Answers

Practice Final Exam B - FULL LENGTH

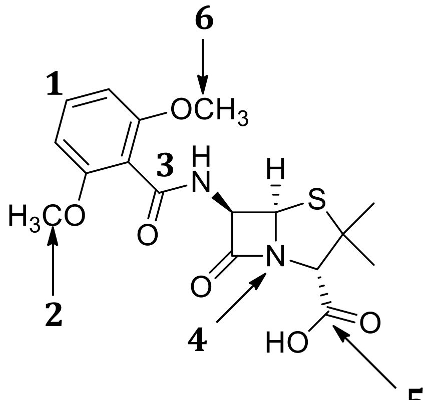
The following practice exam contains questions from past final exams as well as new questions. You will get the most out of this practice test if you complete it under EXAM CONDITIONS - that is, without distractions and within a 2.5 hour time limit.

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

Questions 1-7. Methicillin is a powerful antibiotic that was heavily used in the 1950's-1970's to treat bacterial infections. Overuse has led to Methicillan-resistant *Staphylococcus aureus*, (MRSA) which is a health concern in many hospitals. Take note that specific carbon atoms in this structure have been labelled **1-6**.



Methicillin

1) What is the hybridization of the carbon labelled **1**?

(A) sp [✓ **(B)** sp^2] **(C)** sp^3 **(D)** s **(E)** σ (sigma) **(F)** π (pi) **(G)** s **(H)** p

2) What is the hybridization of the carbon labelled **2**?

(A) sp **(B)** sp^2 [✓ **(C)** sp^3] **(D)** s **(E)** σ (sigma) **(F)** π (pi) **(G)** s **(H)** p

3) What is the name of the functional group in which carbon **3** is incorporated?

(A) ether **(B)** alkane **(C)** ketone **(D)** thiol [✓ **(E)** 2° amide] **(F)** 2° amine **(G)** carboxylic acid

4) What is the hybridization of the nitrogen labelled **4**?

(A) sp [✓ **(B)** sp^2] **(C)** sp^3 **(D)** s **(E)** σ (sigma) **(F)** π (pi) **(G)** s **(H)** p

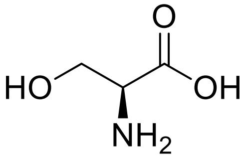
5) What is the name of the functional group in which carbon **5** is incorporated?

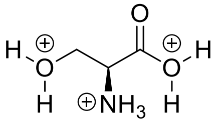
(A) ether **(B)** alkane **(C)** ketone **(D)** thiol **(E)** 2° amide **(F)** 2° alcohol [✓ **(G)** carboxylic acid]

6) What is the total number of lone pairs of electrons in Methicillin?

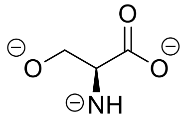
(A) 32 **(B)** 10 **(C)** 30 [✓ **(D)** 16] **(E)** 5 **(F)** 9 **(G)** 1 **(H)** 22

To the right is a representation of the amino acid serine. Answer questions 7 and 8 using this representation, and the structures below this box.

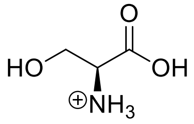




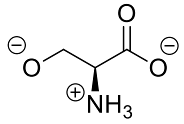
A



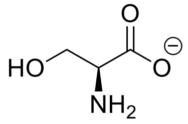
B



C



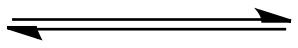
D



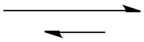
E

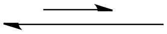
7) What is the predominant form of serine at pH 1? C
8) What is the predominant form of serine at pH 11? E

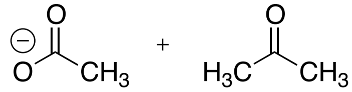
Questions 9 to 18. Select the letter (A, B, C, D) that corresponds to the arrow(s) that best describes the relationship between the "reactants" and the "products".

A


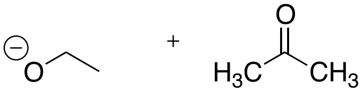
B


C


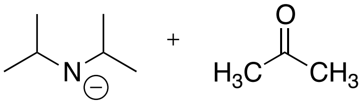
D


9)

D

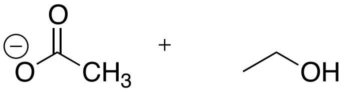
products of proton transfer

10)

D

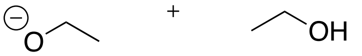
products of proton transfer

11)

C

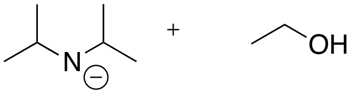
products of proton transfer

12)

D

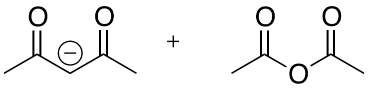
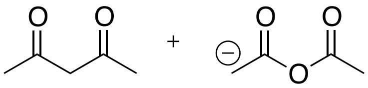
products of proton transfer

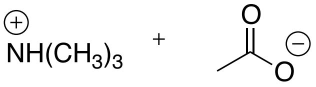
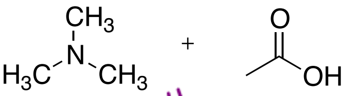
13)

A

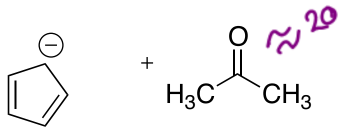
products of proton transfer

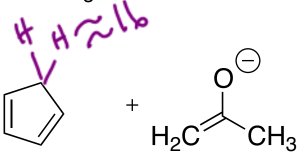
14)

C

products of proton transfer

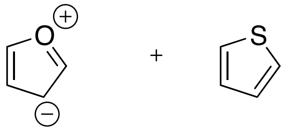
15)

D


16)

D


17)


D


18)

B


Questions 19-27. Indicate the statements as true (A), false (B), or cannot be determined (C).

A 19) A cyclic system with 8 pi electrons does not obey Hückel's rule.

B 20) Serine proteases carry out biological ~~amine~~ amide! hydrolysis reactions.

A 21) The reaction rate of an E2 reaction is dependent on the concentration of both the substrate and base.

B 22) Anomers of the same carbohydrate have the same melting point. anomers are diastereomers

A 23) $NaBH_4$ is soluble in water.

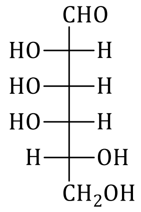
A 24) Propanoyl chloride undergoes a reaction with water at a faster rate than propyl propanoate reacts with water.

B 25) The C-5 epimer of D-glucose is L-glucose. D+L glucose are enantiomers

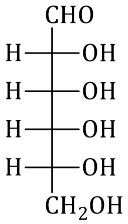
B 26) Carboxylic esters are more electrophilic than thioesters.

B 27) Protonation of carbonyl oxygen atoms makes them more nucleophilic.

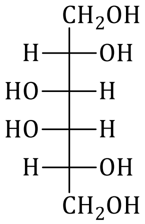
Consider the structure of D-talose and the structures (**A** – **E**) provided below when answering questions 28-33. Take note that incorrect answers will be subtracted from correct answers to a minimum of zero for this section.



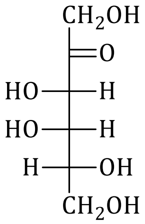
D -Talose



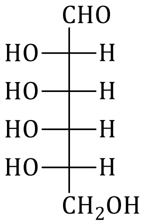
A



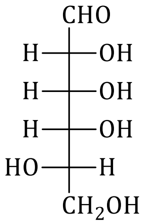
B



C



D

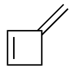


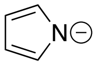
E

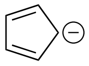
28) Which compound(s) (**A**-**E**) is/are diastereomers of D-talose? A D
29) Which compound(s) (**A**-**E**) is/are meso compounds? B
30) Which compound(s) (**A**-**E**) is/are enantiomers of D-talose? E
31) Which compound(s) **(A-E)** is/are constitutional isomers of D-talose? C
32) Which compound(s) **(A-E)** is/are epimers of D-talose? D
33) Which compound(s) **(A-E)** is/are L-carbohydrates? D E

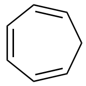
34) Consider compounds A-J below. Select the structure(s) that are aromatic.

