ANSWER KEY

Practice Final Exam A - FULL LENGTH

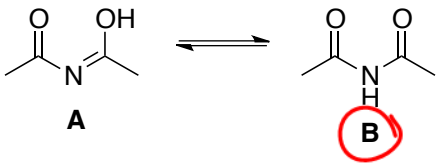
The following practice exam contains questions from past final exams as well as new questions. You will get the most out of this practice test if you complete it under EXAM CONDITIONS - that is, without distractions and within a 2.5 hour time limit.

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!

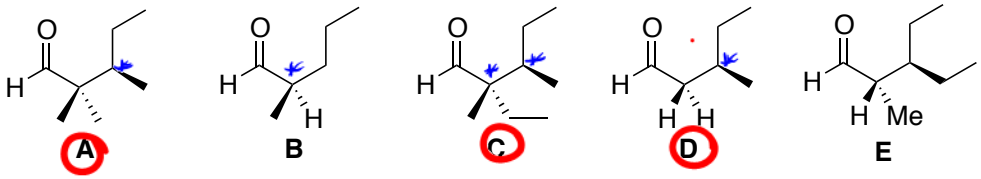
Part 1. Multiple Choice.

1. Which isomer is favoured in the following equilibrium?



C=O >> C=N

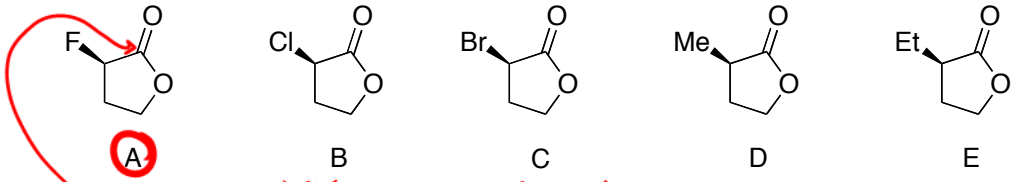
2. Solutions of the following optically active compounds are subjected to catalytic hydrochloric acid in water. After this treatment, some solutions do not display optical activity. Identify the compounds whose solutions retain optical activity.



* chirality centres

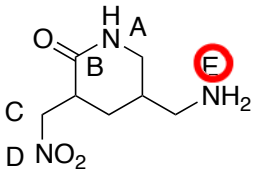
Structures retain optical activity when they have chirality centres that do NOT have acidic protons.

3. Which structure will react most rapidly with ethoxide?



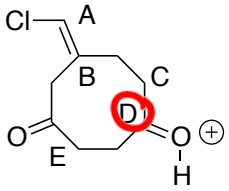
most electrophilic carbonyl carbon

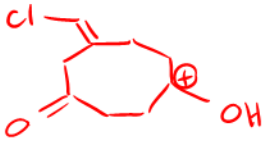
4. Of the labeled atoms, identify the most nucleophilic atom in the following structure:



A: lone pair is involved in resonance
B: carbonyl C is electrophilic; no lone pair
C: carbon w/out a lone pair
D: nitro group has no lone pair on $-NO_2$

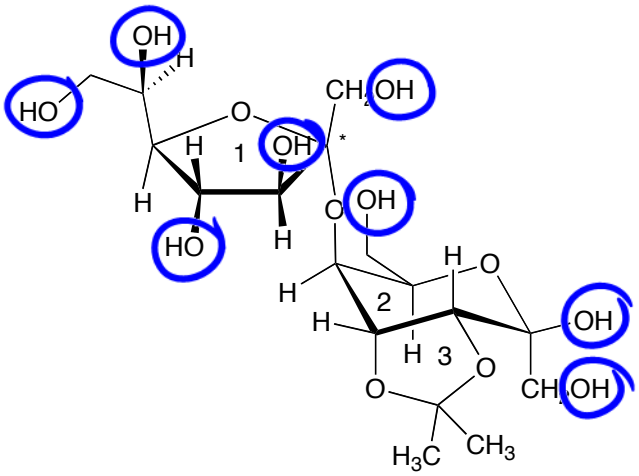
5. Of the labeled atoms, identify the most electrophilic carbon atom in the following structure:





D has a resonance structure with a positive formal charge on carbon.

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



8 OH groups to react with Ag_2O, CH_3I (question 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.

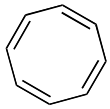
12. How many equivalents of Ag_2O/CH_3I would be needed to fully react with this structure?

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

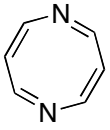
For questions 13 to 18, classify the following structures as aromatic or not aromatic.

Question 13
A. aromatic
B. not aromatic

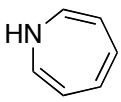
Question 14
A. aromatic
B. not aromatic



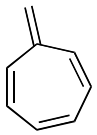
Question 15
A. aromatic
B. not aromatic



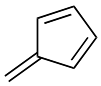
Question 16
A. aromatic
B. not aromatic



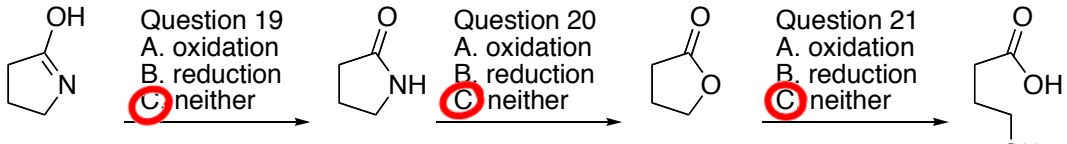
Question 17
A. aromatic
B. not aromatic



Question 18
A. aromatic
B. not aromatic



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



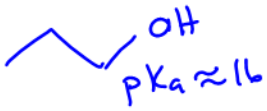
tautomerization
→ a rearrangement reaction

hydrolysis

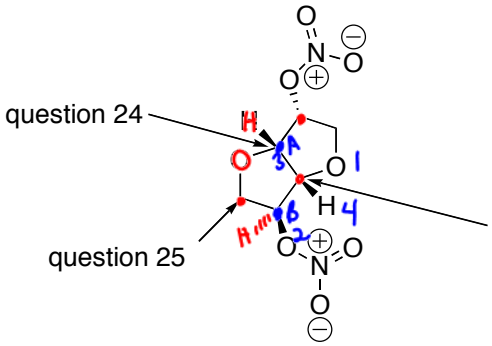
22. Which of the following bases would largely deprotonate 2-propanol?

