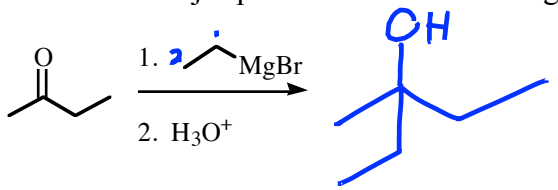
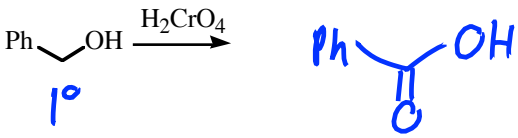
Practice Tests Answer Keys, Organic Chemistry 2

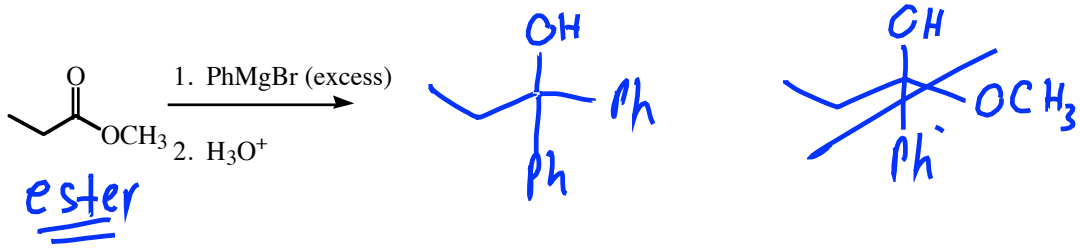
Online Organic Chemistry 2, Chem 360, Dr. Craig P. Jasperse, Minnesota State University Moorhead
For full class website, see
https://collaborate.mnstate.edu/public/blogs/jasperse/online-organic-chemistry-courses/online-organic-chemistry-ii-360-fall-spring/

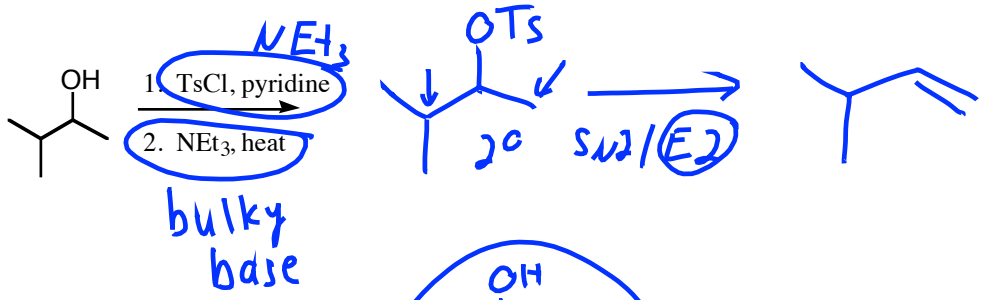
JASPERSE CHEM 360 TEST 1 VERSION 1
Alcohols and Retrosynthesis

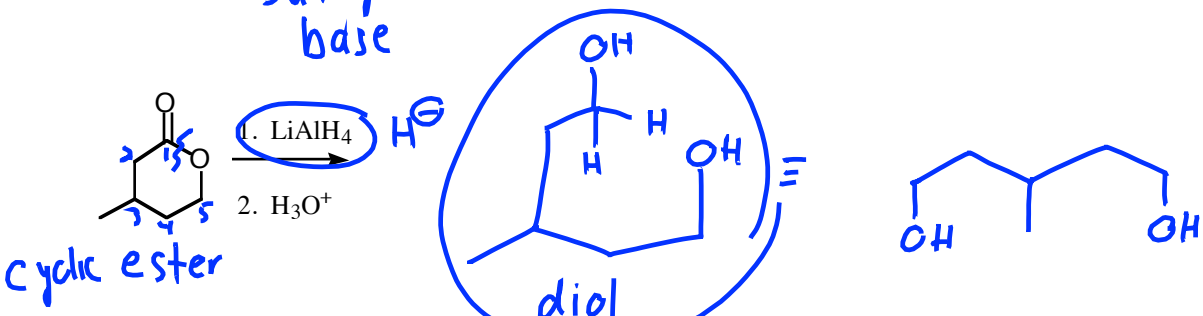
1. Give the major product for the following reactions. (3 points each)

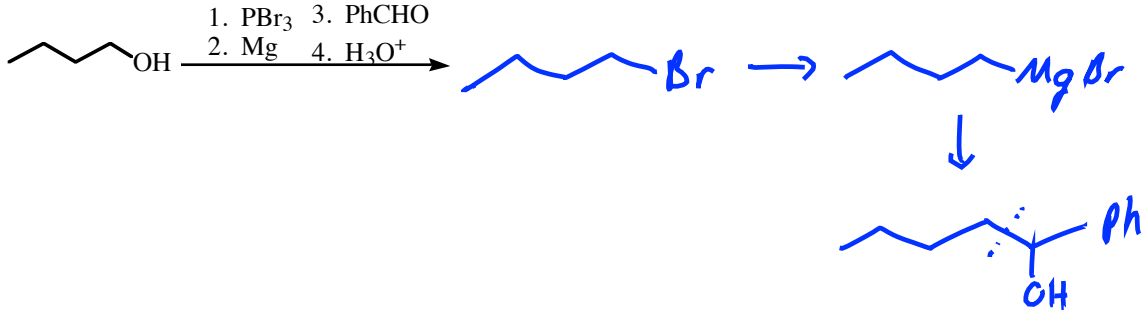






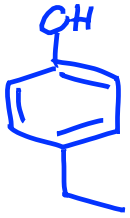


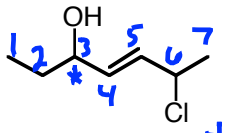




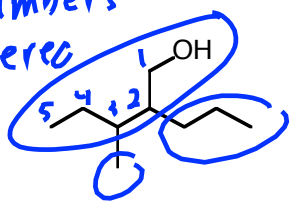
2. Give Names or structures for the following: (9 points)

para-ethylphenol



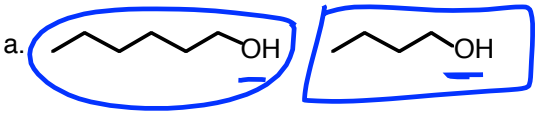


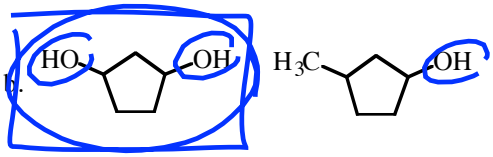
(E)-6-chlorohept-4-en-3-ol



3-methyl-3-propylpentan-1-ol

3. For each of the following pairs, circle the one that is higher boiling and put a square around the one with the higher water solubility. (4 points)

a. 



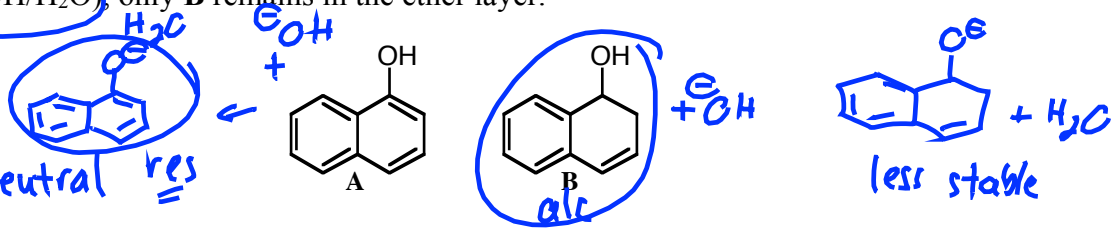
4. Which of the following statements is **true**? (4 points)

a. When an ether solution of **A** and **B** in a separatory funnel is treated with neutral water, only **B** remains in the ether layer.

b. When an ether solution of **A** and **B** in a separatory funnel is treated with neutral water, neither **A** nor **B** remains in the ether layer.

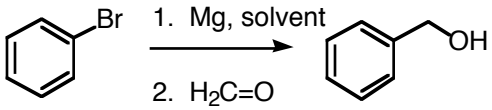
c. When an ether solution of **A** and **B** in a separatory funnel is treated with basic water ($NaOH/H_2O$), both **A** and **B** remain in the ether layer.

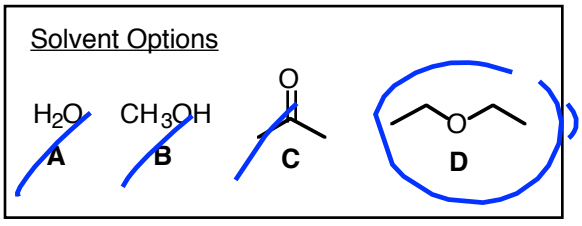
d. When an ether solution of **A** and **B** in a separatory funnel is treated with basic water ($NaOH/H_2O$), only **B** remains in the ether layer.



5. For the following transformation, which of the following statements is true? (4 points)

a. **D** is the only acceptable solvent
b. **C** is the only acceptable solvent
c. **C** and **D** are both acceptable solvents
d. **B**, **C**, and **D** are all acceptable solvents
e. **A** and **B** are the only acceptable solvents





6. Suggest a possible structure for an unknown **A** whose formula is $C_5H_{10}O$ and gives the following chemical test results. (5 points)

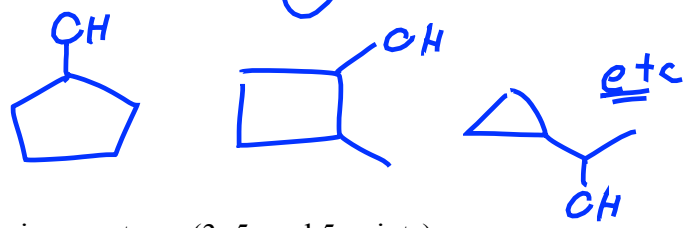
Formula	$C_5H_{10}O$	
Hydrogenation Test	H_2/Pt	No reaction
Chromic Acid Test	H_2CrO_4	Turns Green
Lucas Test	$HCl/ZnCl_2$	Reacts within 5 minutes

