH ₃ |
| C. KOC(CH ₃) ₃ | G. KBr |
| D. NaOH | H. NaOCH ₃ |

Use the following structure to answer questions 23 to 25.



23. What is the absolute configuration of the carbon indicated above?

- A. R
- B. S
- C. E
- D. Z
- E. this carbon is achiral

24. To what functional group does the carbon indicated above belong?

- | | |
|---------------|-------------|
| A. alcohol | E. acetal |
| B. ether | F. ketal |
| C. hemiacetal | G. ketone |
| D. hemiketal | H. aldehyde |

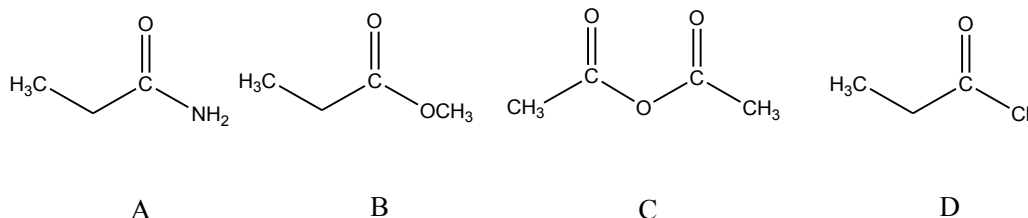
25. What is the hybridization of the carbon atom indicated above?

- | | |
|----------------------|-----------------------------------|
| A. sp | E. sp ³ d ² |
| B. sp ² | F. σ |
| C. sp ³ | G. π |
| D. sp ³ d | |

26. Which of the following compounds has the highest boiling point?

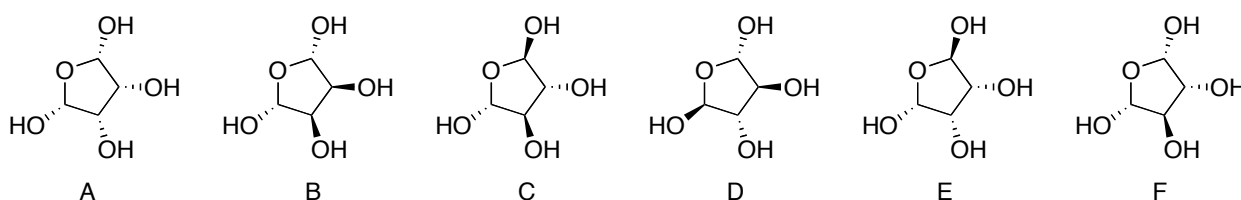
- A. CH₃CH₂COCH₃
- B. CH₃CH₂COOCH₃
- C. CH₃CH₂CHOHCH₃
- D. CH₃CH₂CH₂CH₃
- E. CH₃CH₂CHFCH₃

27. Rank the following compounds in order of **increasing** rate of base hydrolysis. Circle the correct answer.



- a. $B < A < C < D$ b. $A < B < D < C$ c. $A < B < C < D$ d. $D < C < B < A$

Use the structures below to answer questions 28 to 30.