A. NaH
B. LDA
C. $KOC(CH_3)_3$
D. NaOH
E. $NaNH_2$
F. NH_3
G. KBr
H. $NaOCH_3$

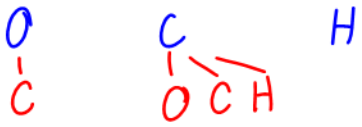
pka of $HOC(CH_3)_3$ is 18



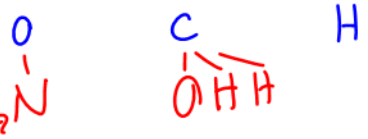
Use the following structure to answer questions 23 to 25.



attached to A:



attached to B:



highest atomic #

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

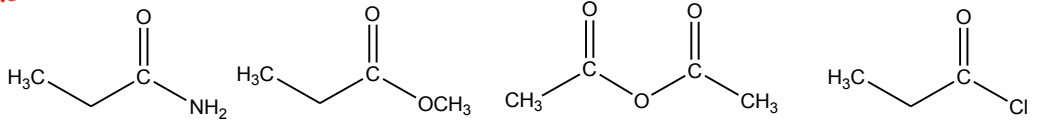
25. What is the hybridization of the carbon atom indicated above?

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

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

A. $CH_3CH_2COCH_3$ ketone
B. $CH_3CH_2COOCH_3$ ester
C. $CH_3CH_2CHOHCH_3$ alcohol
D. $CH_3CH_2CH_2CH_3$ alkane
E. $CH_3CH_2CHFCH_3$ alkyl halide. ⇒

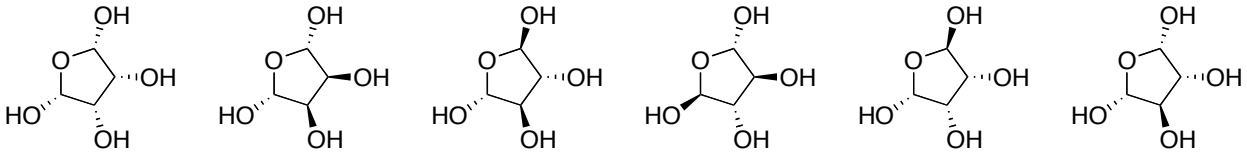
27. Rank the following compounds in order of **increasing** rate of base hydrolysis. Circle the correct answer.



A B C D

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.



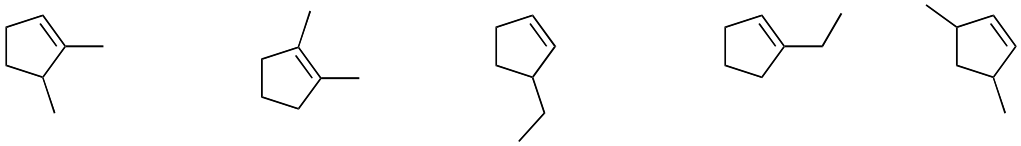
A B C D E F

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

29. Which structures are diastereomers of each other?

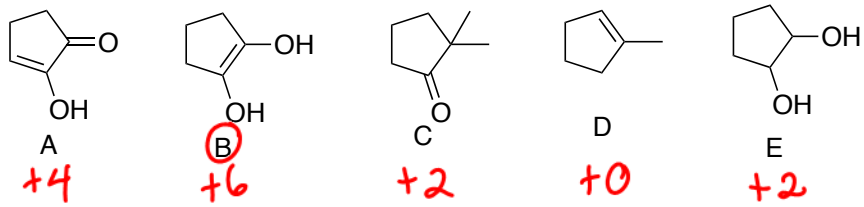
30. Which structure(s) is/are meso?

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



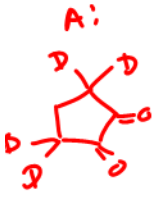
A B C D E

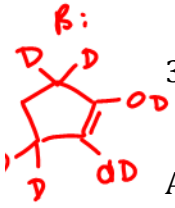
32. When the following compounds are mixed with NaOD and D_2O, which shows the greatest increase in mass?



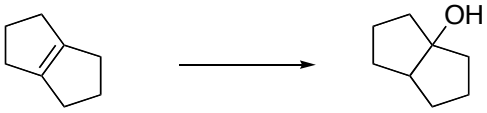
A B C D E

+4 +6 +2 +0 +2



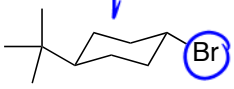
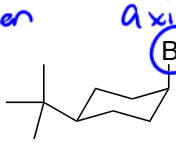


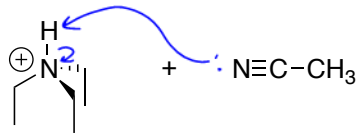
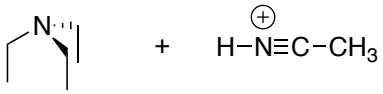
33. Select the term that best describes this transformation.

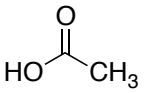


A. tautomerization
B. racemization
C. mutarotation
D. hydrolysis
E. epimerization
F. reduction
G. oxidation
H. hydration
I. acylation
J. alkylation

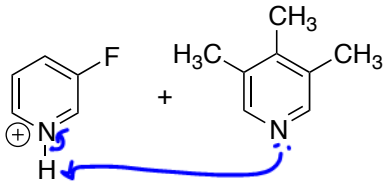
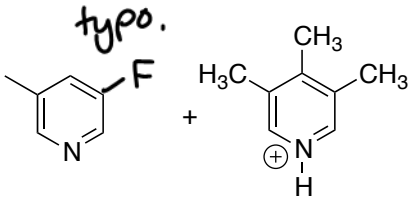
For questions 34 to 40, select the arrow(s) that best describes the relationship between the structures on the left and right sides of the arrow(s).