EU = 1

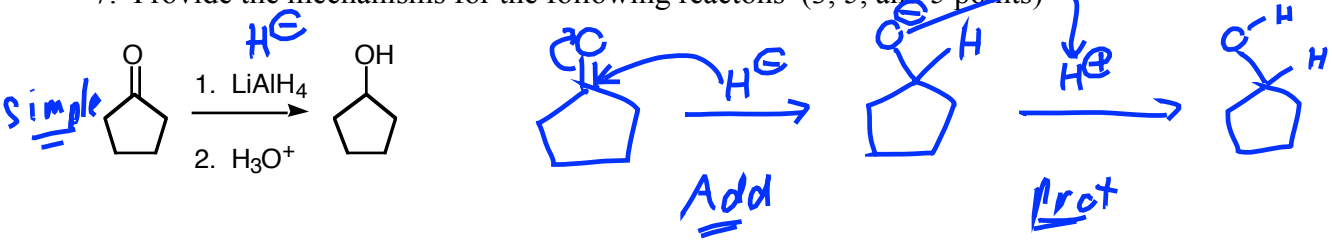
12 − 10 = 2H ÷ 2 = 1 EU

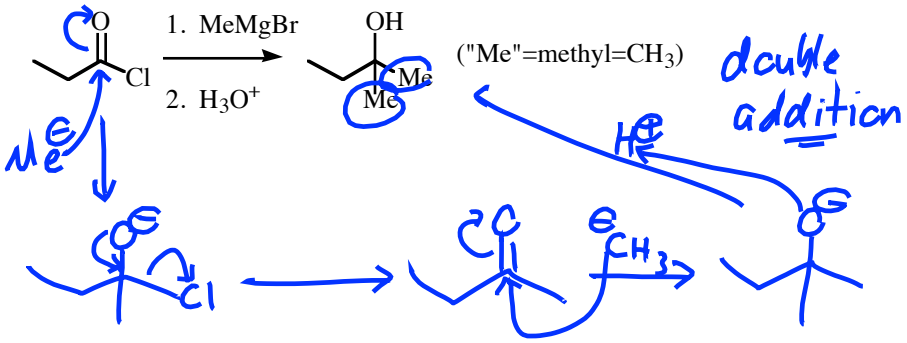
1° or 2° or 2° or 3°

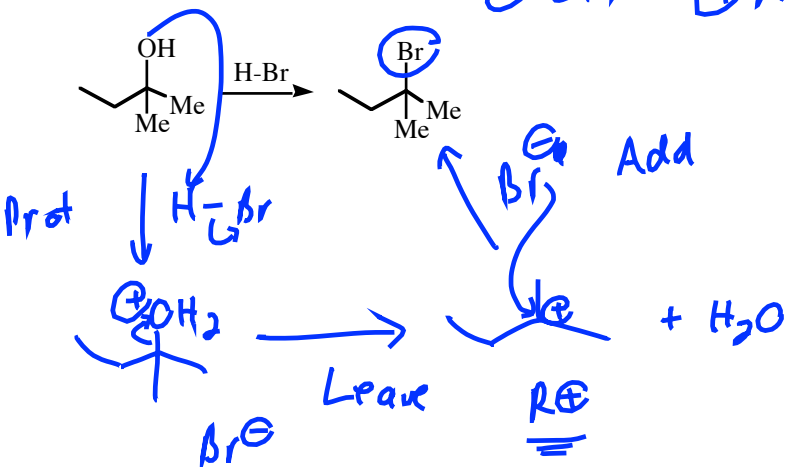
2° alc 1 ring 1 EU not C=C C=O



7. Provide the mechanisms for the following reactons (3, 5, and 5 points)

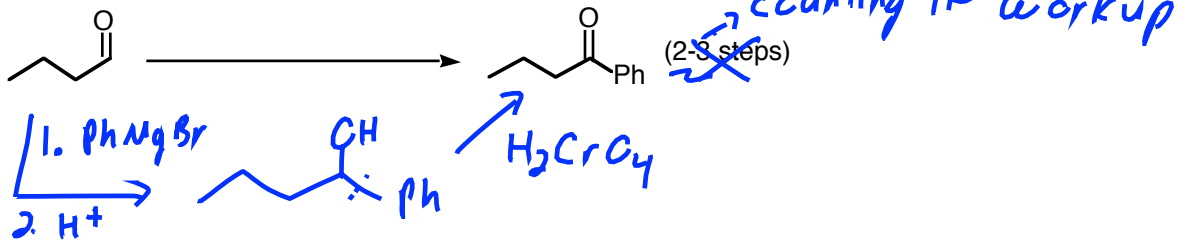


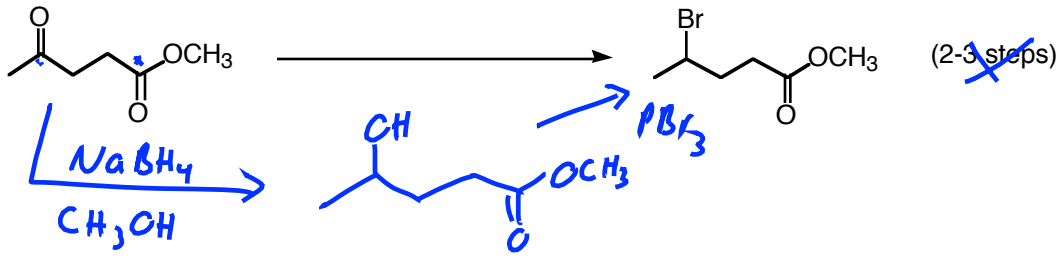


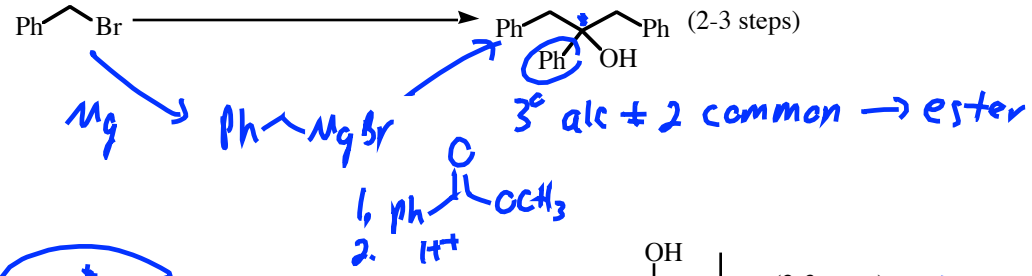


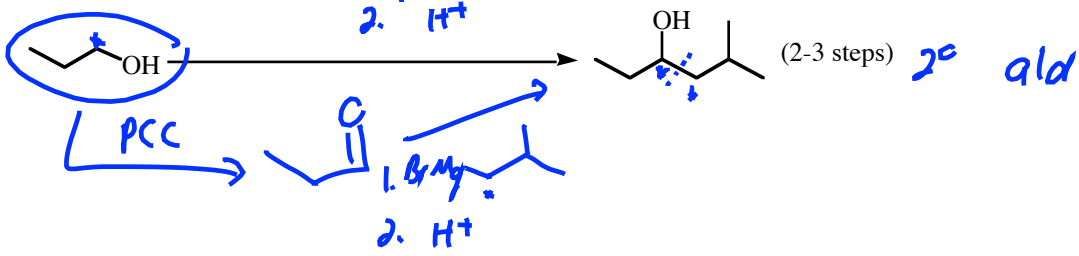
1. Draw all intermediates
2. Draw all formal charges
3. Draw all arrows
4. No backwards arrows

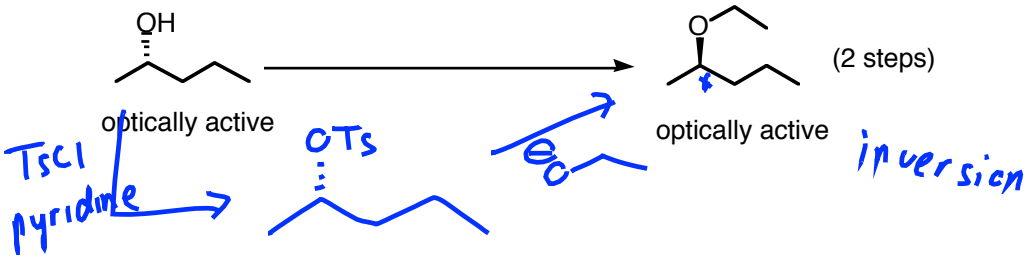
8. Provide the reagents necessary to accomplish the following transformations (4 points each)

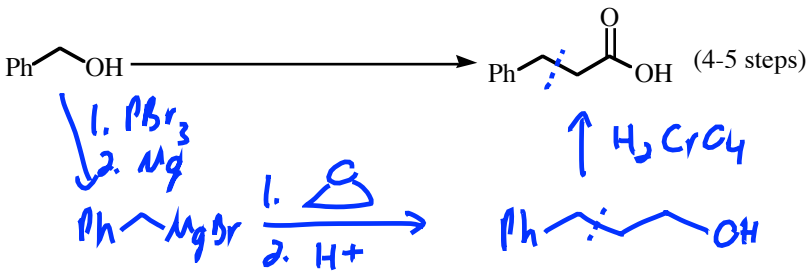




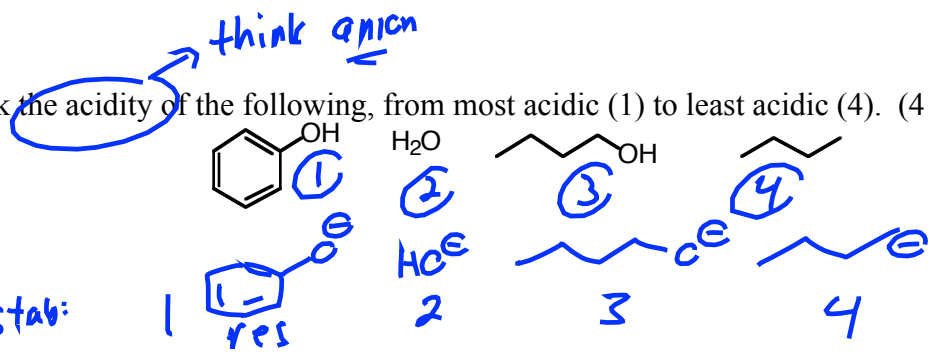




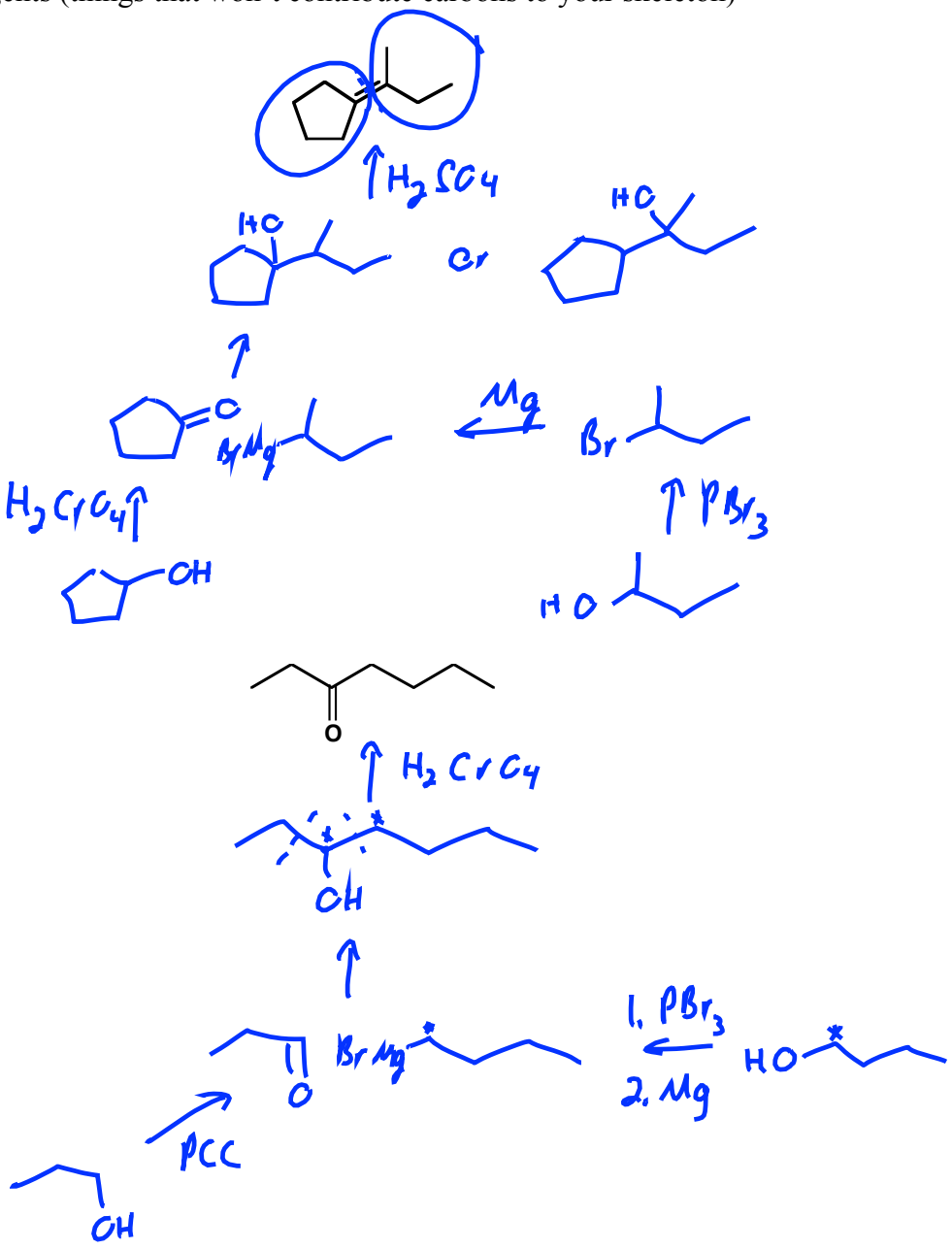




9. Rank the acidity of the following, from most acidic (1) to least acidic (4). (4 points)



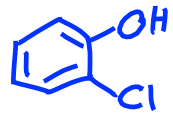
10. Design syntheses of the following. (6 points each). Allowed starting materials (same as practice) include:
cyclopentanol any esters ethylene oxide formaldehyde iodomethane
any acyclic alcohol or alkene wth ≤4 carbons
any "inorganic" agents (things that won't contribute carbons to your skeleton)