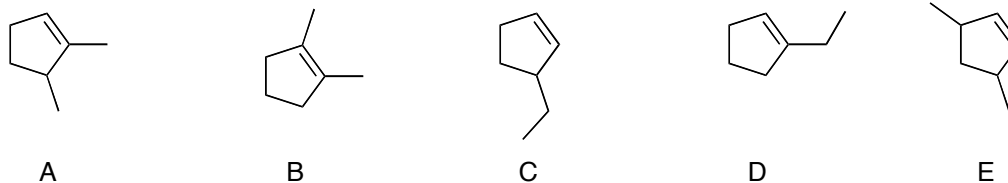


28. Select the two letters that correspond to ONE pair of enantiomers.

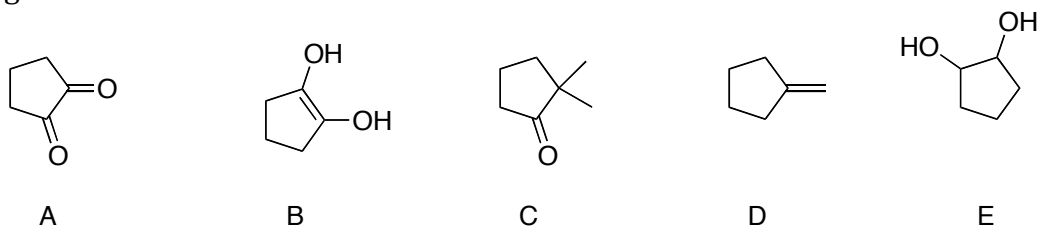
29. Which structures are diastereomers of each other?

30. Which structure(s) is/are meso?

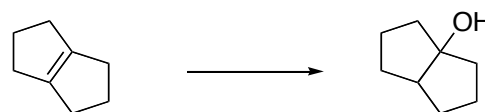
31. Which of the following is the most stable alkene?