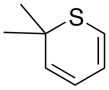

A

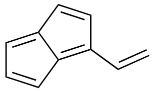

B

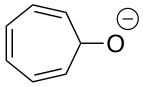

[✓ **C**]

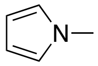

[✓ **D**]

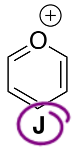

E


F

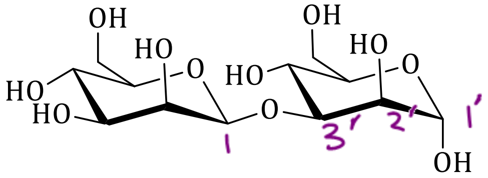

G


H


[✓ **I**]


[✓ **J**]

Consider the disaccharide shown to the right for questions 35-38. Indicate true or false for each statement.



35) Contains a monosaccharide derived from an aldose. [✓ (A) True] (B) False

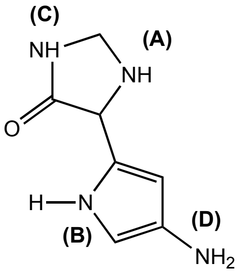
36) Contains a β - 1 → 3' linkage. [✓ (A) True] (B) False

37) Contains a monosaccharide derived from a pentose. (A) True [✓ (B) False]

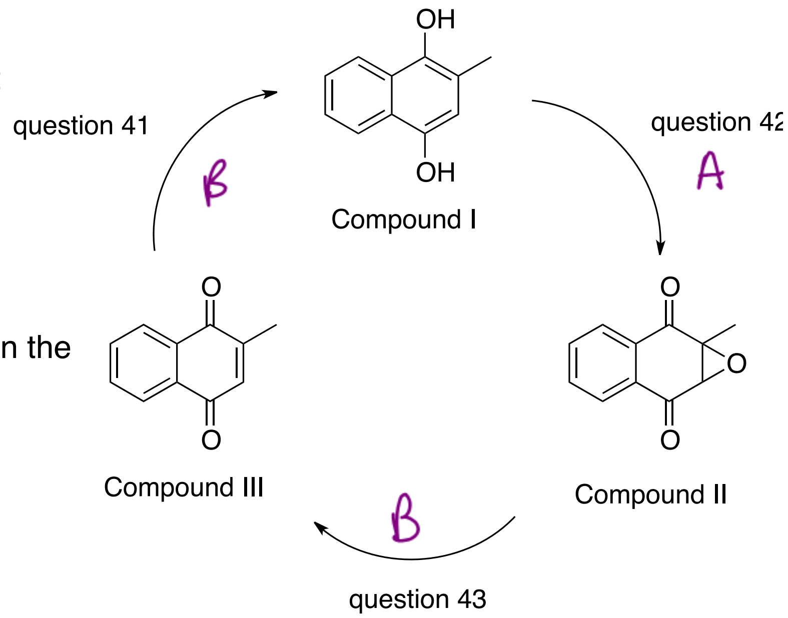
38) Contains an α-glycosidic bond. (A) True [✓ (B) False]

A 39. Which nitrogen atom is the most basic?

B 40. Which nitrogen atom is the least basic?



Vitamin K is a group of fat-soluble compounds that are involved in the process of blood clotting. Shown to right are three forms of vitamin K. Various enzymes catalyze the reactions shown in this cycle, which carboxylates of clotting factors and recycles the vitamin K.



Questions 41-43. Indicate whether each reaction on the catalytic cycle is an oxidation, reduction or neither.

(A) Oxidation
(B) Reduction
(C) Neither

44) Which of the three compounds, (**I** - **III**) is the *most reduced* form of vitamin K?

[✓ A) I] B) II C) III D) none

For questions 45-49, select the reagents and reaction conditions (**A** – **I**), that would ***best*** carry out each transformation in the reaction scheme below.

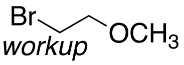
(A)
a) $NaBH_4$, CH_3OH
b) *workup*

(B)
a) $SOCl_2$
b) *workup*

(C)
a) H_2, Lindlar's catalyst
b) *workup*

(D)
a) H_2, Pd/C
b) *workup*

(E)
a) $LiAlH_4$, *solvent*
b) H_3O^+, H_2O (*workup)*

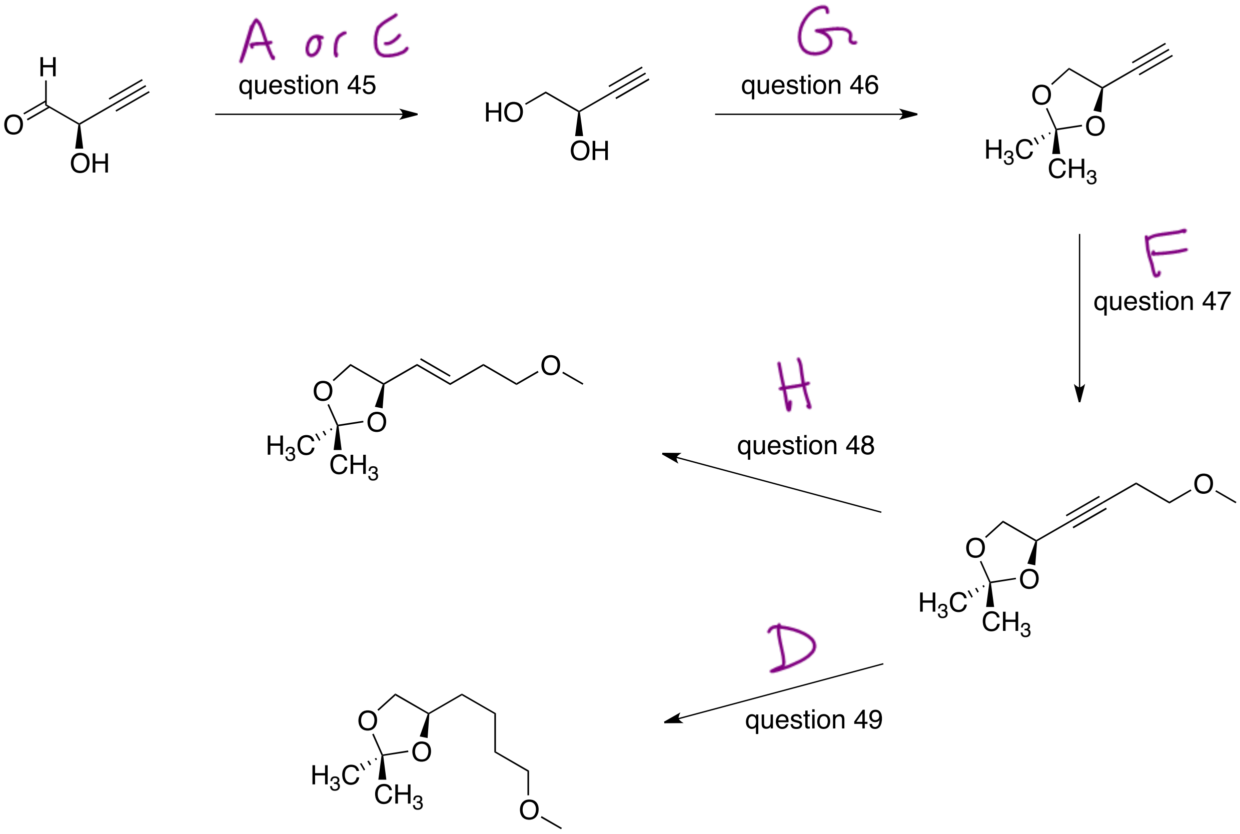
(F)
a) $NaNH_2$, NH_3
b)  , *solvent*

c) *workup*

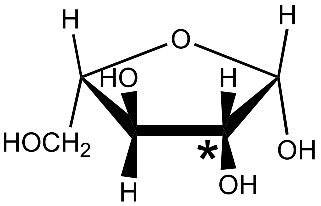
(G)
a) H_2SO_4 (catalyst), 2-propanone
b) *workup*