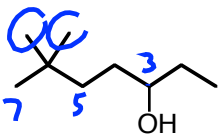


JASPERSE CHEM 360 TEST 1 VERSION 2
Alcohols and Retrosynthesis

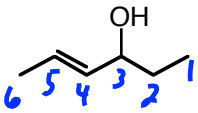
1. Give Names or structures for the following: (9 points)

ortho-chlorophenol



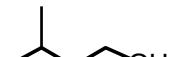


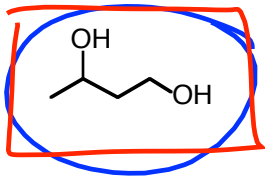
6,6-dimethylheptan-3-ol



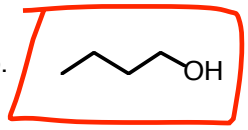
E- hex-4-en-3-ol
trans-

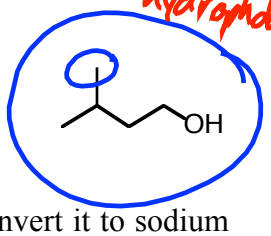
2. For each of the following pairs, circle the one that is higher boiling and put a square around the one with the higher water solubility. (4 points)

a. 



more H-bond

b. 



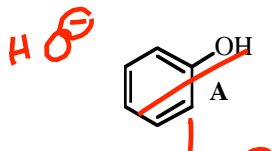
London
hydrophobic

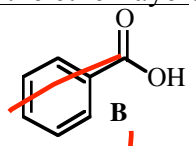
3. Of the listed four chemicals, circle those which would ionize methanol (convert it to sodium or magnesium methoxide)? (4 points)

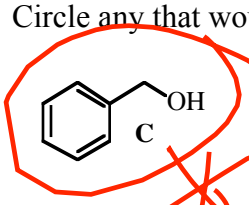
$CH_3OH \rightarrow CH_3O^-$

Na $NaNH_2$ ~~$NaOH$~~ CH_3MgBr

4. If an ether solution of the following three compounds was washed with $NaOH/H_2O$, which (if any) of the compounds would remain in the ether layer? Circle any that would. (3 points)







HO^-

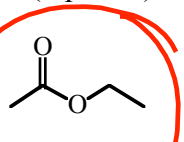
ionized ⇒ water

res res

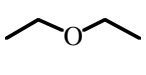
neutral ⇒ ether

no res less stable

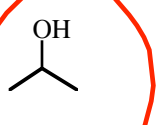
5. Of the following common solvents, circle those that are unsuitable as solvents for the preparation and reactions of Grignard reagents (assuming you want the Grignard reagent to react with something else). (3 points)



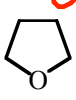
ethyl acetate



diethyl ether



isopropanol



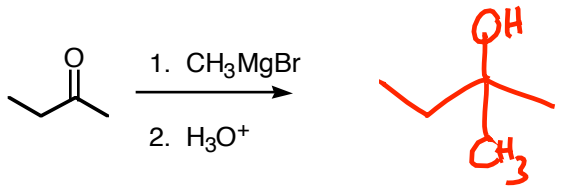
tetrahydrofuran

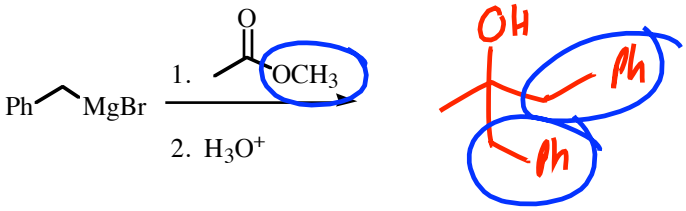
OK OK

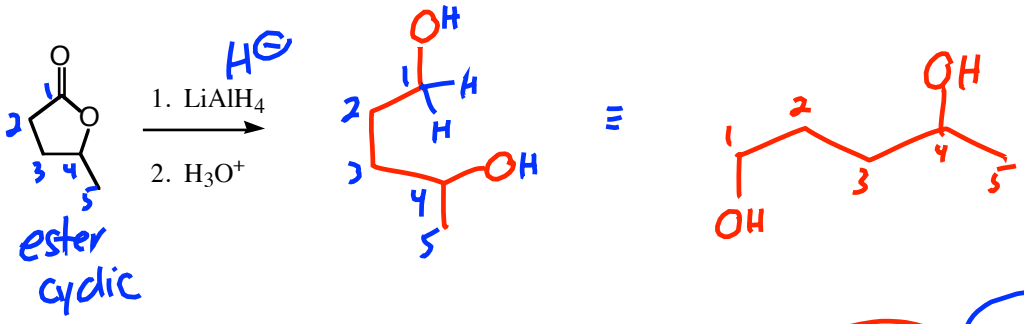
C=O

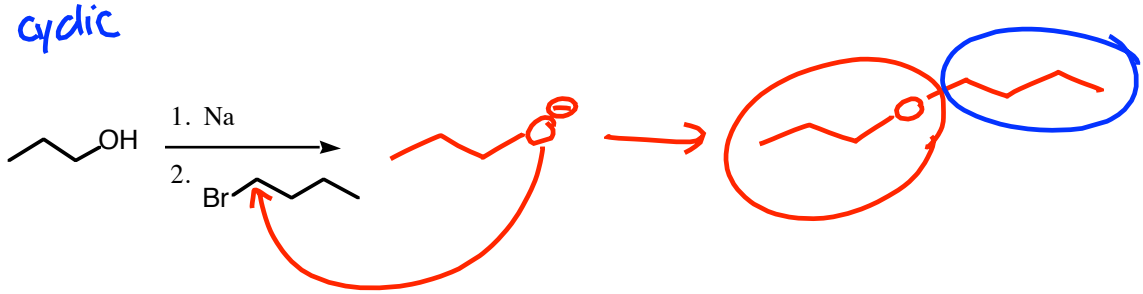
OH NH

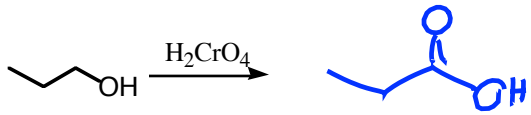
6. Give the major product of the following reactions. (3 points each)

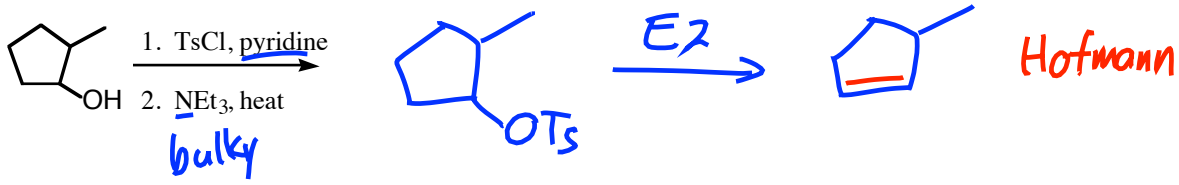


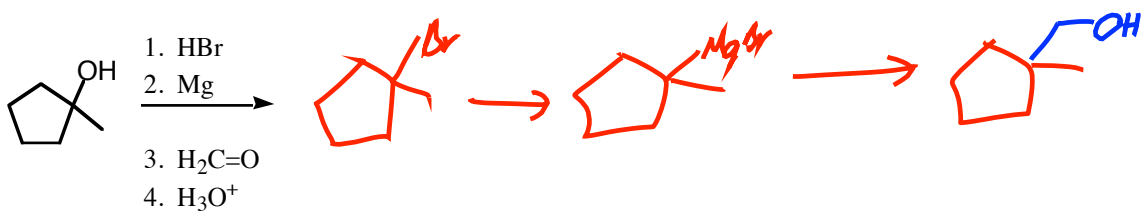




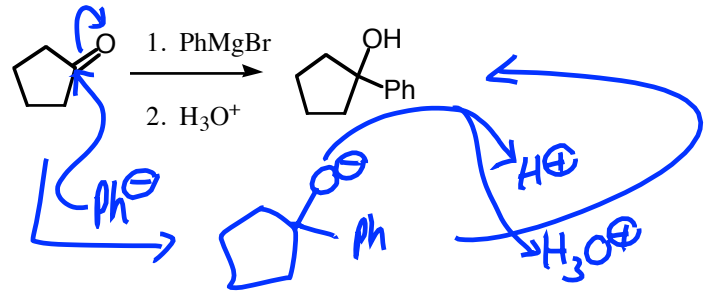


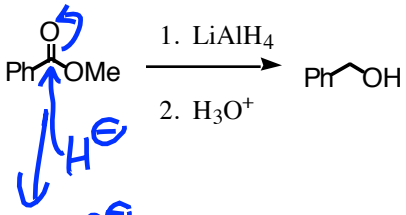


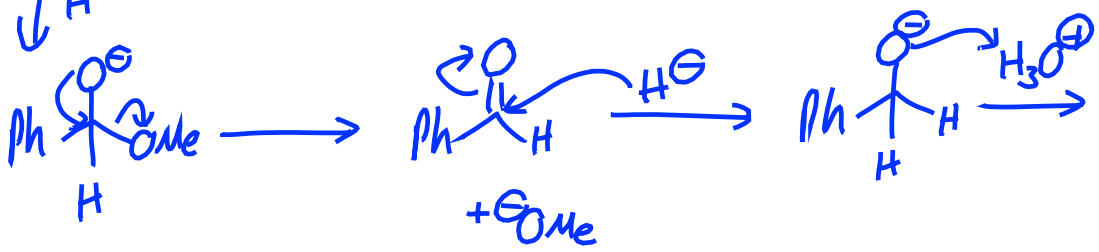


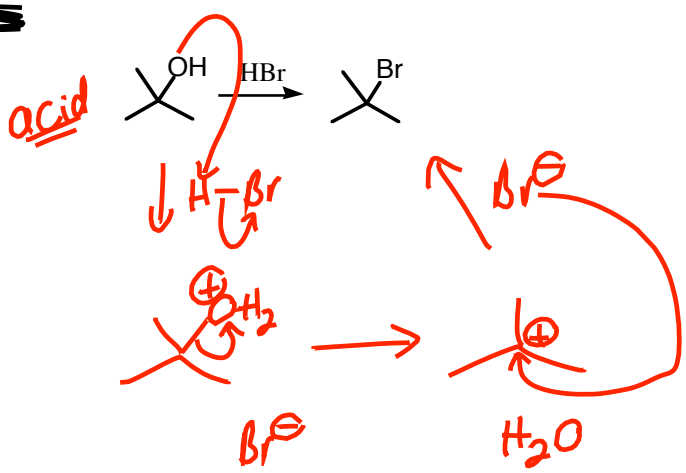


7. Draw mechanisms for the following reactions. (3, 5, and 5 points)





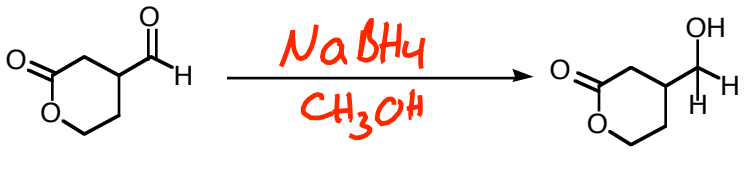




8. Suggest a possible structure for an unknown **A** whose formula is $C_6H_{12}O$, and gives the following chemical test results: (Double check that your answer is consistent with all the data) 5 pt