32. When the following compounds are mixed with NaOD and D₂O, which shows the greatest increase in mass?



33. Select the term that best describes this transformation.

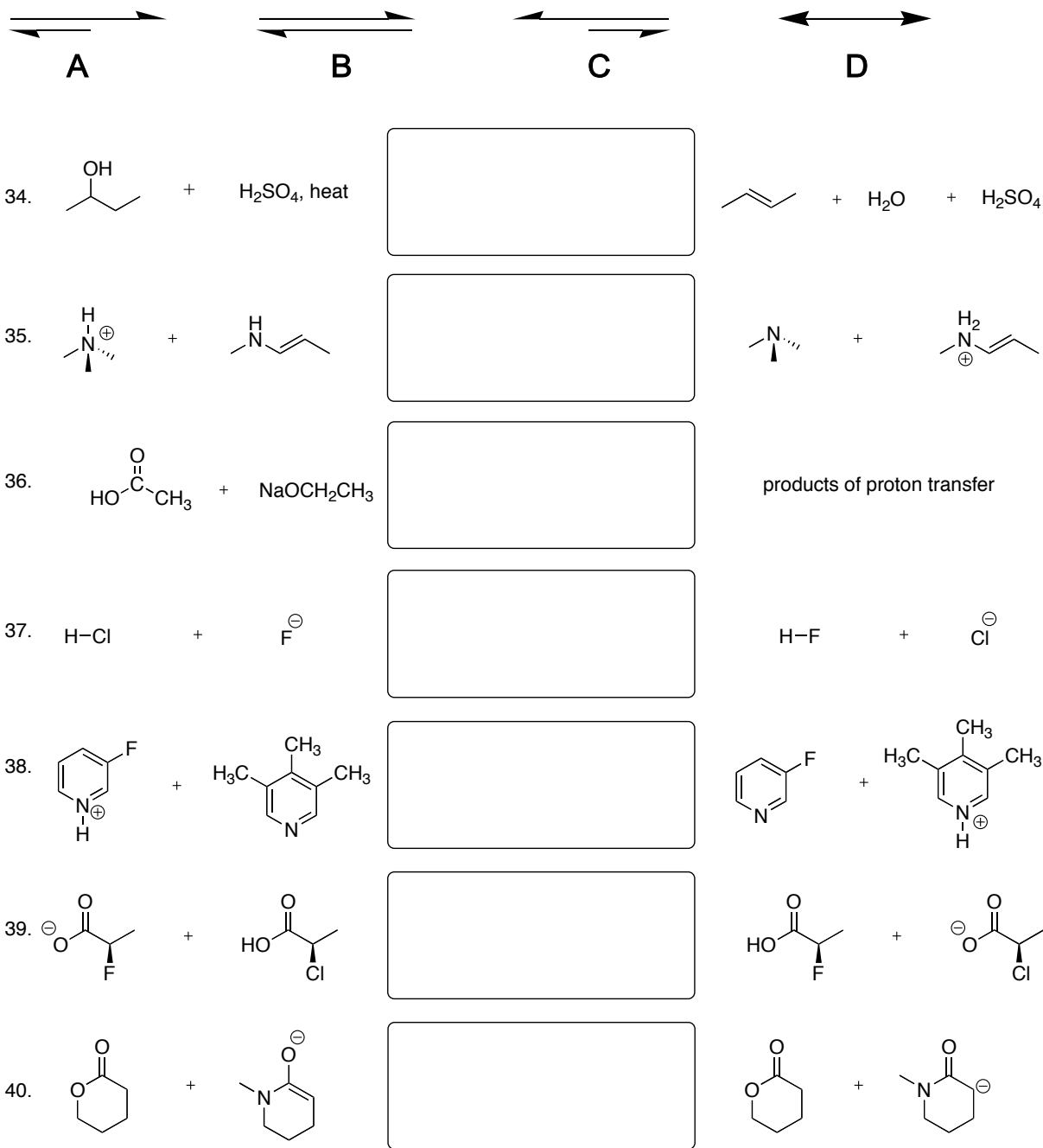


- A. tautomerization
 B. racemization
 C. mutarotation
 D. hydrolysis

- E. epimerization
 F. reduction
 G. oxidation
 H. hydration

- I. acylation
 J. alkylation

For questions 34 to 40, select the arrow(s) that best describes the relationship between the structures on the left and right sides of the arrow(s).

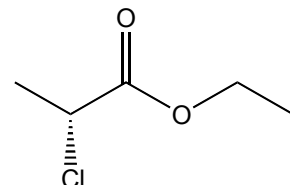


41. An L-aldose sugar rotates plane-polarized light:

- to the right (clockwise)
- to the left (counterclockwise)
- must be determined experimentally
- does not rotate plane-polarized light

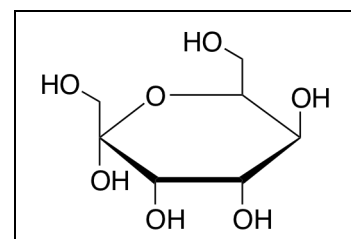
42. What is the systematic (IUPAC) name of this compound?

- (2*S*)-2-chloropropyl ethanoate
- (2*R*)-2-chloropropyl ethanoate
- (2*S*)-2-chloroethyl propanoate
- (2*R*)-2-chloroethyl propanoate
- (2*S*)-propyl 2-chloroethanoate
- (2*R*)-propyl 2-chloroethanoate
- (2*S*)-ethyl 2-chloropropanoate
- (2*R*)-ethyl 2-chloropropanoate



Questions 43-48. Choose the terms that best describe the carbohydrate in the box below.

- tetrose
 - pentose
 - hexose
 - heptose
- D
 - L
- alpha
 - beta
- aldose
 - ketose
- reducing
 - non-reducing



48. Will the carbohydrate shown above react with NaBH_4 in ethanol? a. Yes b. No

Questions 49-51. Select the reagent(s) and reaction conditions that could best carry out the indicated transformations.

A
 $\text{CrO}_3, \text{H}_2\text{SO}_4, \text{H}_2\text{O}$
then workup

B
 $\text{CrO}_3, \text{pyridine}, \text{HCl}$
then workup

C
 $\text{NaBH}_4, \text{solvent}$
then workup

D
a) LiAlH_4
b) H_3O^+ workup

E
 $\text{PBr}_3, \text{solvent}$
then workup

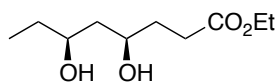
F
 $\text{LDA}, \text{solvent}$
then workup

G
 $\text{H}_2\text{SO}_4 (\text{cat.}), \text{H}_2\text{O}$
then workup

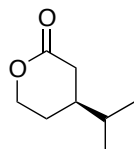
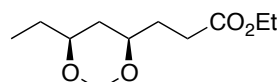
H
 $\text{H}_2\text{SO}_4 (\text{cat.}), \text{H}_2\text{CO}$
then workup