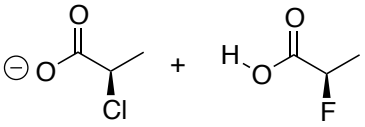
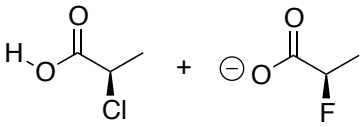
34. equatorial  + NaBr — substitution reaction — C — axial  + NaBr

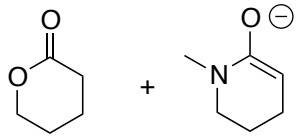
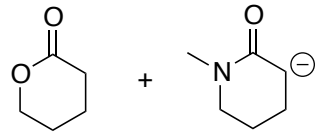
35.  — proton transfer — C — 

36.  + $NaOCH_2CH_3$ — A — products of proton transfer

37. H–Cl + $F^{\ominus}$ — A — H–F + $Cl^{\ominus}$

38.  — A — typo. 

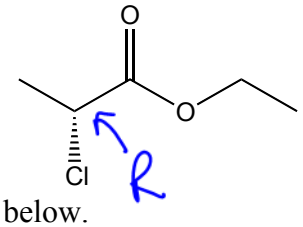
39.  — A — 

40.  — C — 

41. An L-aldose sugar rotates plane–polarized light:
a. to the right (clockwise)
b. to the left (counterclockwise)
c. must be determined experimentally
d. does not rotate plane–polarized light

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

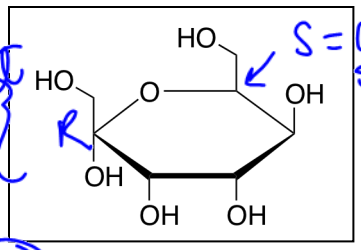
a. (2*S*)-2-chloropropyl ethanoate
b. (2*R*)-2-chloropropyl ethanoate
c. (2*S*)-2-chloroethyl propanoate
d. (2*R*)-2-chloroethyl propanoate
e. (2S)-propyl-2-chloroethanoate
f. (2*R*)-propyl-2-chloroethanoate
g. (2S)-ethyl-2-chloropropanoate
h. (2*R*)-ethyl-2-chloropropanoate



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

43. a. tetrose b. pentose c. hexose d. heptose
44. a. D b. L
45. a. alpha b. beta
46. a. aldose b. ketose
47. a. reducing b. non-reducing

hemiketal = reducing

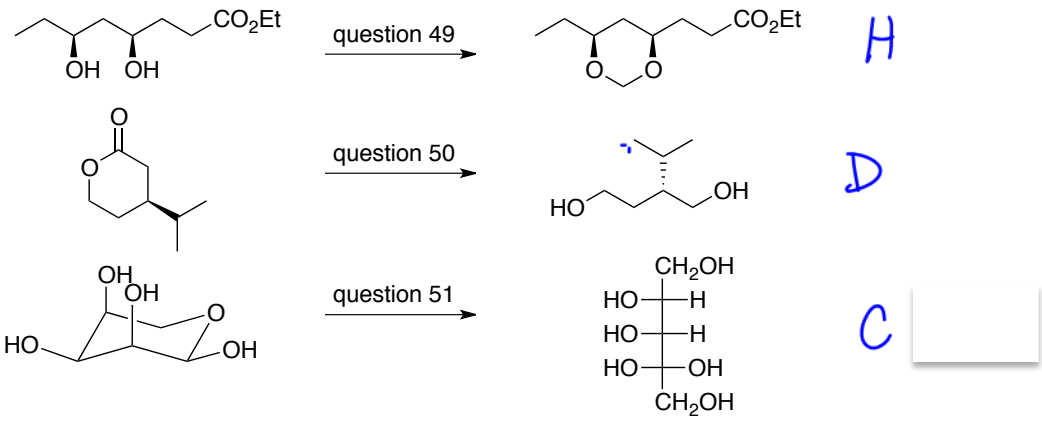


48. Will the carbohydrate shown above react with $NaBH_4$ in ethanol? a. Yes b. No

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

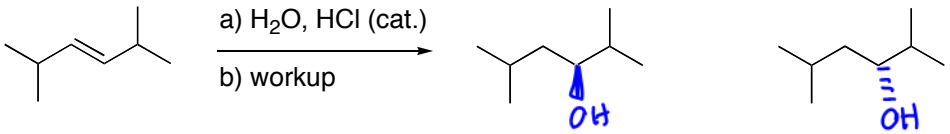
A	B	C	D	E
CrO_3, H_2SO_4, H_2O *then workup*	CrO_3, pyridine, HCl *then workup*	$NaBH_4$, *solvent then workup*	a) $LiAlH_4$ b) H_3O^+ workup	PBr_3, *solvent then workup*

F	G	H	I	J
LDA, *solvent then workup*	H_2SO_4 (cat.), H_2O *then workup*	H_2SO_4 (cat.), H_2CO *then workup*	H_2SO_4 (cat), MeOH *then workup*	H_2SO_4 (cat.), propanone *then workup*



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.



Structure A Structure B Structure C

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.

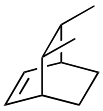
e) The { syn / anti / non-stereoselective }, { regioselective / non-regioselective } process that occurs when the { σ / π } bond of the alkene behaves as { a nucleophile / an electrophile } { involves / does not involve } reaction intermediates.

→ symmetrical alkene starting material

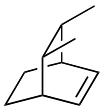
f) The alkene has undergone { reduction / oxidation / no redox change } during the reaction.