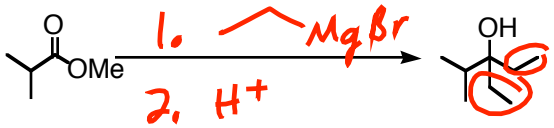
Formula:	$C_6H_{12}O$	
Hydrogenation Test	H_2/Pt	No reaction
Chromic Acid Test	H_2CrO_4	Turns green
Lucas Test	$HCl/ZnCl_2$	No reaction

9. Provide reagents for the following transformations. ("workup" means H_3O^+ or H_2O steps)
(First two are 3 points each; last four are 5 points each)

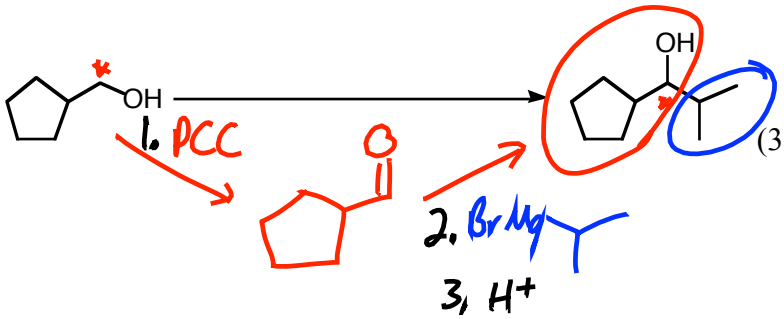


(1 step)

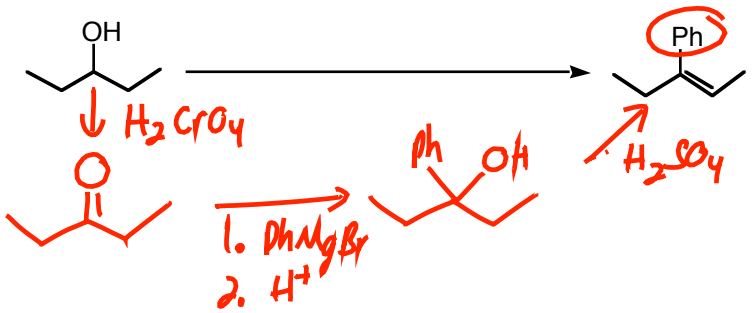
reduction
selective



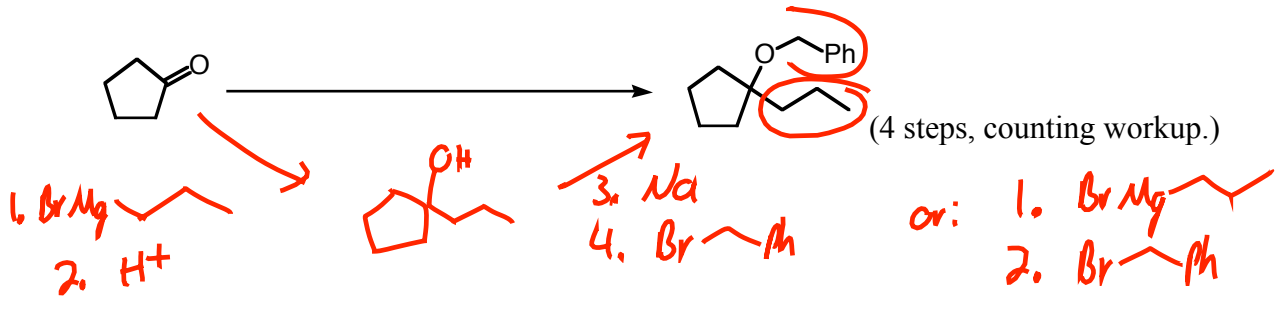
(2 steps, counting workup)



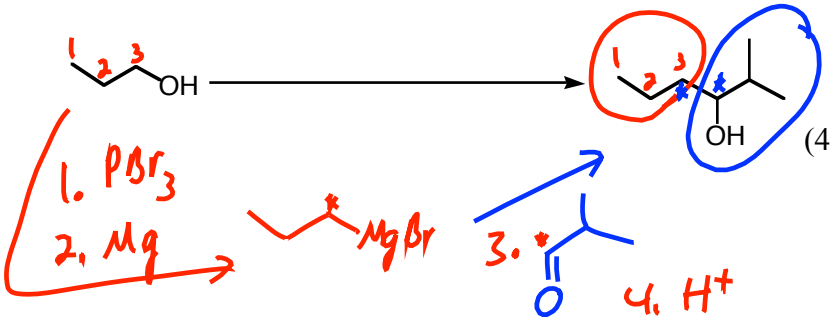
(3 steps, counting workup)



(4 steps, counting workup)

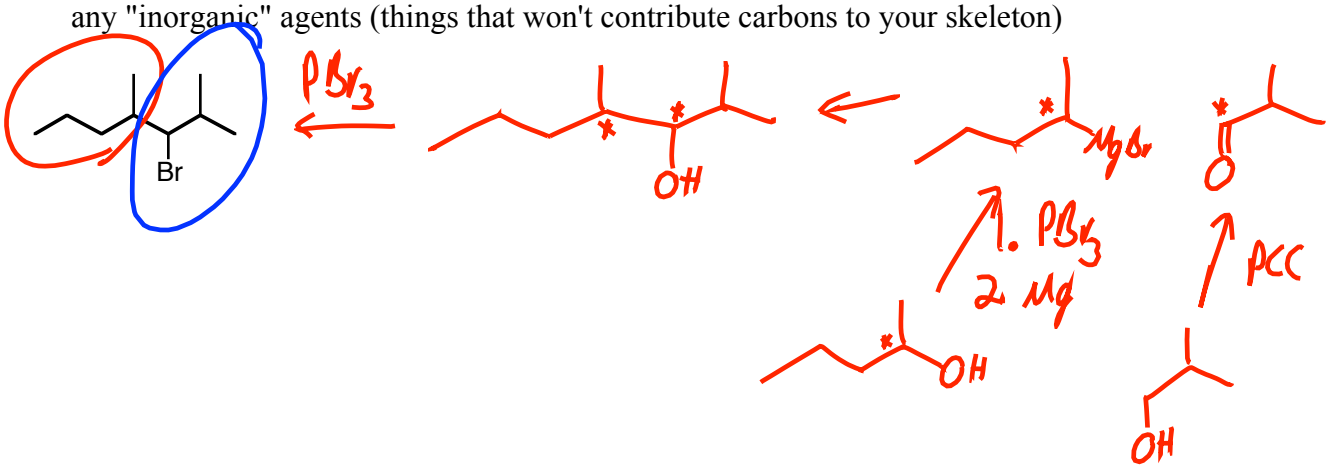


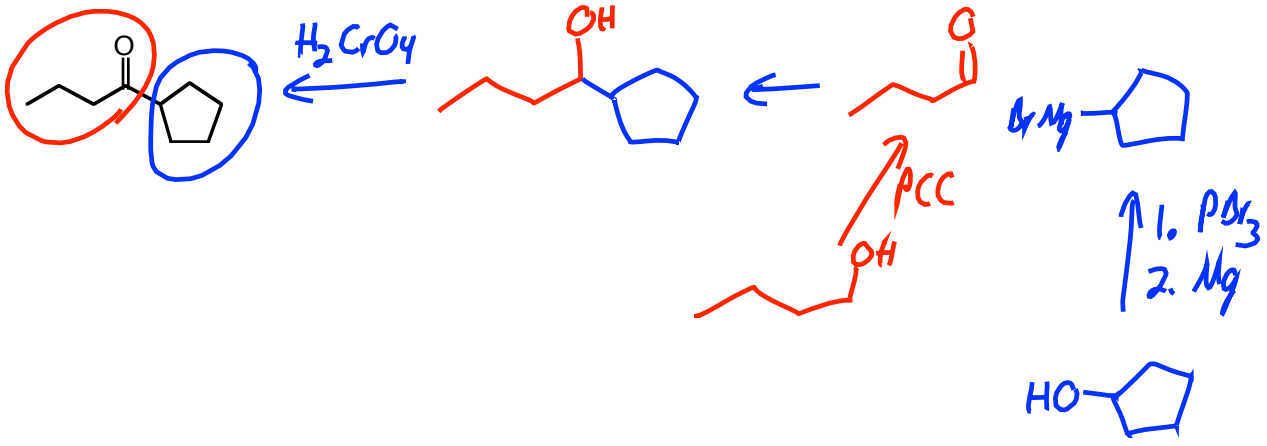
(4 steps, counting workup.)



(4 steps, counting workup)

10. Design syntheses for the following. Allowed starting materials (same as practice) include: 6 points each
bromobenzene
cyclopentanol
any acyclic alcohol or alkene with ~~≤4~~ 5 carbons
any esters
ethylene oxide
formaldehyde (CH_2O)
iodomethane
any "inorganic" agents (things that won't contribute carbons to your skeleton)

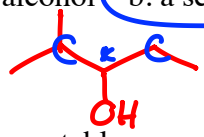




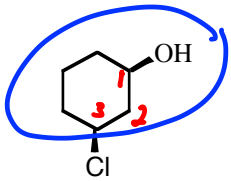
JASPERSE CHEM 360 TEST 1 VERSION 3
Reactions involving Alcohols

1. 2-Methylpentan-3-ol is classified as: (3 points)

a. a primary alcohol b. a secondary alcohol c. a tertiary alcohol d. none of the above

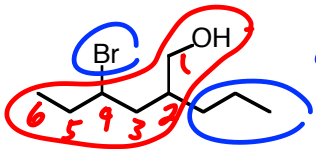


2. Provide acceptable names for the following: (10 points total)

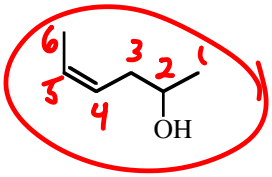


cis-3-chlorocyclohexanol

racemic

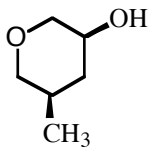


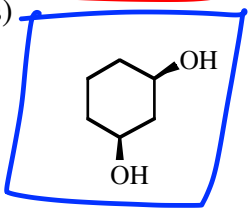
4-bromo-2-propylhexan-1-ol

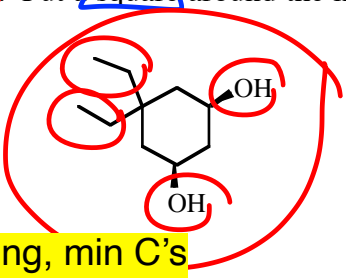


2-hex-4-en-2-ol
cis-

3. Circle the molecule with the highest boiling point. Put a square around the molecule with the highest water solubility. (4 points)



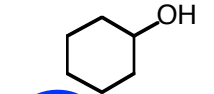




Extra C's raises bp

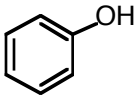
Max H-bonding, min C's ideal for water.

4. Rank the acidity of the following molecules, from 1 (strongest) to 4 (weakest). Explain very briefly why **A** and **B** have very different acidities.