I
 $\text{H}_2\text{SO}_4 (\text{cat.}), \text{MeOH}$
then workup

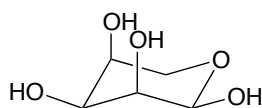
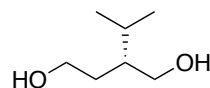
J
 $\text{H}_2\text{SO}_4 (\text{cat.}), \text{propanone}$
then workup



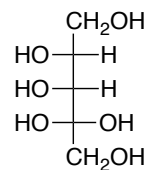
question 49



question 50

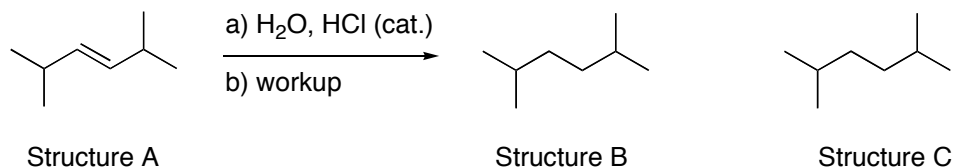


question 51



Part 2. Open-Ended Questions.

1. a) Complete the partial structures of B and C to show the two major products of the reaction shown below.



Circle the term that best completes each of the following statements.

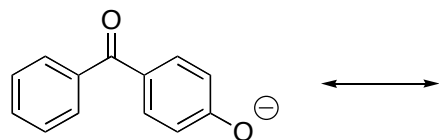
- b) Starting material A is one of { 2 / 4 / 8 / 16 } stereoisomers.
- c) Compounds B and C that are formed in this { addition / elimination / substitution } reaction are { constitutional isomers / diastereomers / enantiomers } of each other.
- d) { Both / Neither / One } of the products would show optical activity.
- e) The { syn / anti / non-stereoselective }, { regioselective / non-regioselective } process that occurs when the { σ / π } bond of the alkene behaves as { a nucleophile / an electrophile } { involves / does not involve } reaction intermediates.
- f) The alkene has undergone { reduction / oxidation / no redox change } during the reaction.

2. a) Explain why compound A undergoes catalytic hydrogenation faster than compound B.

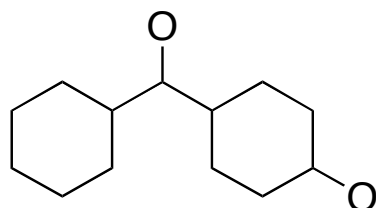


b) What is the relationship between compounds A and B?

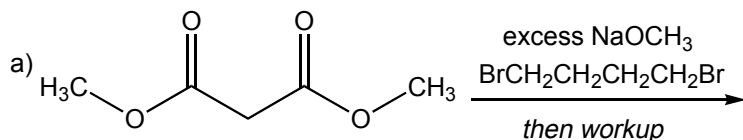
3. a) Draw the major contributing resonance structures of the following molecular ion.



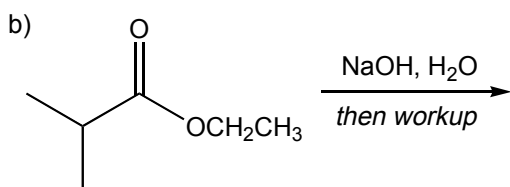
b) On the template below, represent the resonance hybrid of the molecular ion using the conventional notation. Also indicate all atoms that bear a partial negative charge.



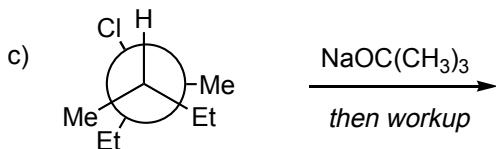
4. Draw the major organic product(s) of the following reactions. Clearly indicate stereochemical features of each product. For each reaction, circle the term that best describes the relationship between major organic products formed. If no terms describe the relationship, do not circle any terms.