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

A



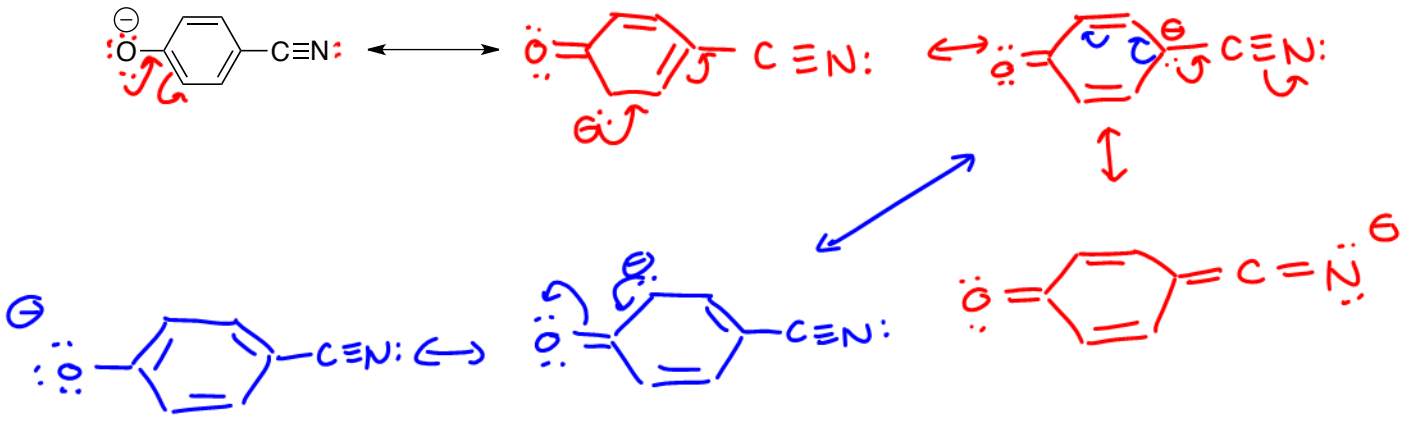
B



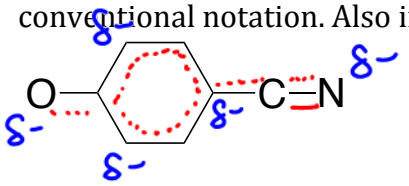
The two methyl groups in B are "blocking" one side of the alkene, making it impossible to interact with the metal catalyst / H atoms on that side. This means it takes more time to hydrogenate B.

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

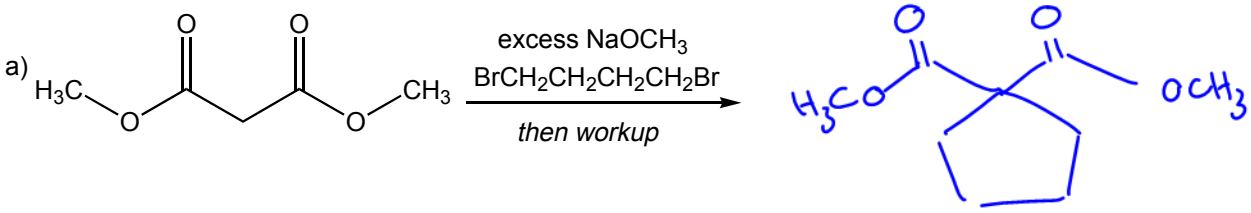
3. a) Draw the major contributing resonance structures of the following molecular ion.



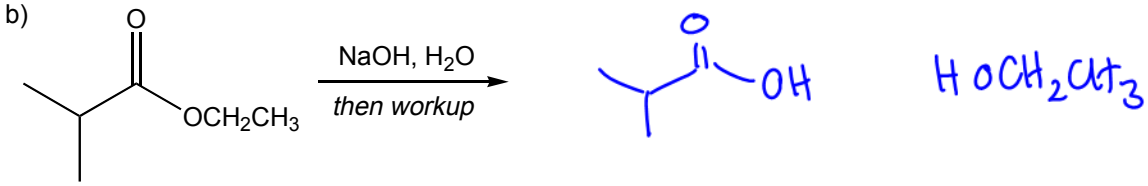
b) On the template below, represent the resonance hybrid of the molecular ion using the conventional notation. Also indicate all atoms that bear a partial negative charge.



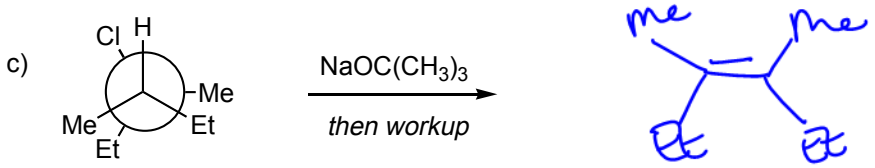
4. Draw the major organic product(s) of the following reactions. Clearly indicate stereochemical features of each product. For each reaction, circle the term that best describes the relationship between major organic products formed. If no terms describe the relationship, do not circle any terms.

a) 

racemic mixture achiral compound diastereomeric mixture meso compound

b) 

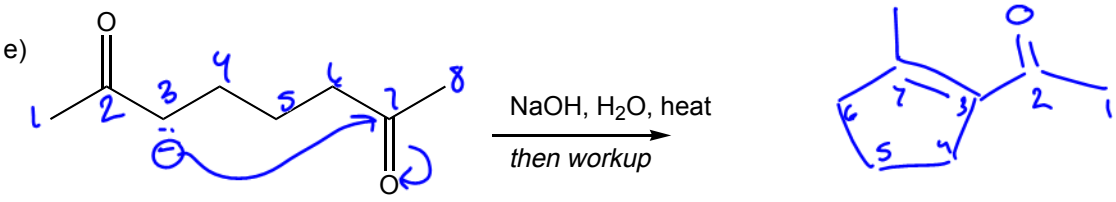
racemic mixture achiral compounds diastereomeric mixture meso compound

c) 

racemic mixture achiral compound diastereomeric mixture meso compound

d) 

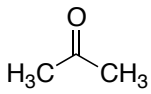
racemic mixture achiral compound diastereomeric mixture meso compound

e) 

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.

a)



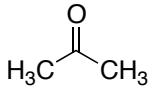
a) HCl (cat.)
CH_3CH_2OH (solvent)

b) workup

ketal formation

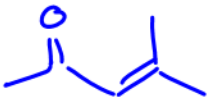
racemic mixture mixture of diastereomers one chiral product one achiral product structural isomers

b)



a) $NaOCH_2CH_3$
CH_3CH_2OH (solvent)
heat

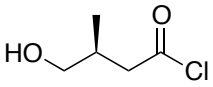
b) workup



aldol condensation

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

c)



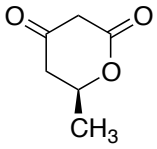
a) solvent

b) workup

nucleophilic acyl substitution

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

d)



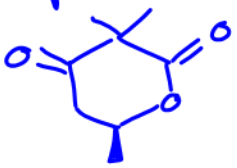
enolate alkylation

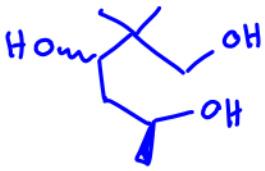
1. $NaOCH_3$ (2 equiv.)
CH_3-I (2 equiv.)
CH_3OH then workup