(H)
a) Na, NH_3
b) *workup*

(I)
a) CrO_3, pyridine, HCl (PCC)
b) *workup*



50) What is the absolute configuration of the carbon indicated by the asterisk (*)? [✓ (A)] R   (B) S

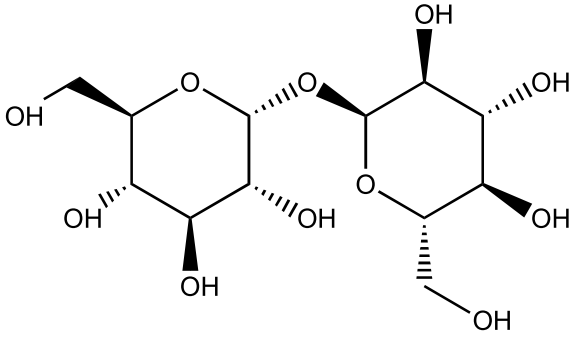


51) Classify the carbohydrate in question 50.
A) ketopentose, beta
B) ketopentose, alpha
[✓ C)] aldopentose, beta
D) aldopentose, alpha
E) aldohexose, beta

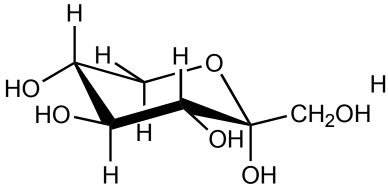
The following image is of trehalose, which is 45% as sweet as sucrose. Trehalose is the major carbohydrate energy storage molecule used by insects that fly. For the following two questions, keep in mind that trehalose is draw in a non-conventional form.

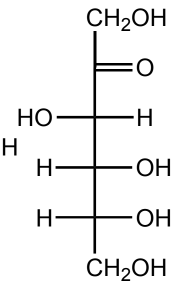
52) Is glucose a component of trehalose?
[✓ A)] Yes
B) No

53) Can trehalose undergo mutarotation?
A) Yes
[✓ B)] No

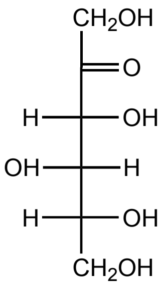


54) Which of the following is an accurate open-chain version of this monosaccharide?

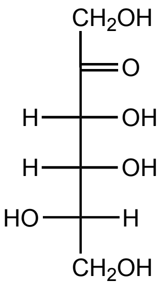




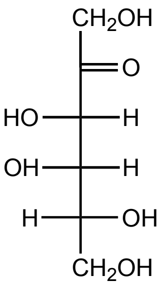
a



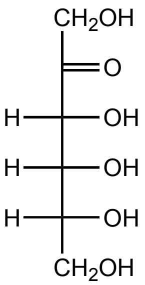
[✓ b]



c

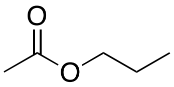


d



e

55) Which of the following is the correct IUPAC name of this structure?

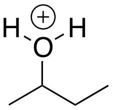


A) methyl propanoate
B) propyl methanoate
C) ethyl propanoate
[✓ D)] propyl ethanoate
E) methyl propanate
F) propyl methanate
G) ethyl propanate
H) propyl ethanate

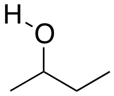
56) Which of the following species has the highest pK_a?

A) CH_3CH_2SH [✓ B)] CH_3CH_2OH C) CH_3COOH D) CH_3COSH

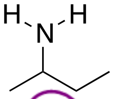
57) Which structure below is most nucleophilic?



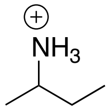
A



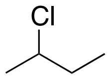
B



[✓ **C**]

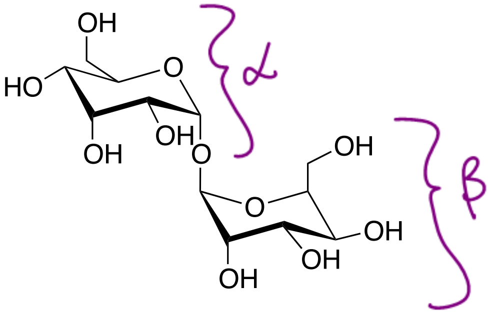


D



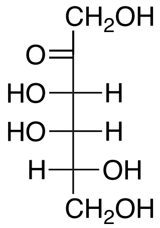
E

Questions 58-50. Use the structure of the disaccharide below to answer these questions.
58) The disaccharide below has a [✓ A)] 1-1' B) 1-2' C) 1-3' D) 1-4' E) 3-1' linkage.
59) The disaccharide below has a [✓ A)] alpha [✓ B)] beta linkage.
60) The disaccharide is a A) reducing [✓ B)] non-reducing sugar.

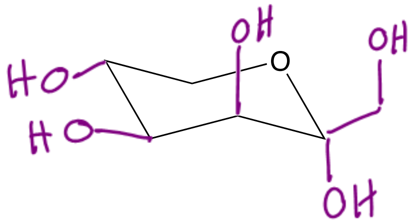


Part 2. Written response.

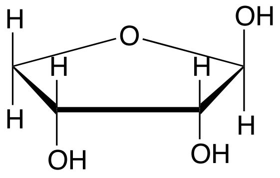
1) Provide the requested structures below.



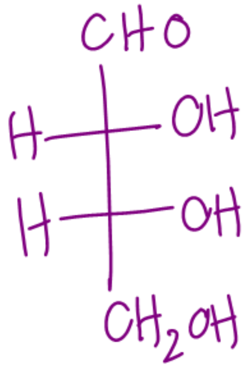
A



α-pyranose of A

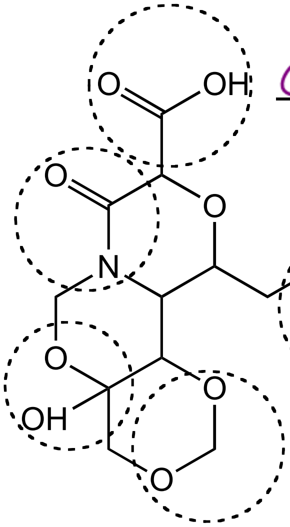


B



Fischer projection of B

2) Write the name of the indicated functional groups on the corresponding line.



carboxylic acid

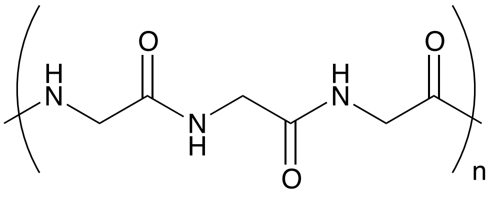
amide

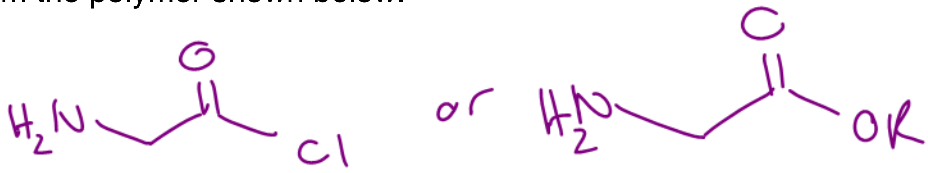
ester (carboxylic ester)

hemiketal

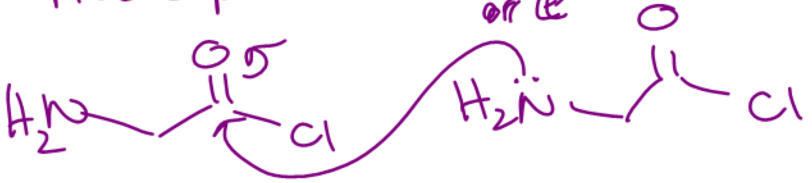
acetal

3) Draw the monomer that can react to form the polymer shown below.