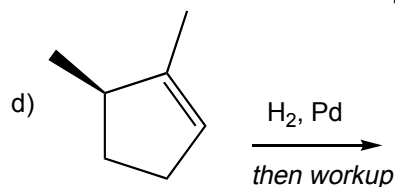
racemic mixture achiral compound diastereomeric mixture meso compound



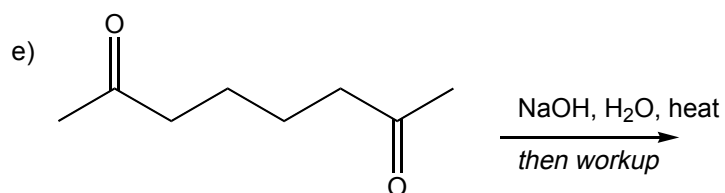
racemic mixture achiral compound diastereomeric mixture meso compound



racemic mixture achiral compound diastereomeric mixture meso compound

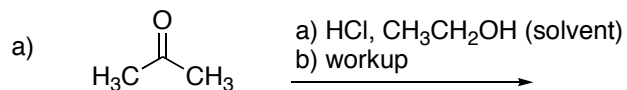


racemic mixture achiral compound diastereomeric mixture meso compound

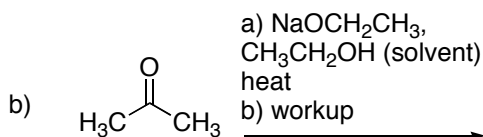


racemic mixture achiral compound diastereomeric mixture meso compound

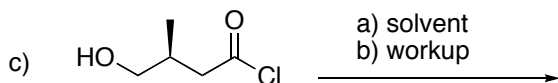
5. Draw the major organic product(s) of the following reactions. Clearly indicate stereochemical features of each product. For each reaction, circle the term that best describes the relationship between major organic products formed. If no terms describe the relationship, do not circle any terms.



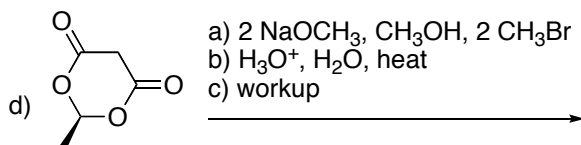
racemic mixture mixture of diastereomers one chiral product one achiral product structural isomers



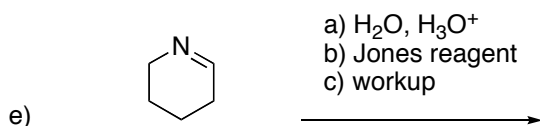
racemic mixture mixture of diastereomers one chiral product one achiral product structural isomers



racemic mixture mixture of diastereomers one chiral product one achiral product structural isomers

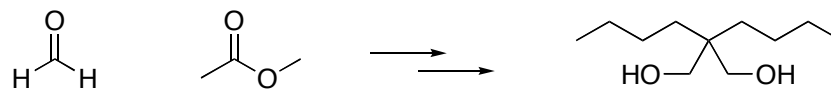


racemic mixture mixture of diastereomers one chiral product one achiral product structural isomers



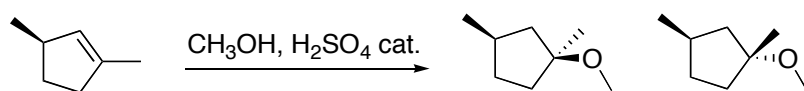
racemic mixture mixture of diastereomers one chiral product one achiral product structural isomers

6. Provide the reagents and write out the steps in the following multi-step synthetic transformation. You may use any organic or inorganic reagents you require in addition to the two starting materials given.

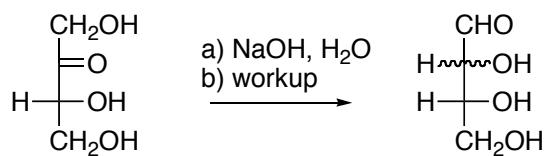


7. Using curved arrows to represent electron movement, draw a step-by-step mechanism for each of the following reactions.