2. a) $LiAlH_4$, diethyl ether
b) workup

reduction

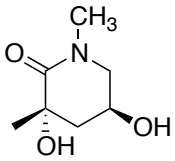
after a:





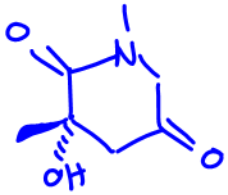
racemic mixture mixture of diastereomers one chiral product one achiral product structural isomers

e)



Jones reagent

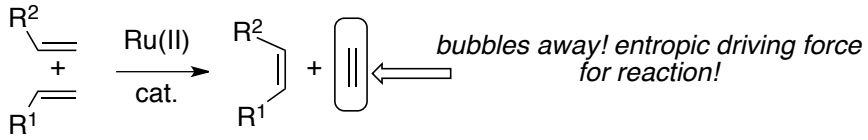
then workup



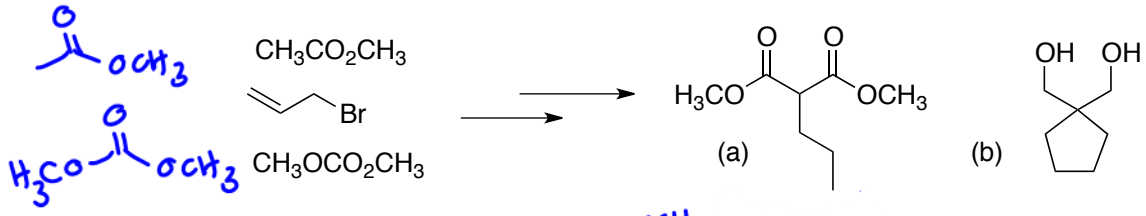
2° alcohol oxidation

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

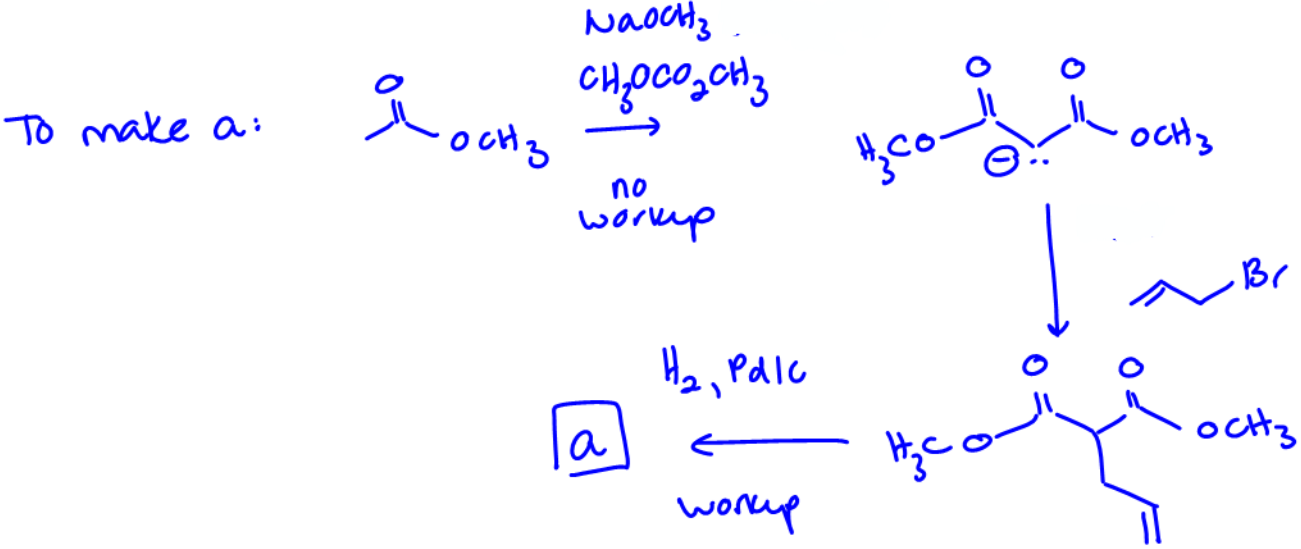
6. A special ruthenium(II) catalyst developed at Caltech enables alkenes to undergo a highly selective reaction:



With this information, and the knowledge of Chem 233 reactions, provide reagents and write out steps necessary to carry out each of the proposed sequences below. The supplied organic compounds are the only carbon containing compounds you need. You can use of inorganic reagents or solvents.

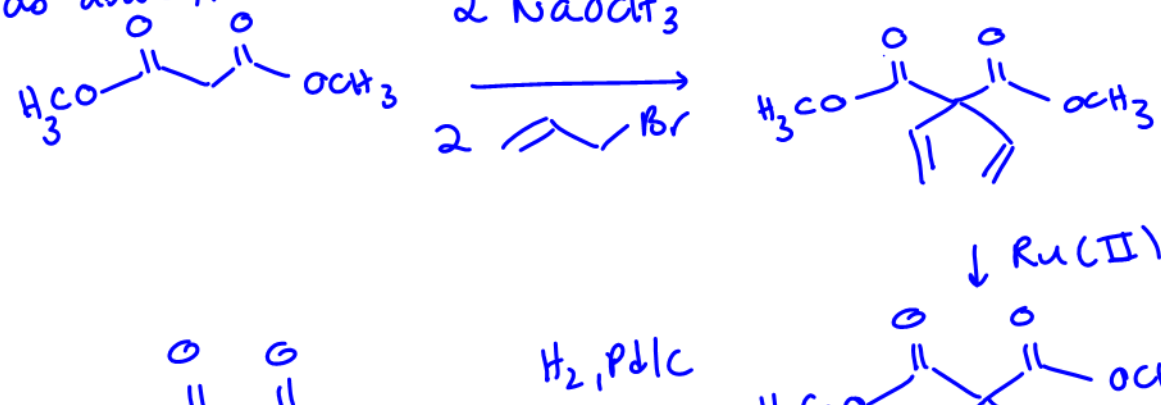


To make a:



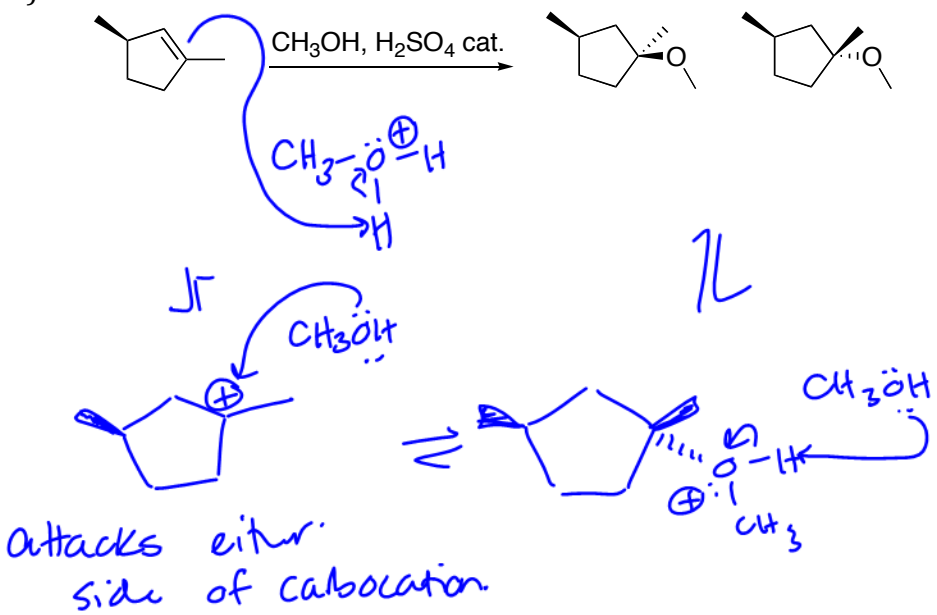
To make b:

do above, make:

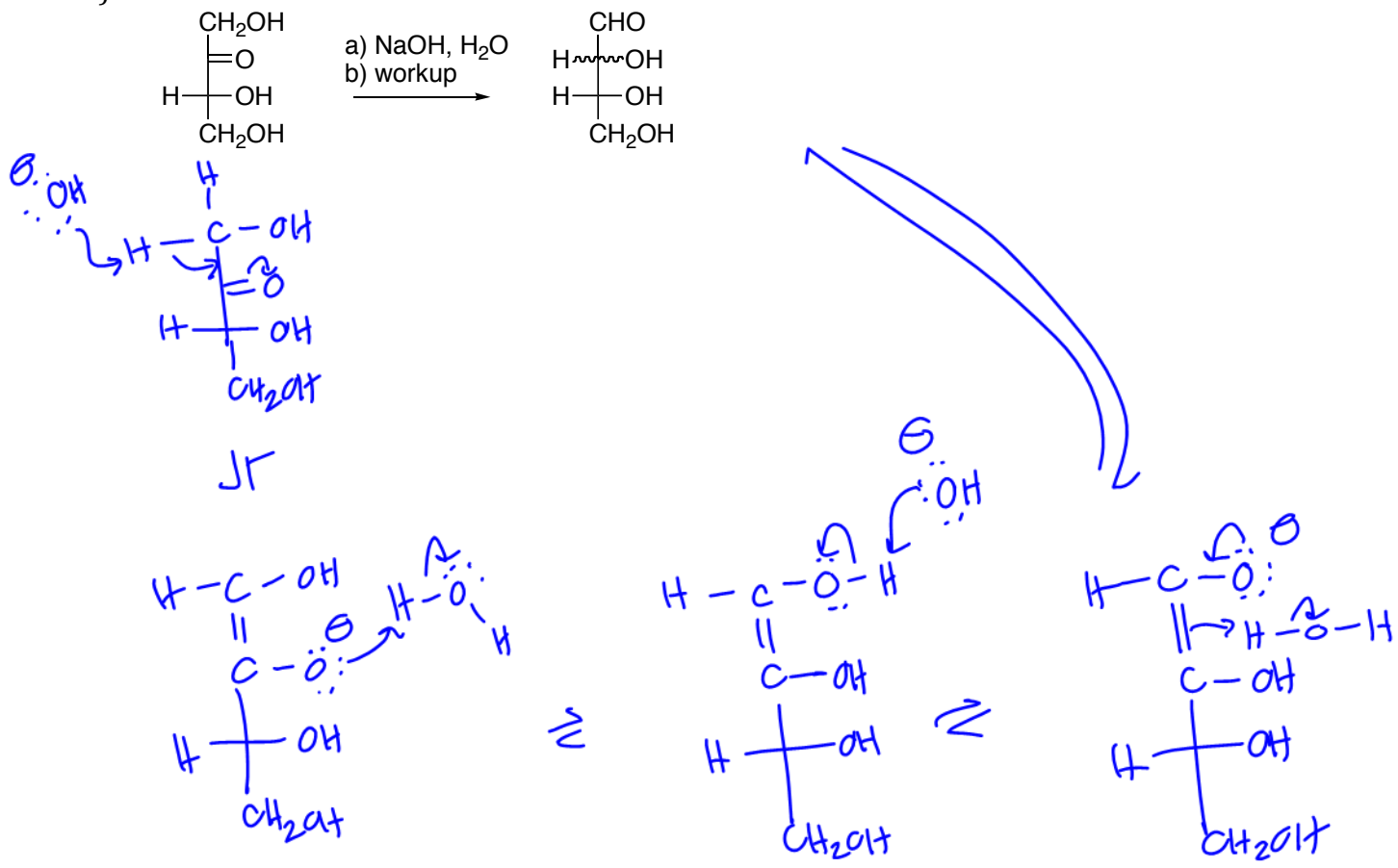


7. Using curved arrows to represent electron movement, draw a step-by-step mechanism for each of the following reactions.