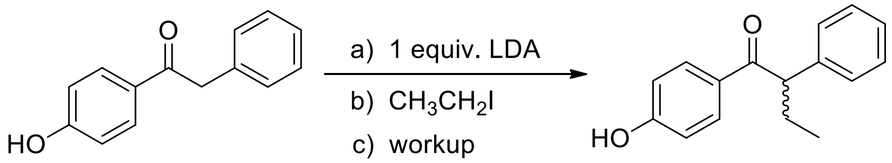




nucleophilic a or E substitution:

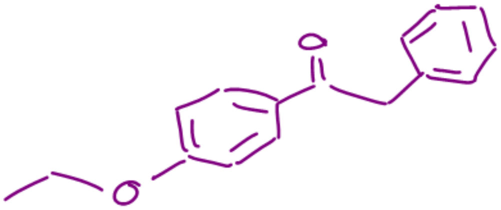


4) A key part of the synthesis of tamoxifen (an anti cancer drug) is the alkylation shown below. A CHEM 233 student decided to do this using the reagents shown below. However, it did not work.

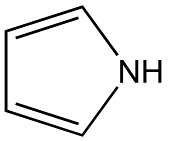


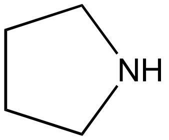
a) Why would the product shown not be formed? The α-hydrogen is not the most acidic proton, the phenolic –OH is, LDA will thus deprotonate that proton and the enolate alkylation will not occur.

b) What product would be formed instead?



5) Both pyrrole (A) and pyrrolidine (B) can act as acids in the presence of a strong enough base.
a) Rank the pK_a values of these compounds by circling the correct statement.


A


B

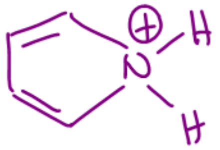
pKa (pyrrole) > pKa (pyrrolidine)

pKa (pyrrole) = pKa (pyrrolidine)

[✓ pKa (pyrrole) < pKa (pyrrolidine)]

b) Both pyrrole (A) and pyrrolidine (B) can also act as bases. Show the conjugate acid, **C**, of pyrrole and the conjugate acid, **D**, of pyrrolidine. Rank the pK_a values of these compounds by circling the correct statement.

C



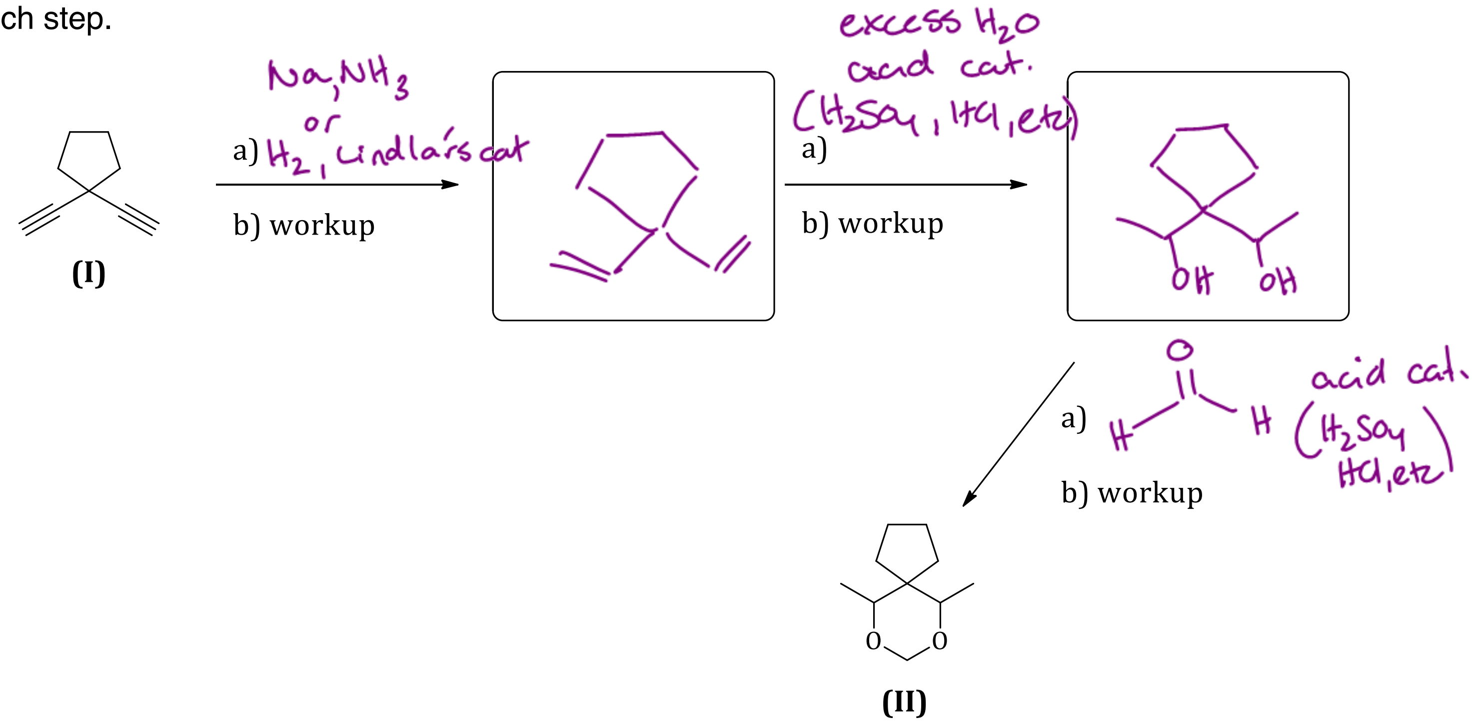
D

pKa (C) > pKa (D)

pKa (C) = pKa (D)

[✓ pKa (C) < pKa (D)]

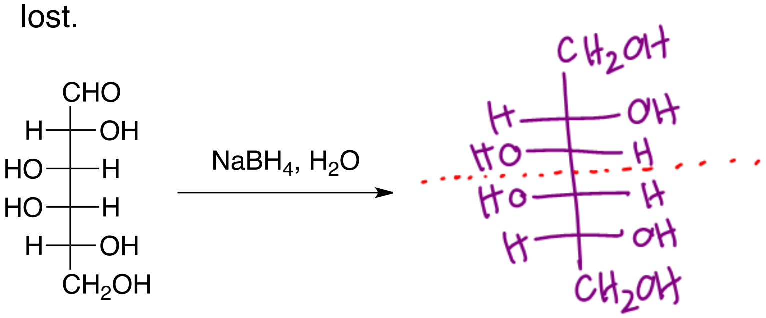
6) Provide the reaction conditions and reagents that would be required to transform the given alkyne **(I)** to the acetal product **(II)**. In the boxes, draw the organic intermediate compound(s) isolated after each step.



(I)

(II)

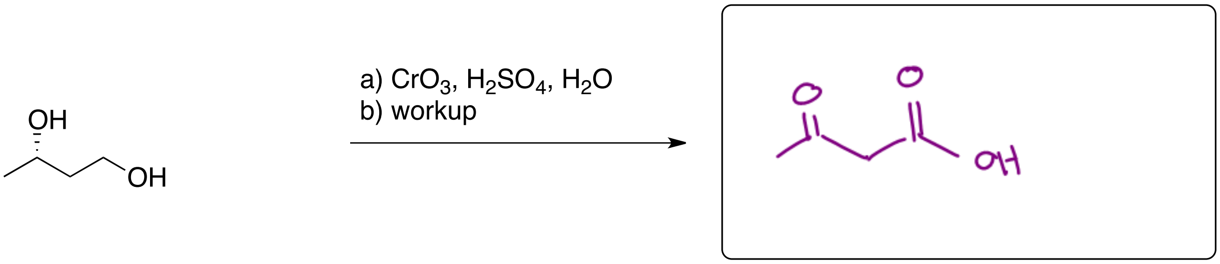
7) D-galactose, shown below, is an optically active compound. Reduction with sodium borohydride yields an optically inactive product. Show the reaction product and explain why the optical activity is lost.