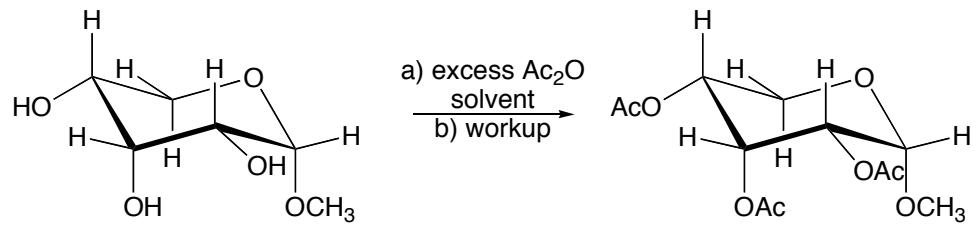
a)



b)

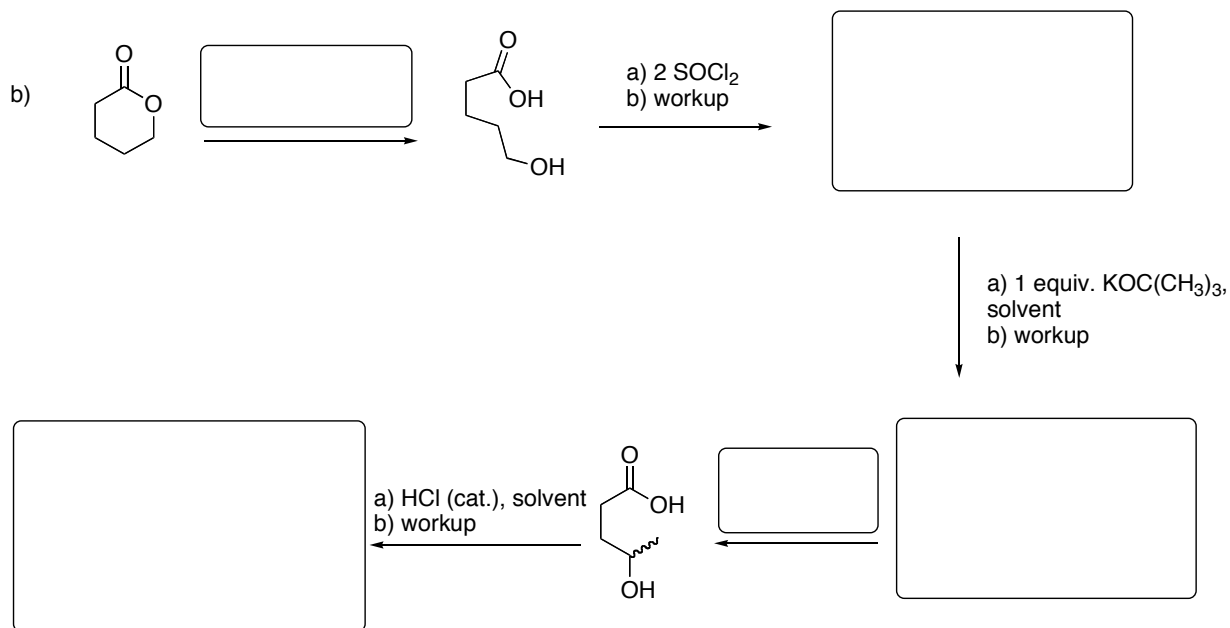
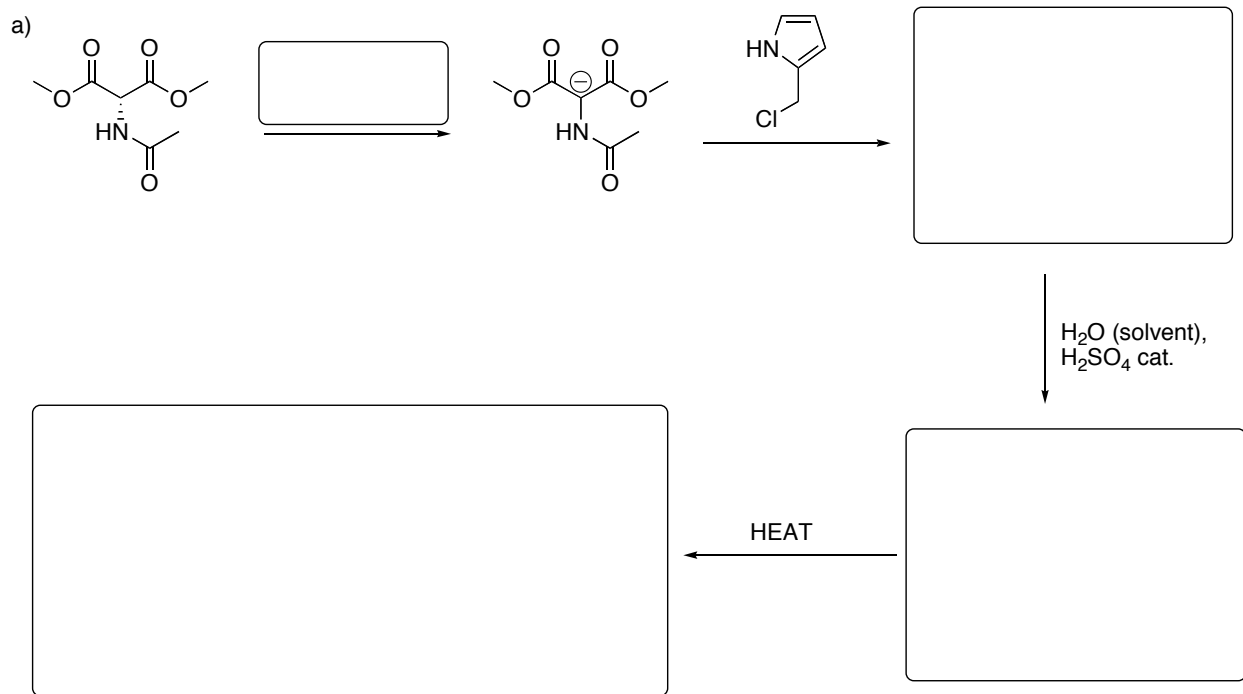