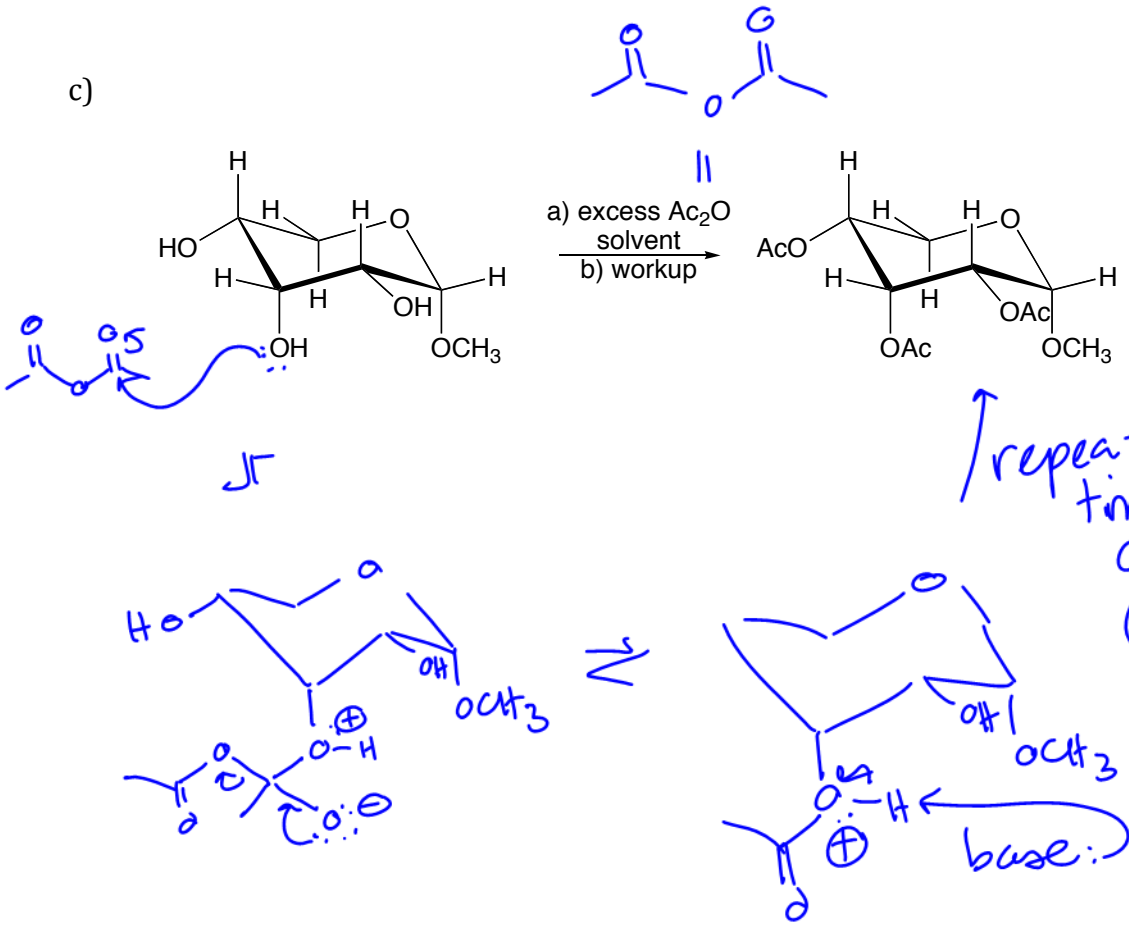
a)



b)



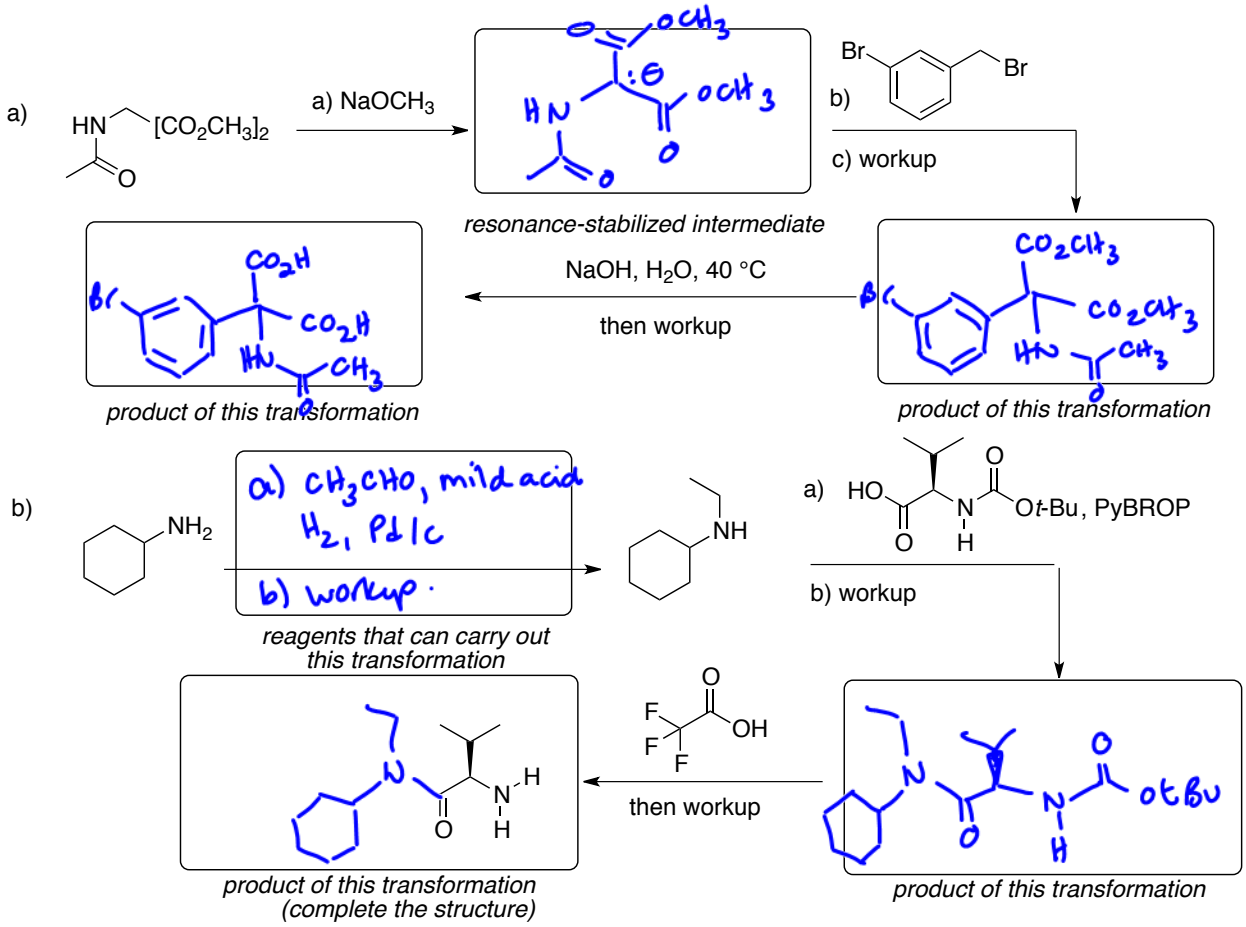
c)