A

H_2O



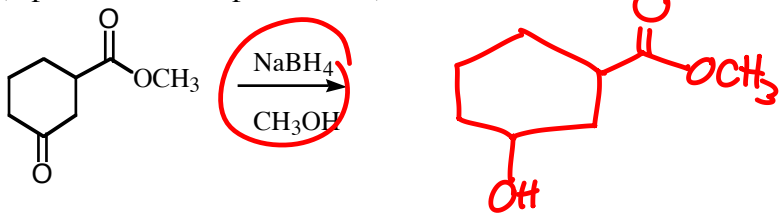
B

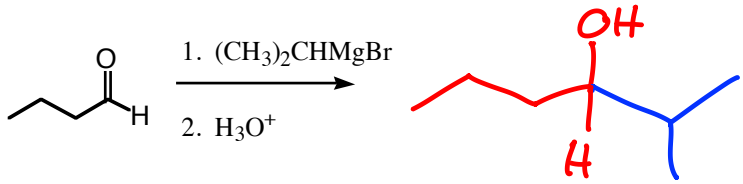
CH_4

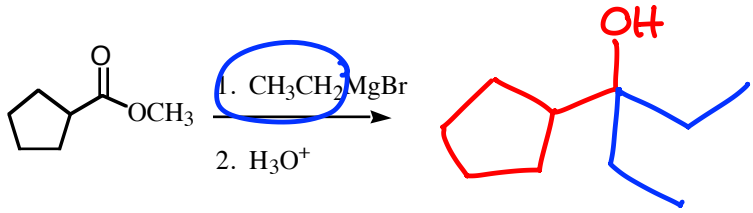
Alcohol less acidic than water due to electron-donating effect of the alkyl group

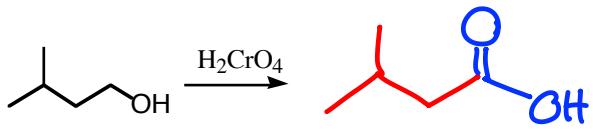
Phenols or acids are more acidic than water due to resonance stabilization

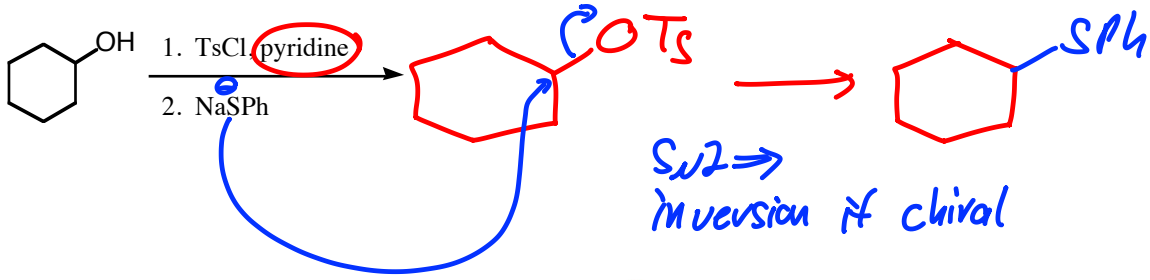
5. Draw the major products for the following reactions. (Assume excess quantities of reagents.) (3 points each, 21 points total)

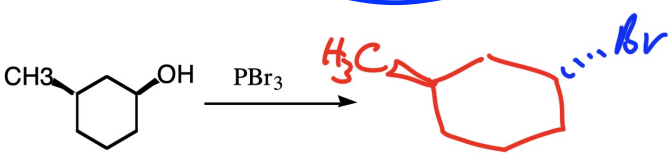


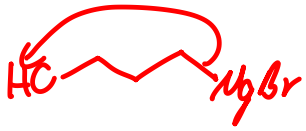




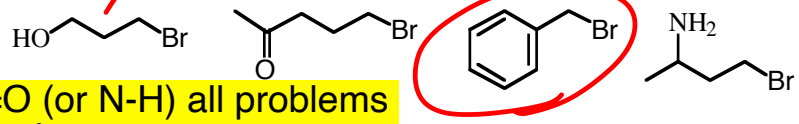






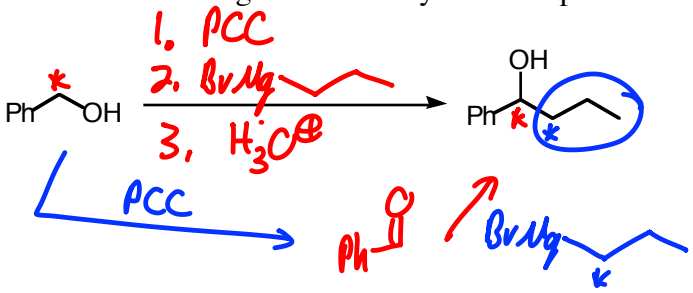


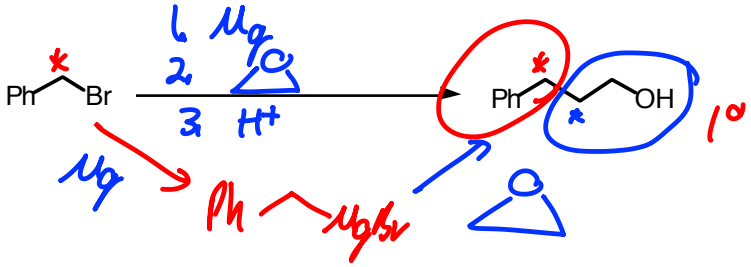
6. Which of the following would be suitable to use when forming a Grignard reagent? (3 points)

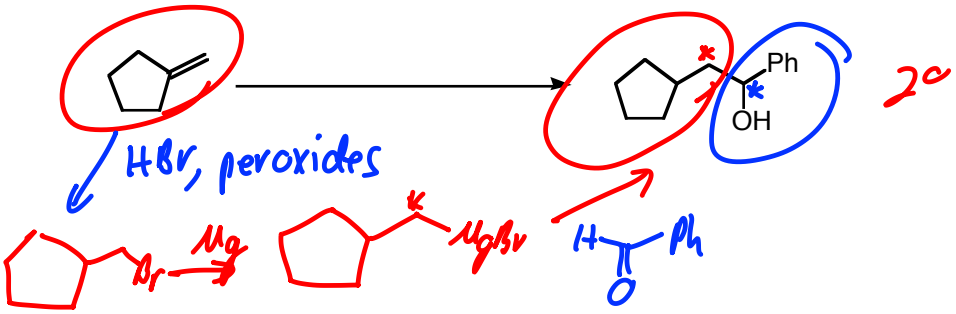


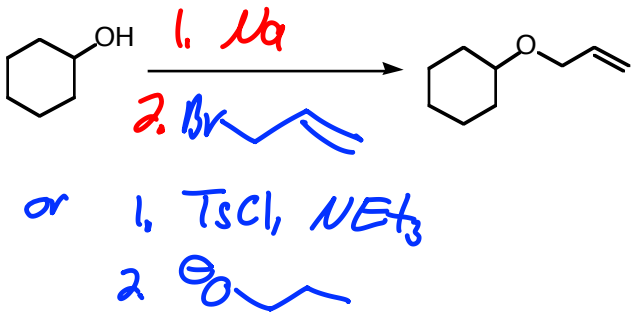
OH or C=O (or N-H) all problems for Grignard reagents.

7. Provide the reagents necessary to accomplish the following transformations (5 each, 20 total)

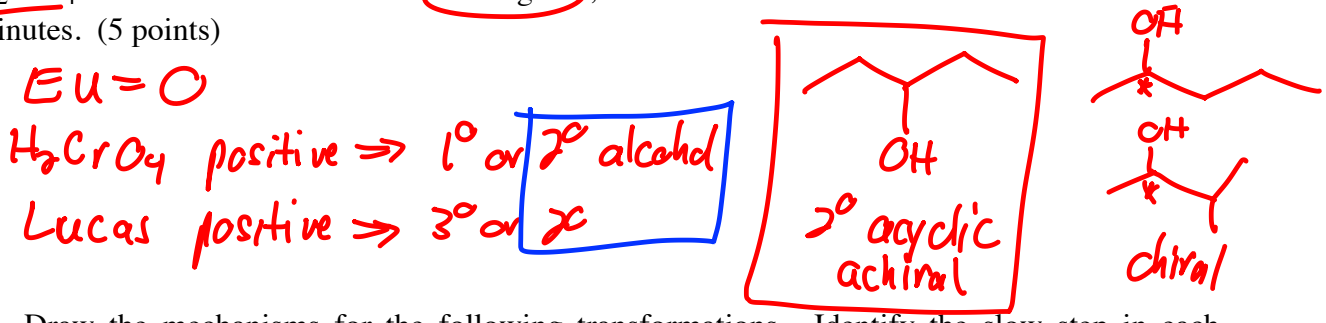




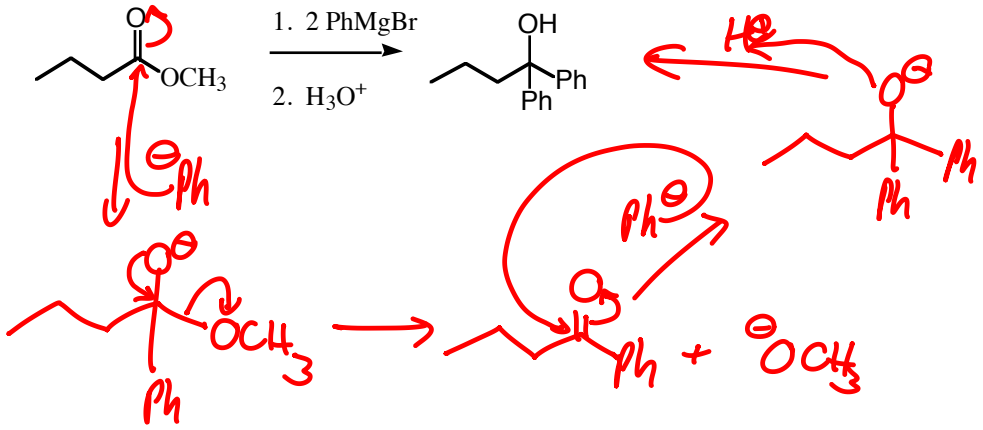


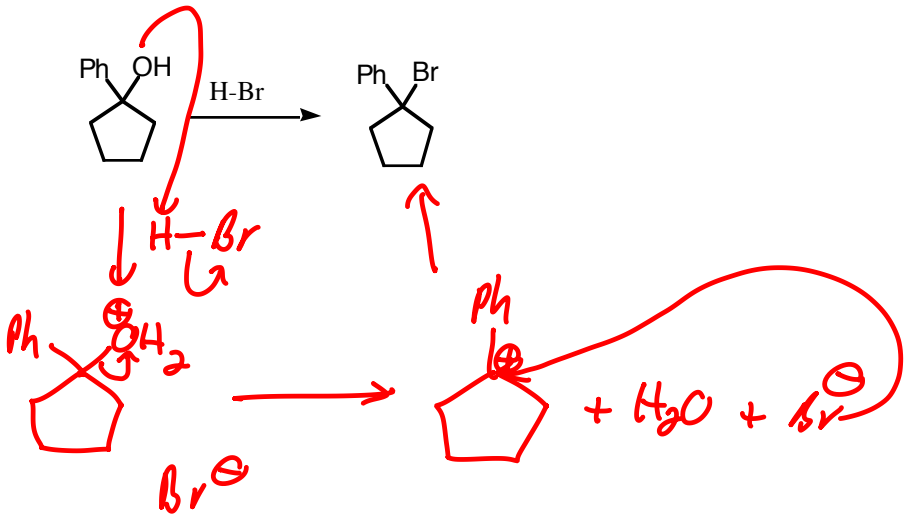


8. Draw a possible structure for an achiral molecule **A** with formula $C_5H_{12}O$, given that when H_2CrO_4 is added to **A** the solution turns green, and that the Lucas test with **A** takes about 3-4 minutes. (5 points)