c)

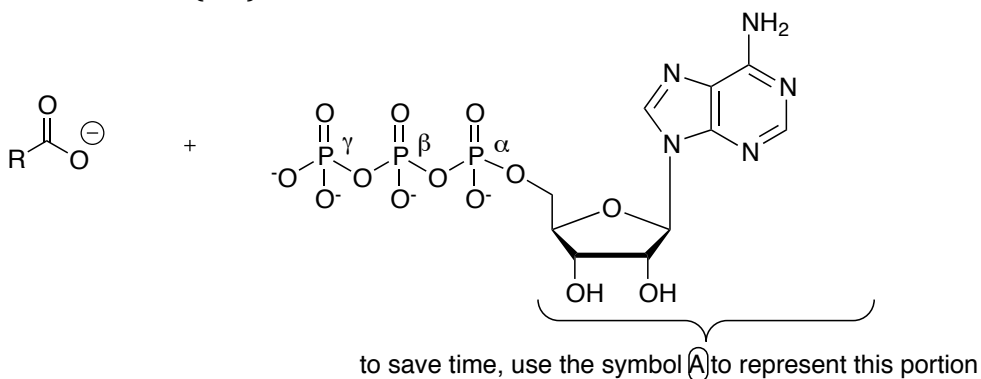


d) Why isn't the $-\text{OCH}_3$ group replaced by $-\text{OAc}$ in the reaction above?

8. Provide the missing information in the reaction sequences below. This may require you to provide starting materials, reagents, and/or products.

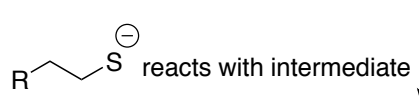


9. Carboxylate ions react with ATP to form a reaction intermediate that can further react with sulfide ions (RS^-). Provide the indicated structures in the boxes below.



carboxylate ion reacts with the γ -phosphorus of ATP

Draw the reaction intermediate and leaving group.



Draw carbonyl-containing product and leaving group.

This is the end of the practice exam.