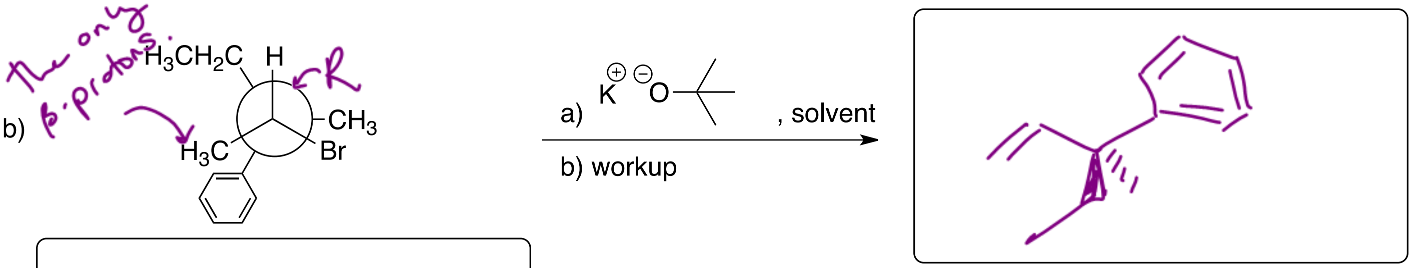
The product has an internal plane of symmetry, which makes it meso. Meso compounds are not optically active.

8) Provide the requested information for questions a to q. Only the major product(s) should be provided. Pay attention to stereochemical details; draw all appropriate stereoisomers.

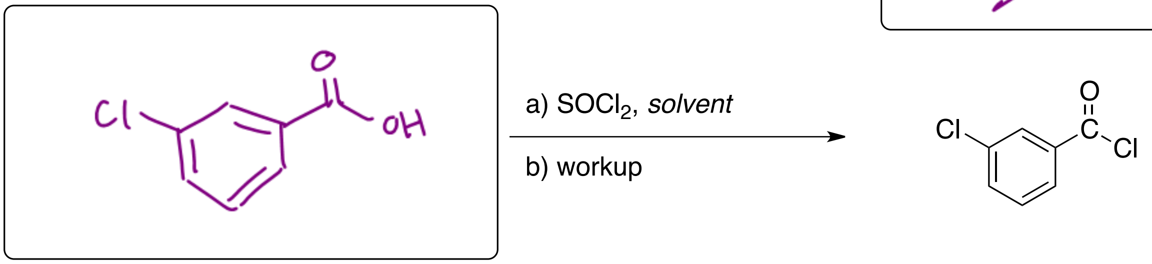
a)



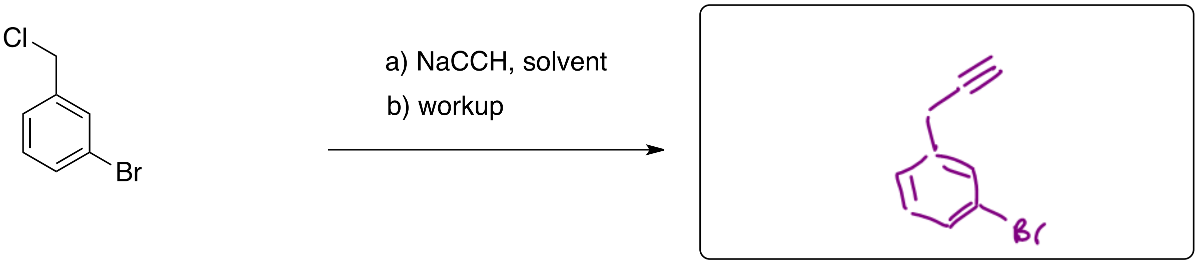
b)



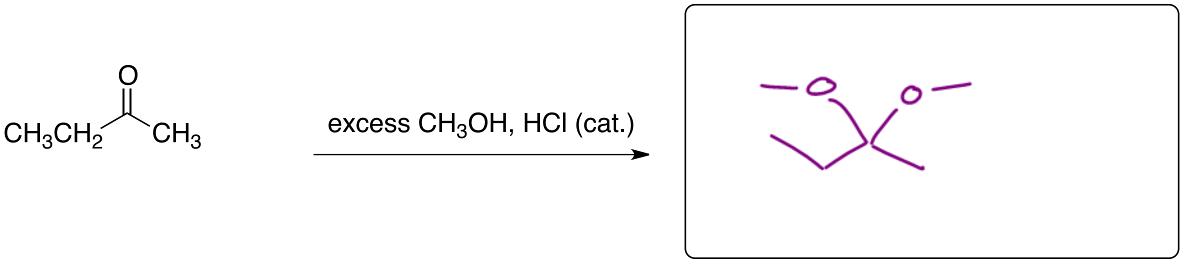
c)



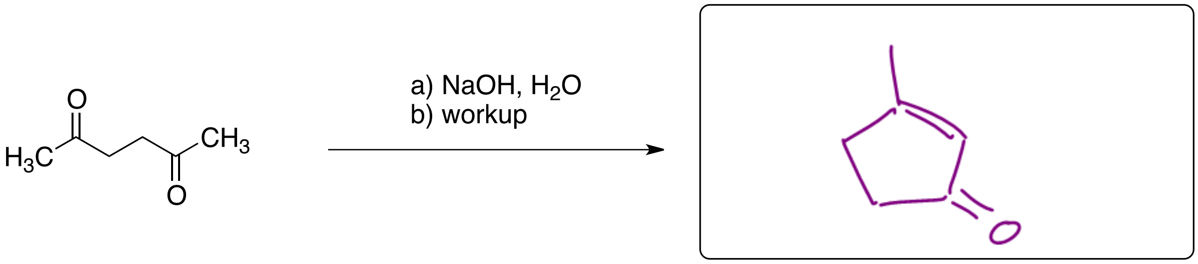
d)



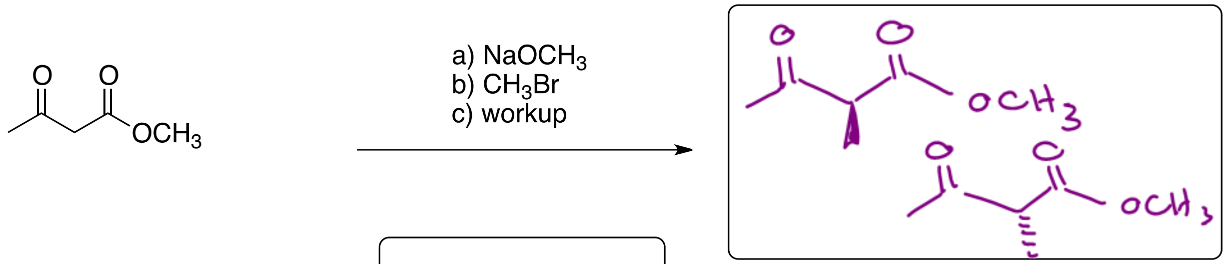
e)



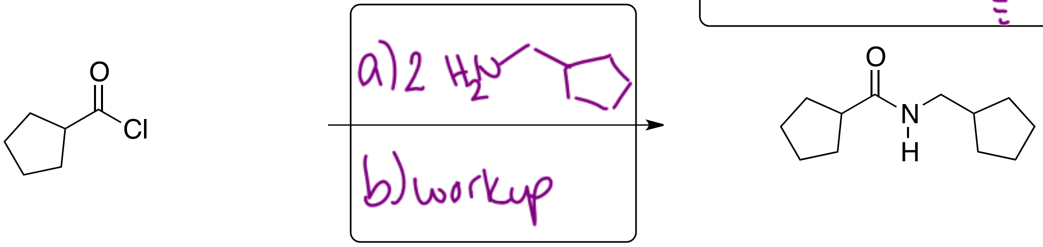
f)