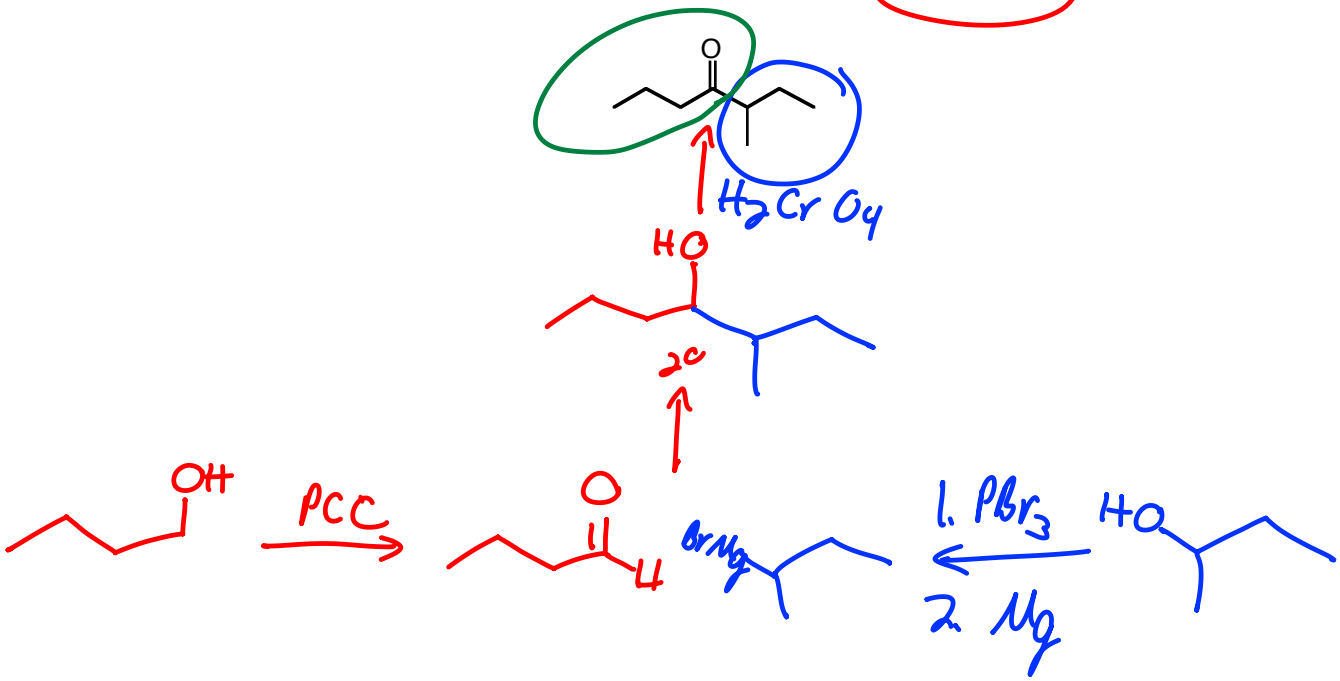


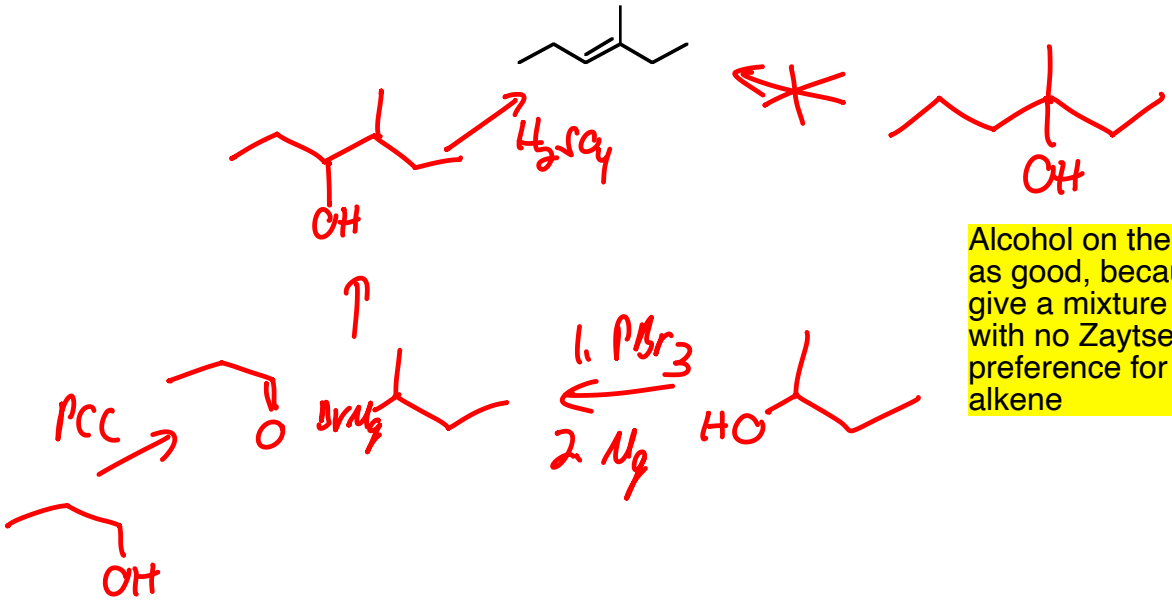
9. Draw the mechanisms for the following transformations. Identify the slow step in each mechanism. (6 points each)





10. Design syntheses of the following, starting from alcohols of ≤4 carbons. (7 points each)



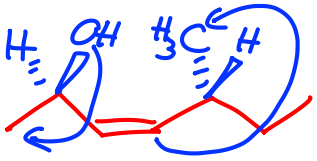


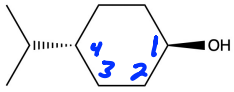
Alcohol on the right is not as good, because it would give a mixture of alkenes, with no Zaytsev preference for the desired alkene

JASPERSE CHEM 360 TEST 1 VERSION 4
Reactions Involving Alcohols

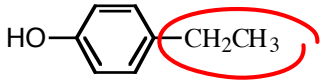
1. Provide Names or Structures for the Following. (10 points total)

a. (2R,5R)-(Z)-5-methylhept-3-en-2-ol



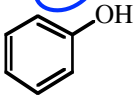
b. 

trans-4-isopropyl cyclohexanol

c. 

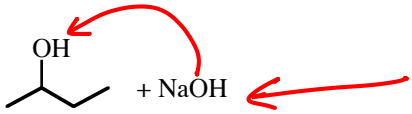
4-ethylphenol
para-

2. Rank the acidity of the following molecules, 1 being most and 4 being least acidic. (3 points)

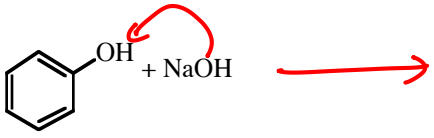
4 CH_3NH_2 1 

3 $(CH_3)_2CHOH$ 2 H_2O

3. Complete the following acid-base reactions, and indicate whether the equilibrium favors the reactants or the products. (3 points each)

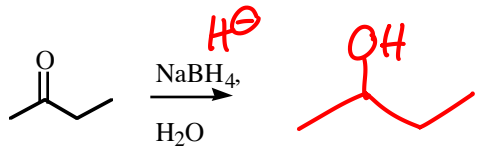
a. 

more stable

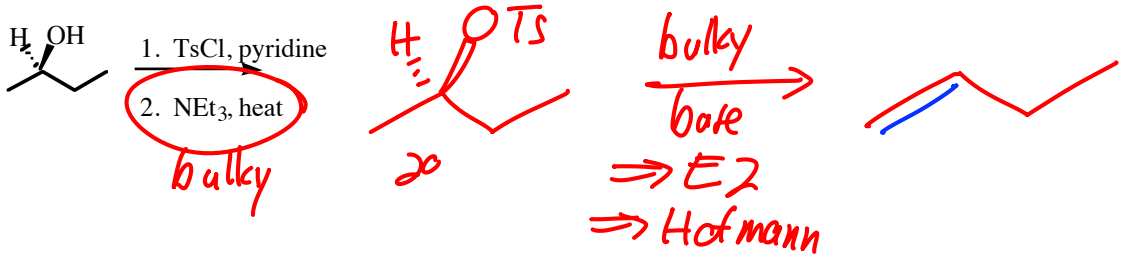
b. 

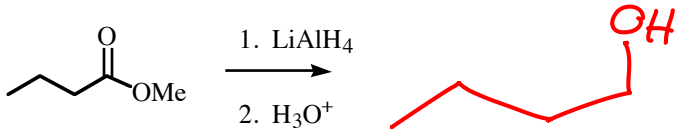
Resonance Stabilized

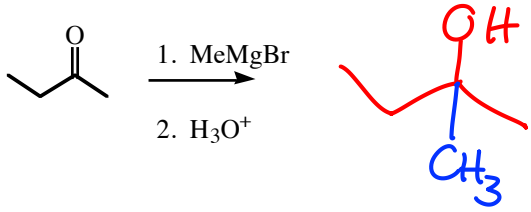
4. Draw the products of the following reactions. (3 points each)

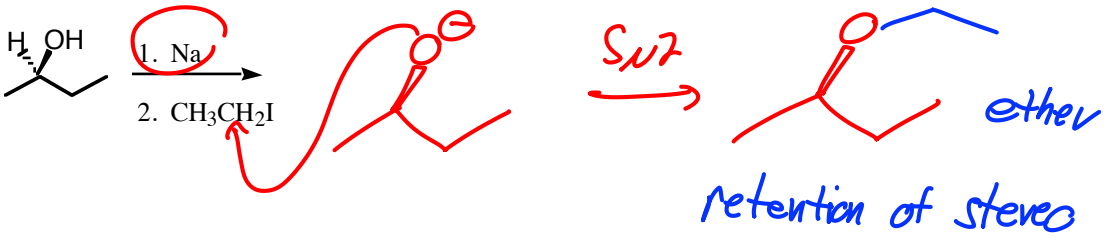
a. 

b. 

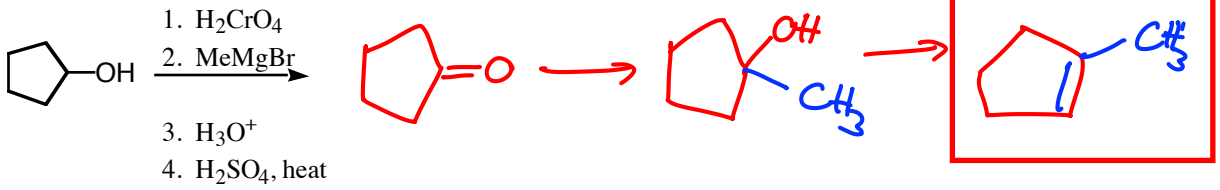
c. 

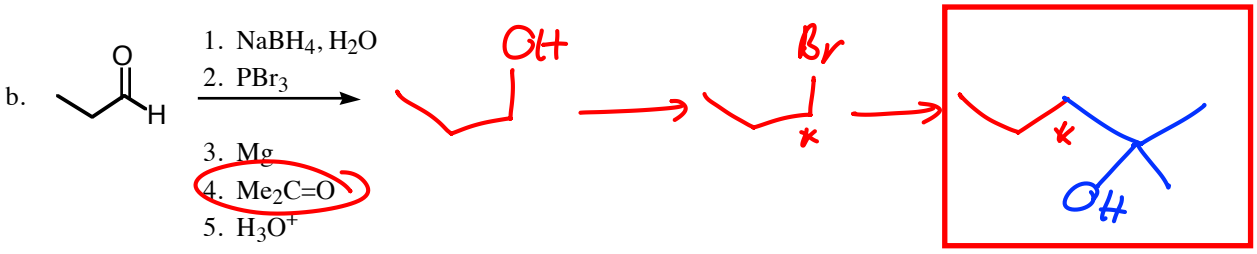
d. 

e. 