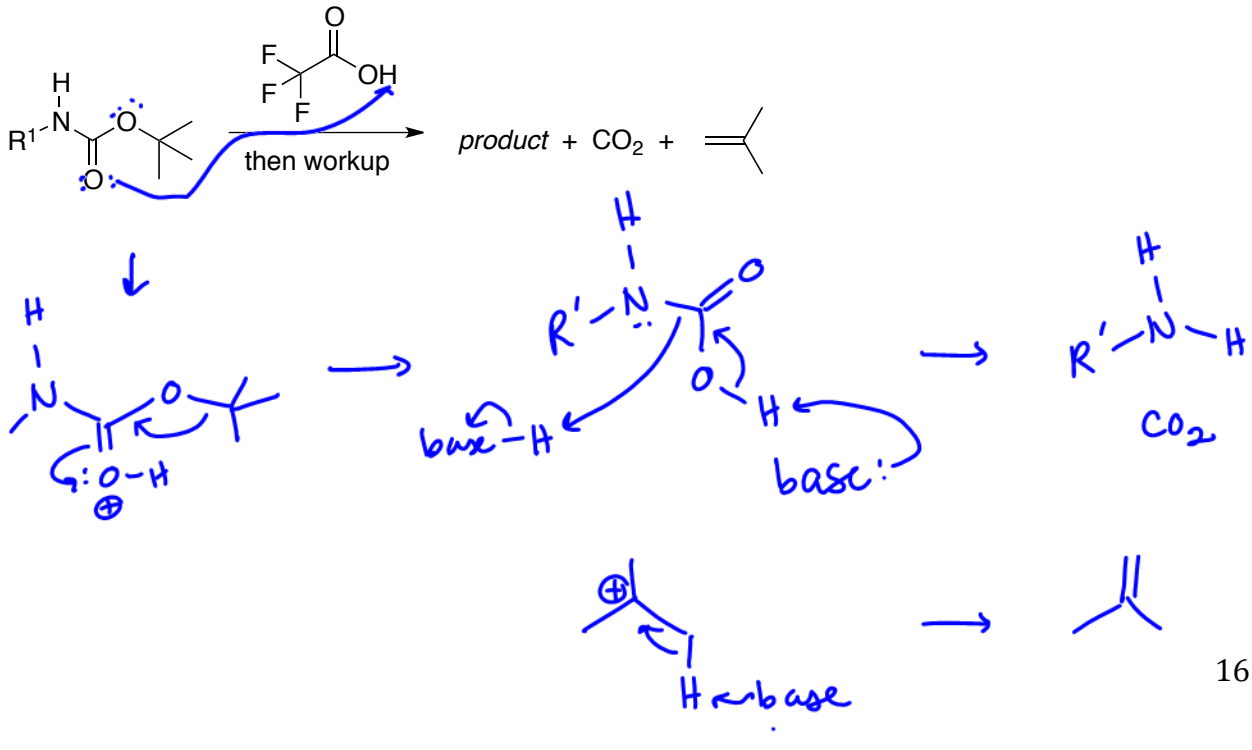
d) Why isn't the -OCH_3 group replaced by -OAc in the reaction above?

A key step in the mechanism above is the deprotonation of the OH group. R–$\overset{\oplus}{O}(R)CH_3$ cannot be deprotonated to give the neutral product.

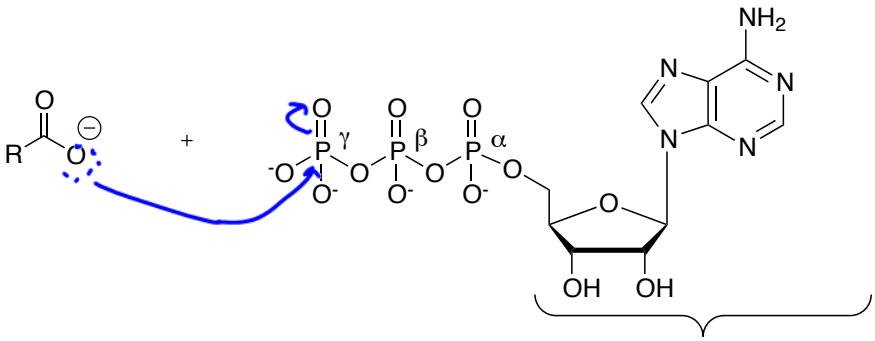
8. Provide the missing information in the reaction sequences below. This may require you to provide starting materials, reagents, and/or products.



9. Using arrows that represent electron movement, provide a mechanism for the following process:



10. 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.

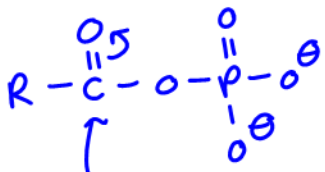


to save time, use the symbol A to represent this portion

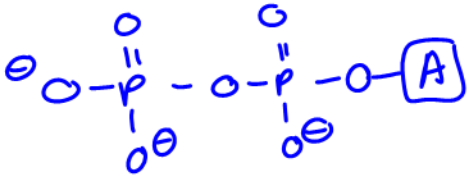
carboxylate ion reacts with the γ-phosphorus of ATP

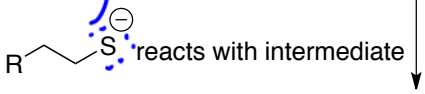
Draw the reaction intermediate and leaving group.

intermediate



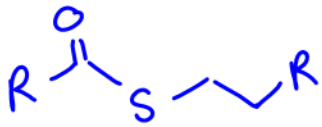
LG:



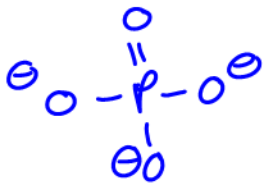


reacts with intermediate

Draw carbonyl-containing product and leaving group.



LG:



This is the end of the practice exam.