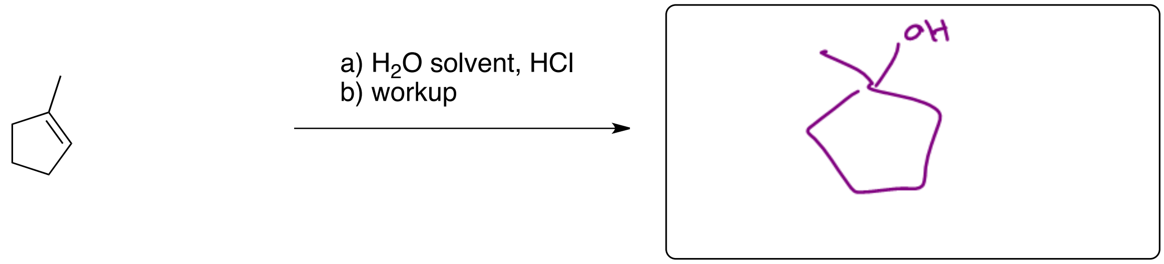
g)



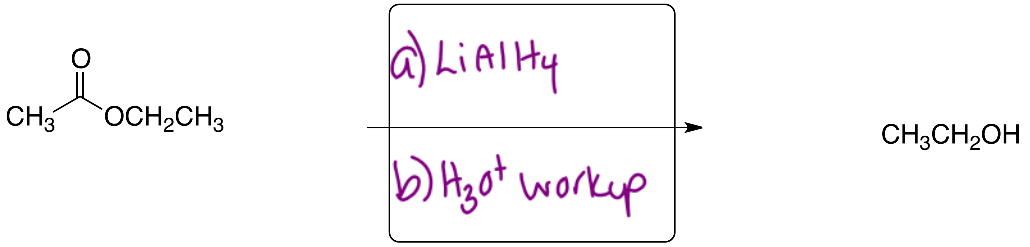
h)



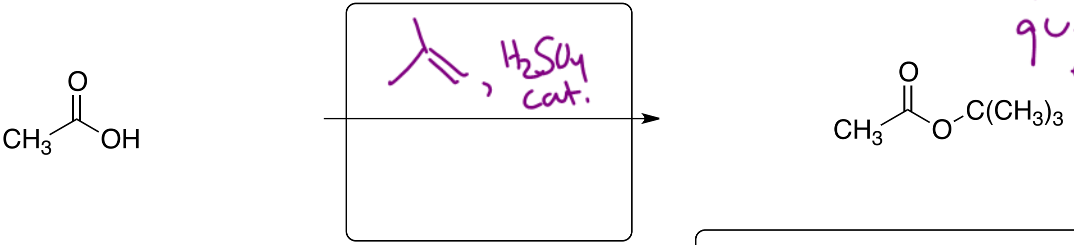
i)



j)

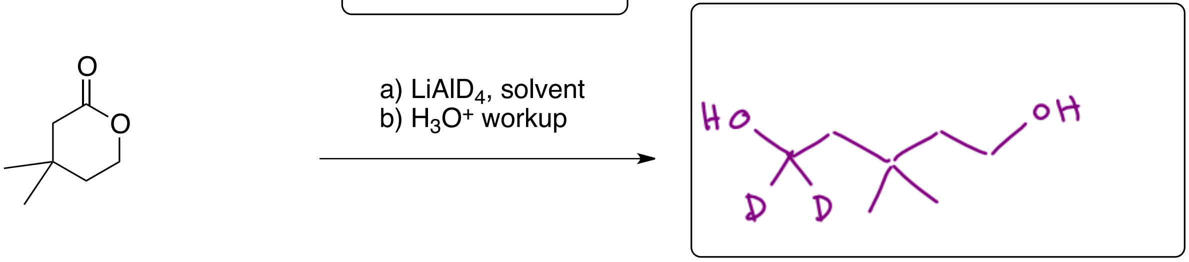


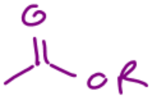
k)



Alternate answer for question k: excess $HOC(CH_3)_3$ H_2SO_4 cat.

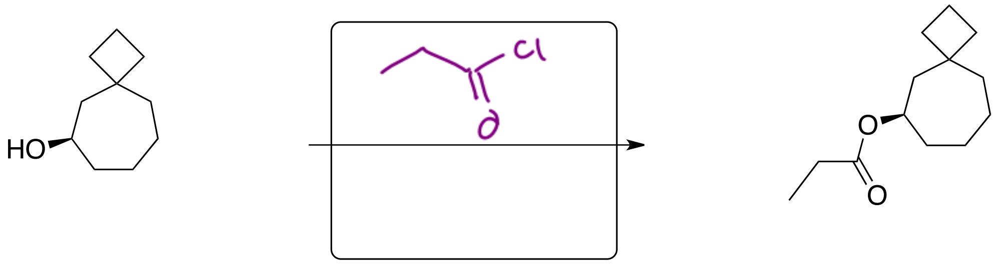
l)



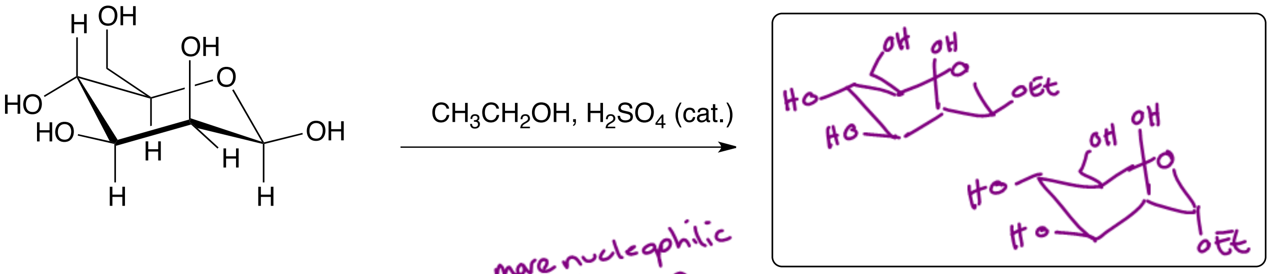


, H_2SO_4 cat. ok too.

m)



n)

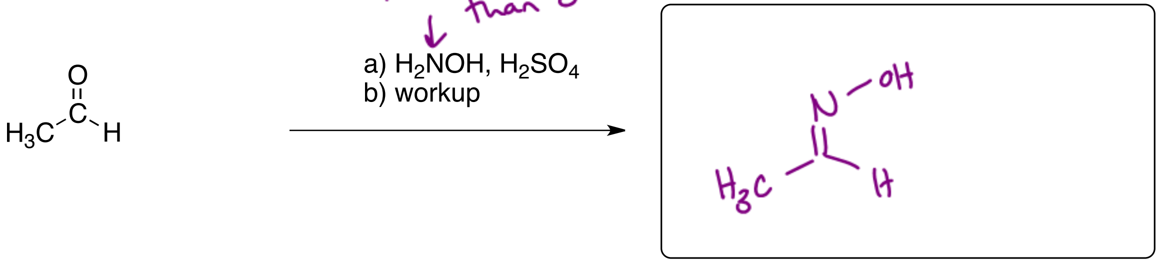


CH_3CH_2OH, H_2SO_4 (cat.)

o)

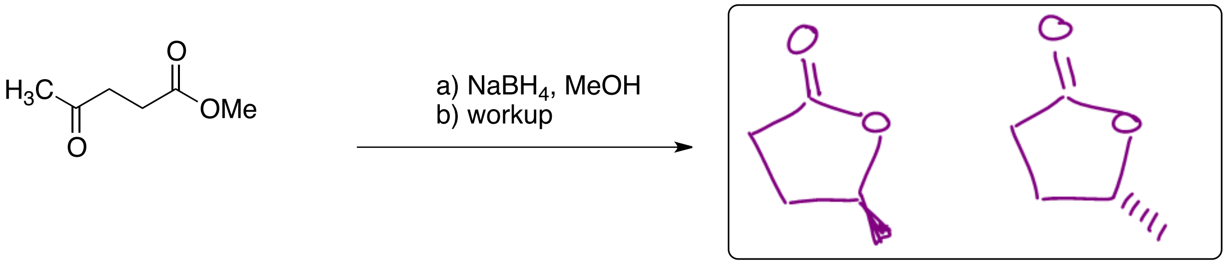
more nucleophilic than O

a) H_2NOH, H_2SO_4
b) workup



p)