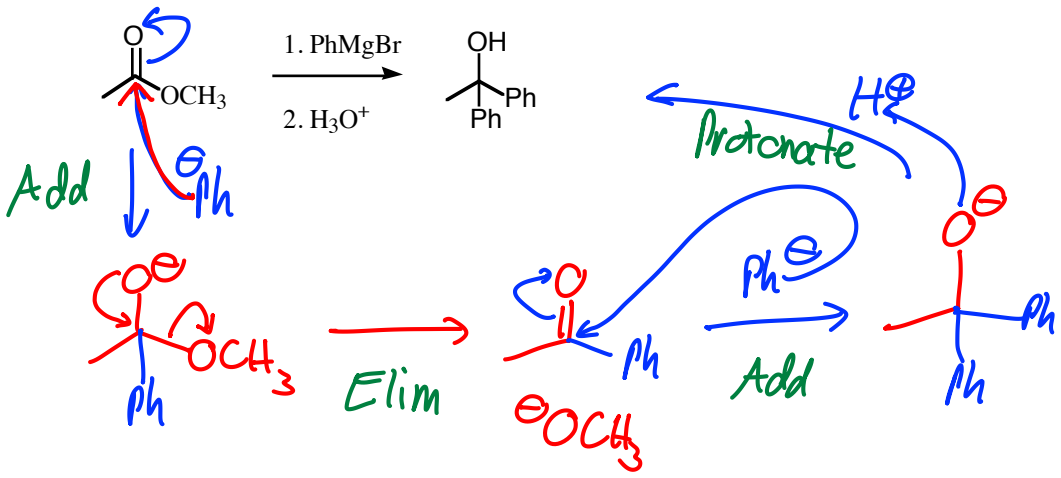
f. 

5. Draw the products for the following multistep syntheses. (5 points each)

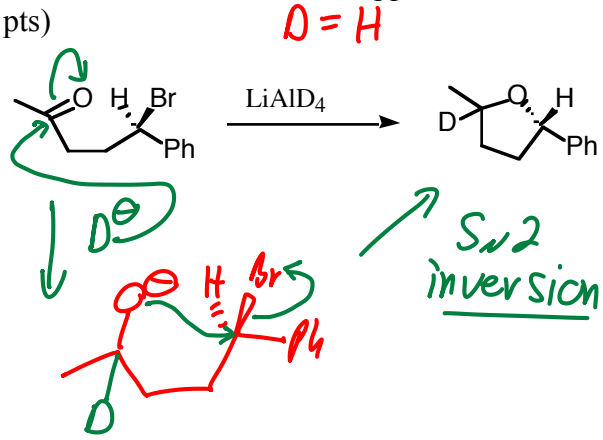
a. 

b. 

6. Draw the mechanism for the following reaction. (6 points)



7. Draw the mechanism for the following reaction. Note: This is a slight twist on familiar stuff. The overall transformation appears unfamiliar, but the individual steps are actually familiar. (6 pts)



8. Suggest a structure for a compound "A" whose formula is $C_5H_{12}O$, that reacts instantly with the Lucas reagent ($ZnCl_2$/HCl), but does not cause an orange to green color change upon mixing with chromic acid. (4 points)

Lucas: 3° or 2° alcohol

H_2CrO_4: ~~1° or 2° alcohol~~

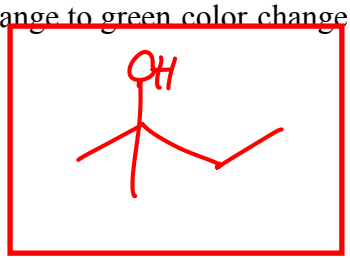
3° alcohol

EU=0

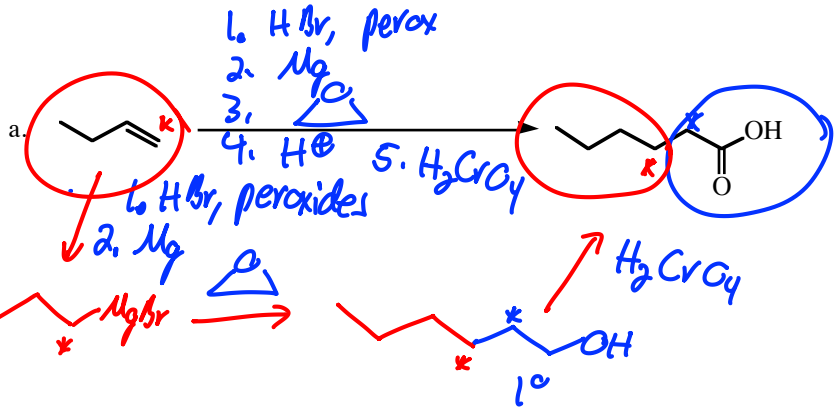
acyclic

no alkene

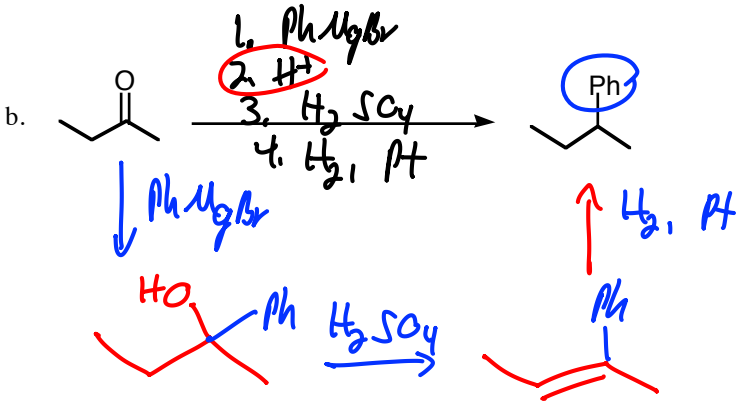
3° alcohol



9. Provide reagents for the following transformations. For this problem, you may use absolutely any reactant you please, including carbonyl compounds or organometallics (so long as it does not include more than one functional group). I have indicated the number of steps I envision, to give you an idea if your route is longer or shorter than necessary. (You may design alternate routes longer, or perhaps even shorter, than the ones I have in mind.) (6 points each)

a. 

(5 steps, counting H_3O^+)

b. 

(4 steps, counting H_3O^+)

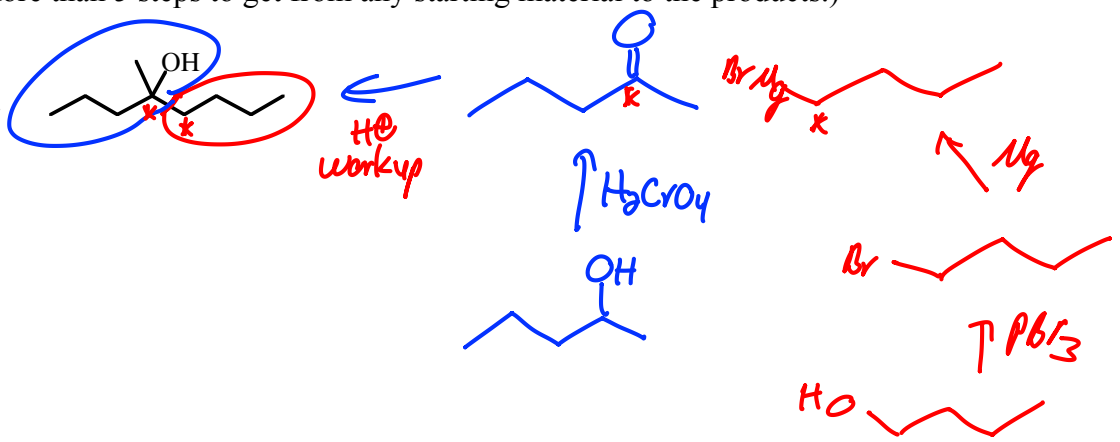
c. 

(4 steps, counting H_3O^+)

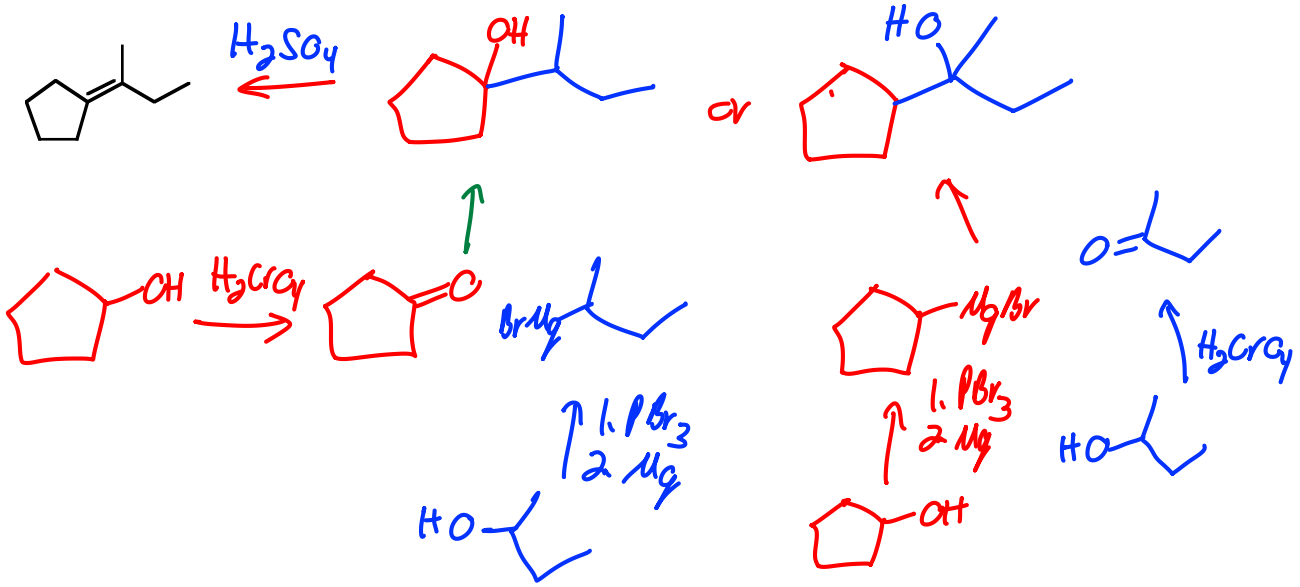
cyclopentanol

10. Provide a synthesis for the following molecules. Permissible starting materials include cyclopentanol, acyclic alcohols or alkenes of ≤5 carbons, formaldehyde, ethylene oxide, esters, and any other support reagents you like. (7 points each) (In none of these examples should it take more than 5 steps to get from any starting material to the products.)

a.



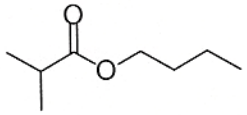
b.



JASPERSE CHEM 360 TEST 2 VERSION 1

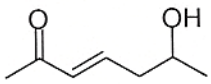
Ch. 12-13 NMR, IR

1. Predict the ^{1}H NMR spectrum. Include the approximate chemical shifts (1's, 2's, etc.), the integration, and the splitting (can use "s" for singlet; "d" for doublet; "t" for triplet' "q" for quartet; and "m" for multiplet, anything more complex than a quartet). Note: for signals that are symmetry equivalent, do not list them twice.



1's 6H d
2's 1H m (septet)
3's 2H t
1's 2H pentet
1's 2H sextet
1's 3H t

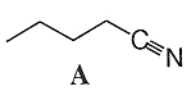
2. Predict the ^{13}C NMR spectrum. Include the approximate chemical shifts (220-160, 160-100, 100-50, or 50-0) and the splitting if a couple carbon was taken (q, t, d, s).