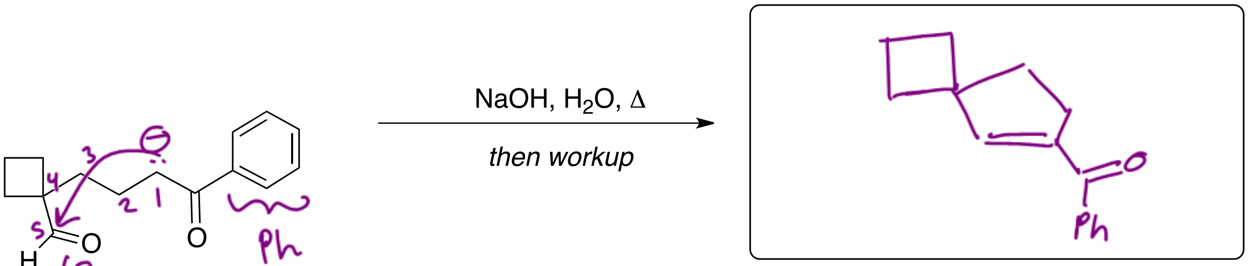
a) $NaBH_4$, MeOH
b) workup

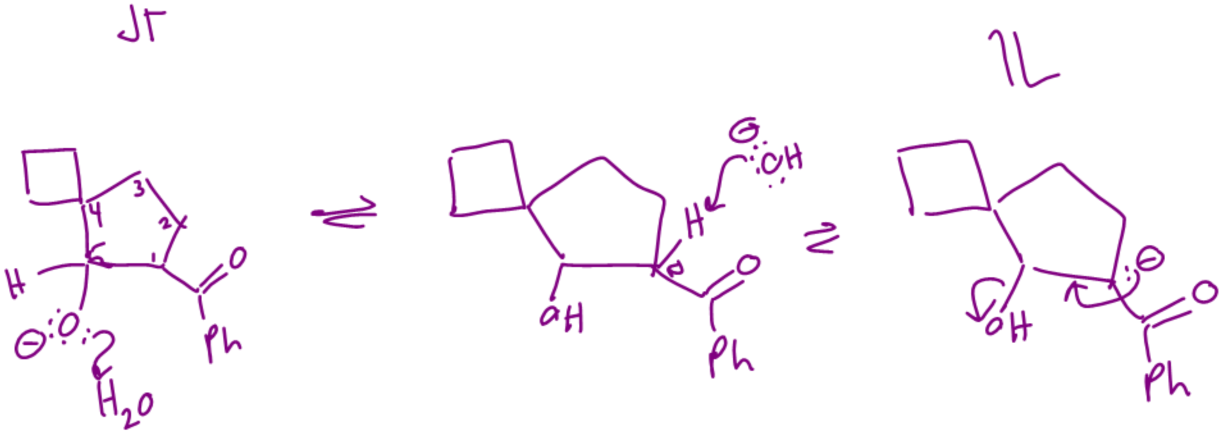


q)

NaOH, H_2O, Δ

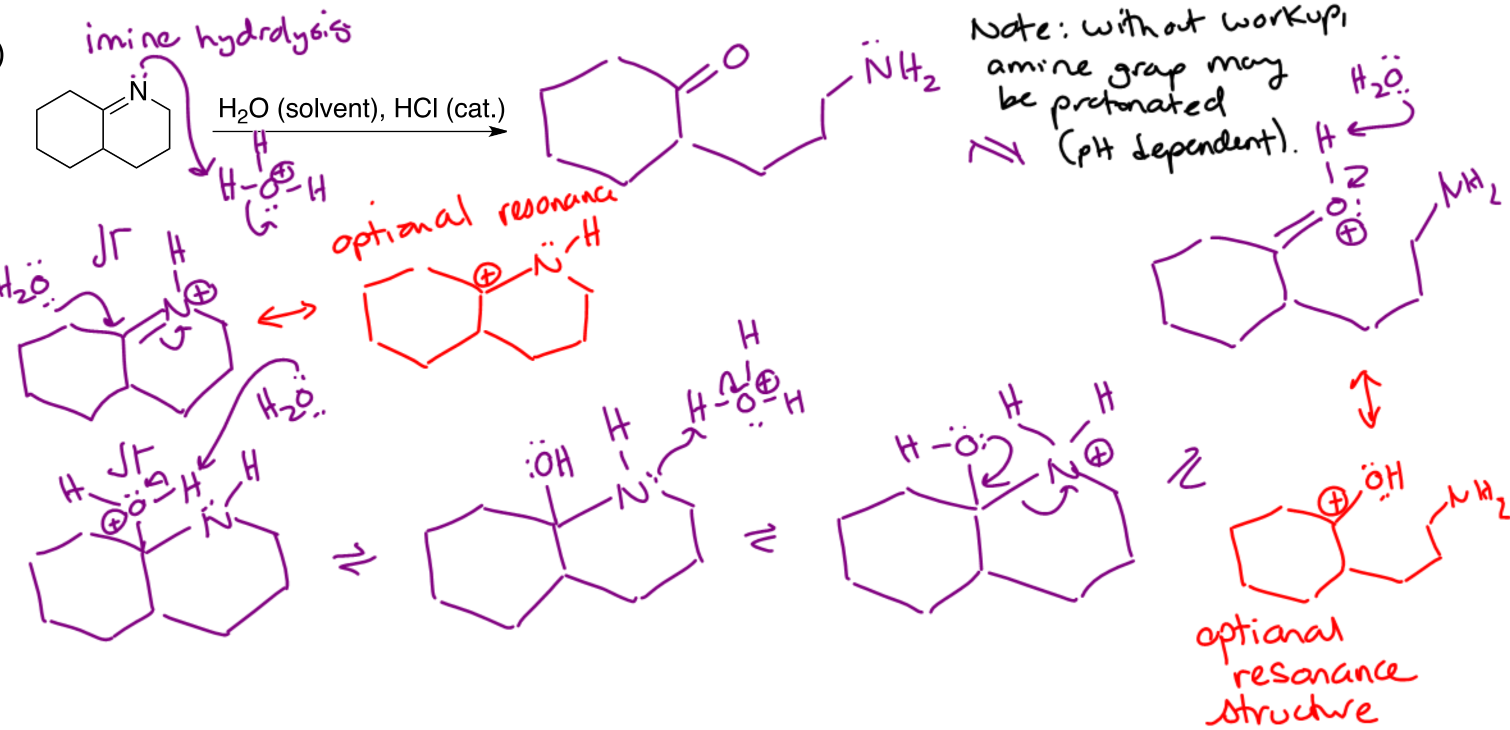
then workup



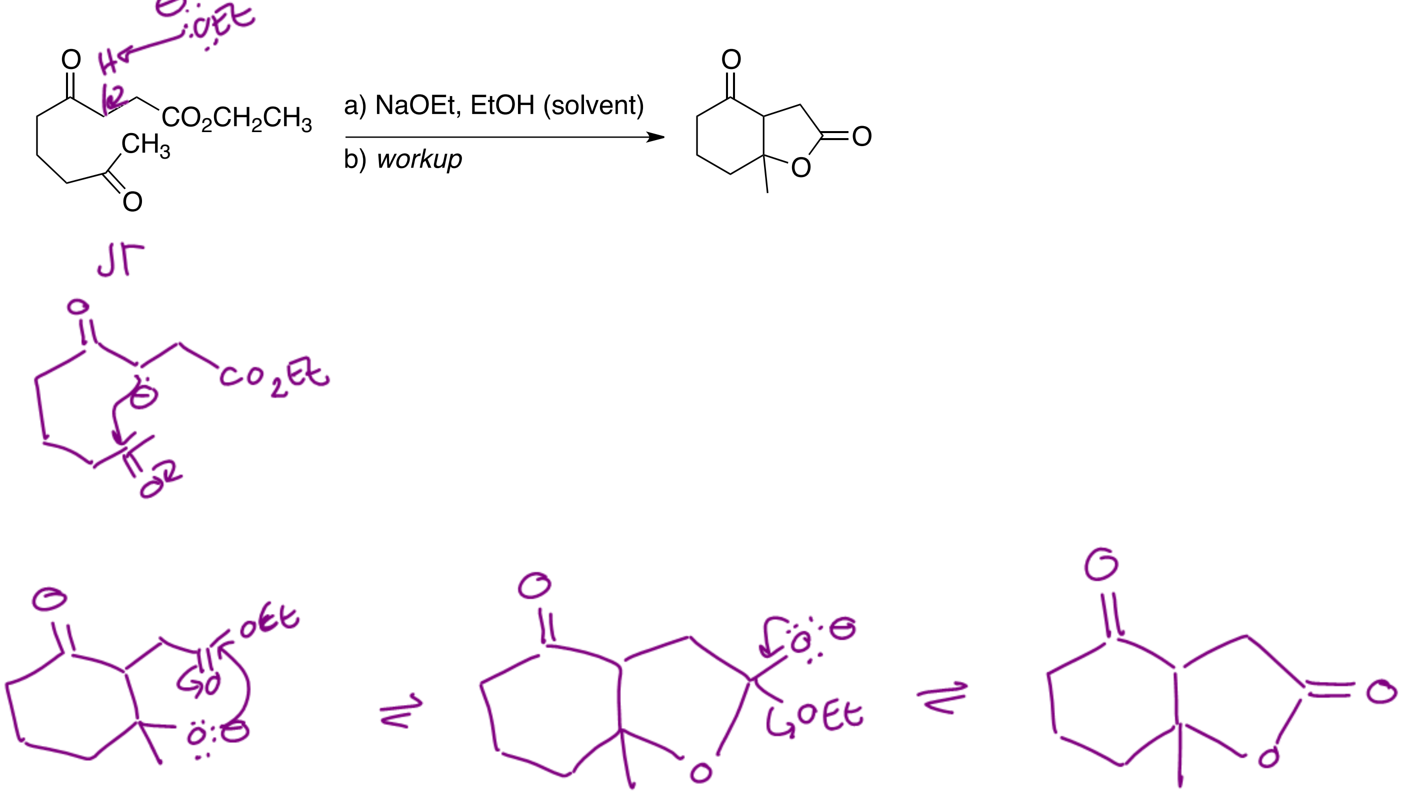


9) For the transformation shown below, provide the product(s) of the reaction and a mechanism rationalizing the product's formation. Include all electron movement arrows, relevant lone pairs of electrons, and intermediates. Non-zero formal charges must also be included.

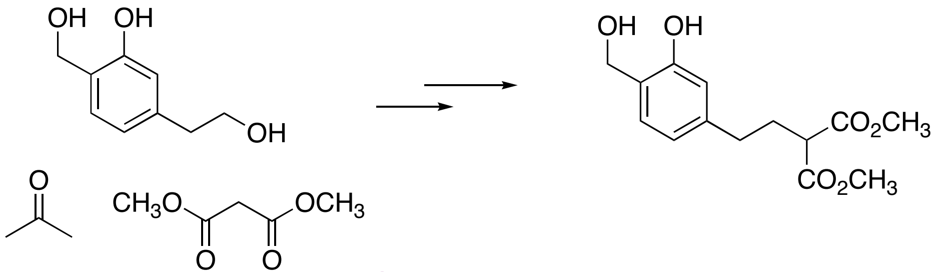
A)

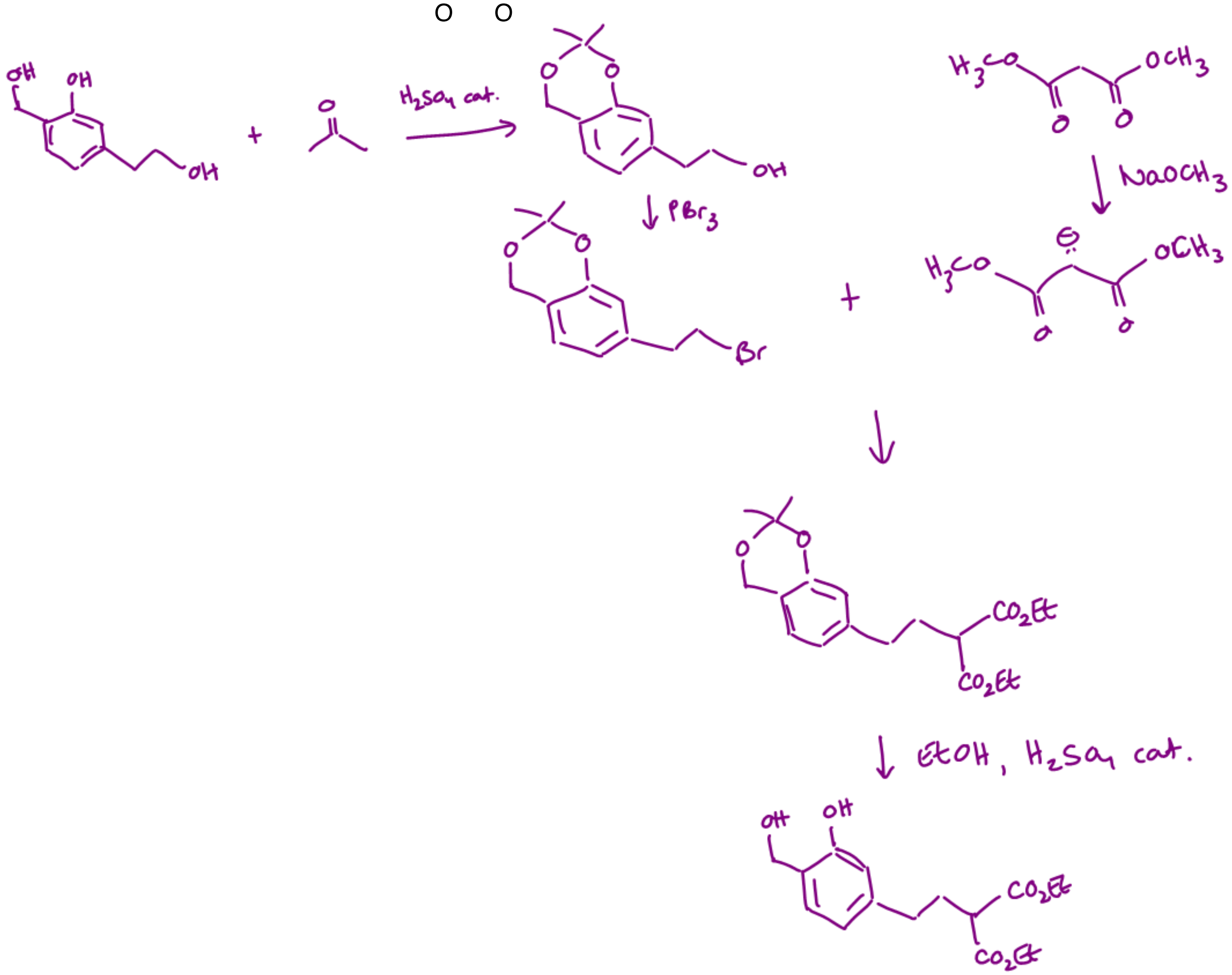


10) Draw the step-by-step mechanism for the following transformation. Include all electron movement arrows, relevant lone pairs of electrons, and intermediates. Non-zero formal charges must also be included.



11) Provide the reagents and write out the steps in the following multi-step synthesis using the starting materials shown. To obtain full marks, the structure of the major organic product expected after each step must be shown. You do not need to show mechanistic details of the reactions.





Note: In the last step, EtOH, H2SO4 cat. is an even better choice than H2O, H2SO4 because the esters will not be hydrolyzed. EtOH / H2SO4 will regenerate the diol. The carbonyl product would be in the form of  instead of .