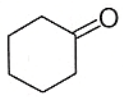
50-0 q
220-160 s
160-100 d
160-100 d
50-0 t
100-50 d
50-0 q

3. Match the following structures with the listed feature IR signals:

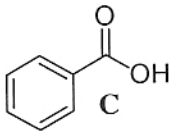
1) 3300-3200 (D) 2) 3300-2500, 1680 (C) 3) 2200 (A) 4) 1720 (B)



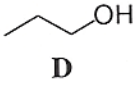
A



B



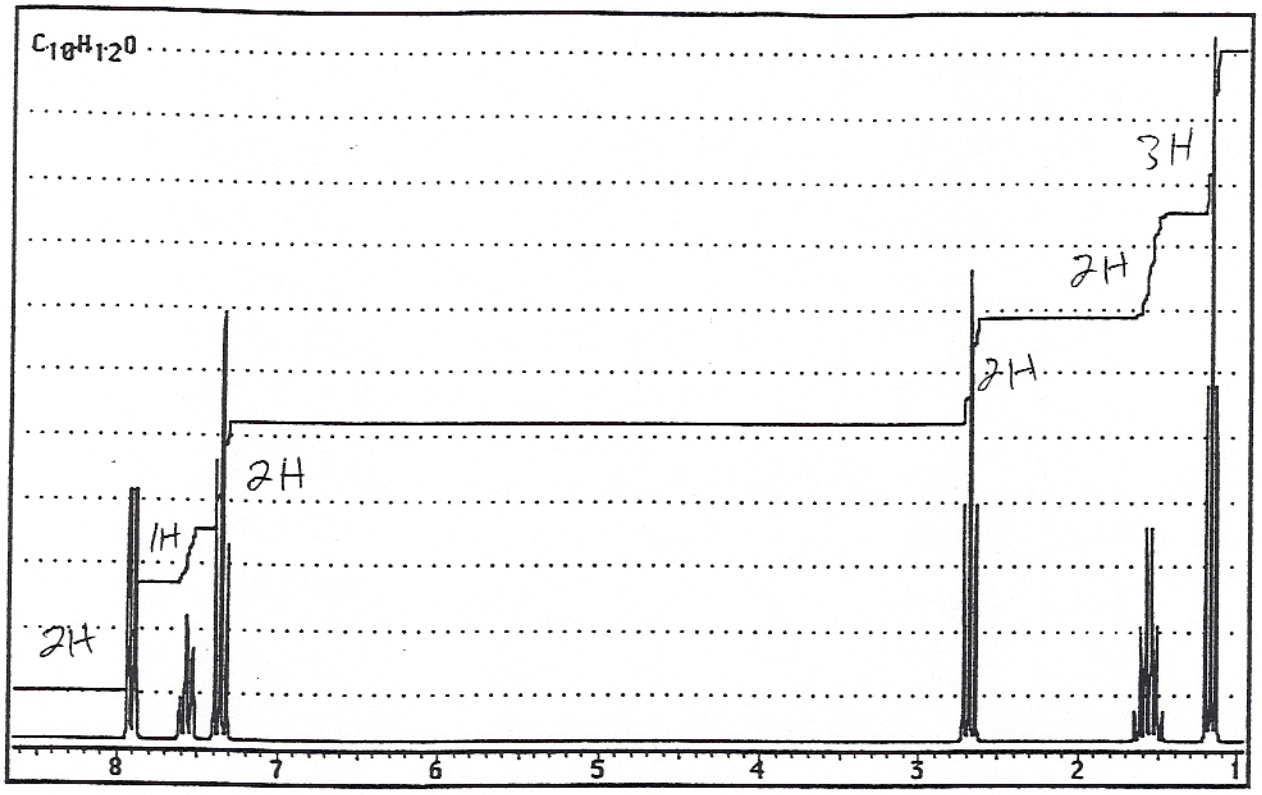
C



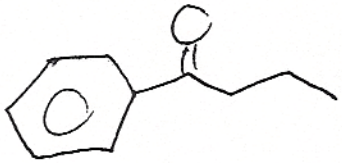
D

Solve the structures for the following. If you get a structure perfect, you will get full credit. If you do not get a structure perfect, you may still get some partial credit. Thus, it is in your interest to show some of your work, make a structure guess, or tell me what you do know for sure.

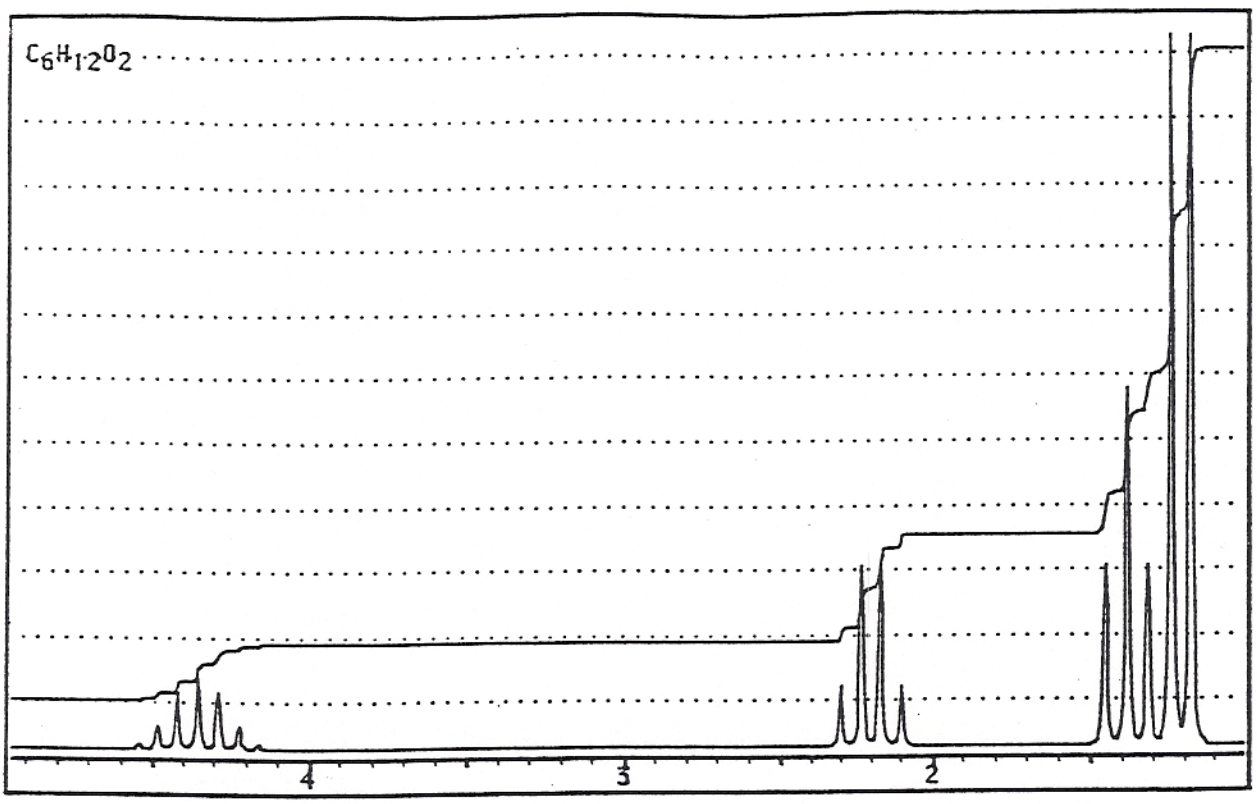
4. $C_{10}H_{12}O$ IR: 1670
^{13}C NMR: 210 (s, short), 150 (s, short), 130 (d, tall) 124 (d, tall), 120 (d), 33 (t), 26 (t), 20 (q)



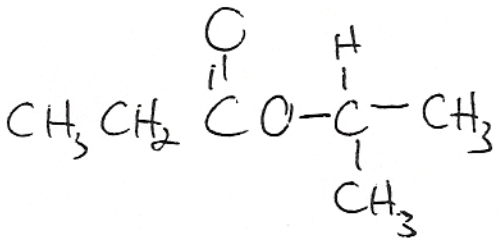
EU = 5 ⇒ aromatic + C=O
C=O conjugated (IR)



5. $C_6H_{12}O_2$ IR: 1750
^{13}C NMR: 180 (s, short), 70 (d), 36 (t), 30 (q), 20 (q, extra tall)

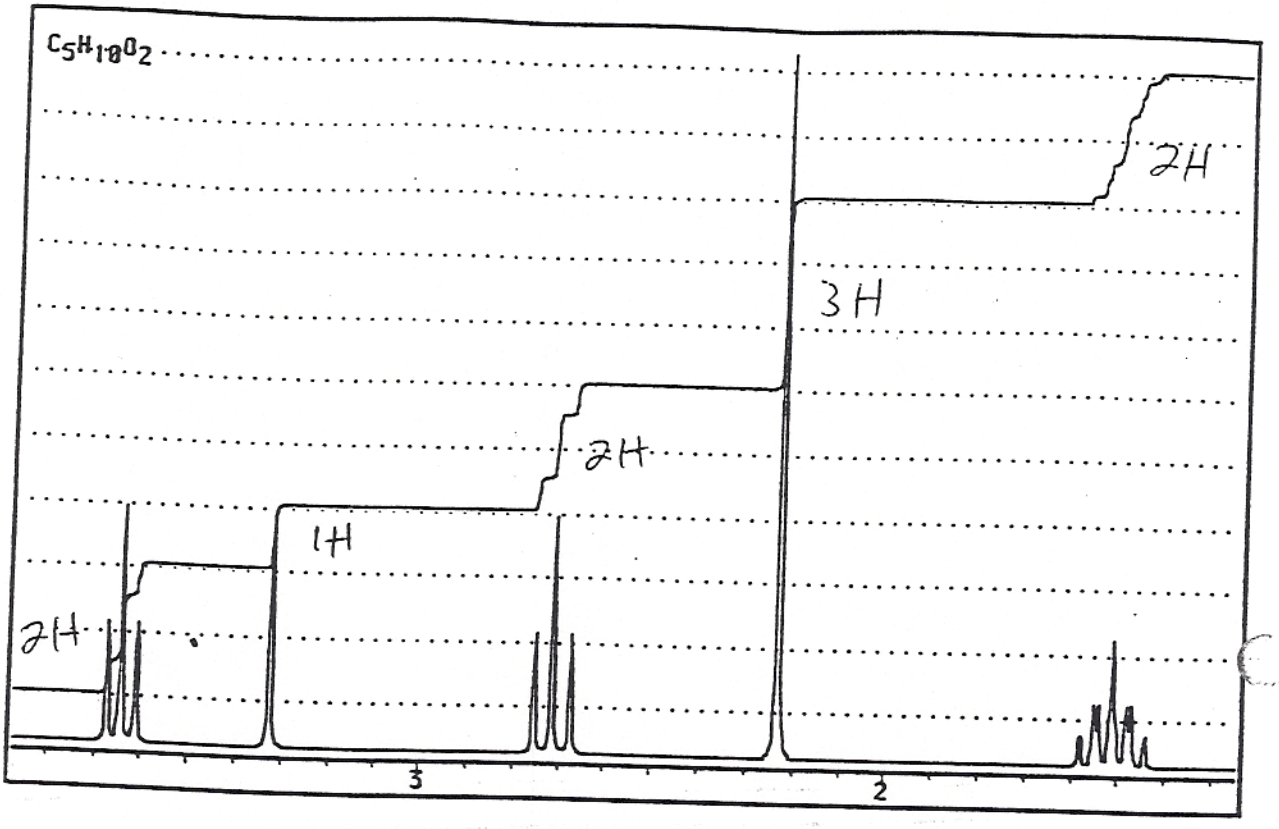


EU=1 ester

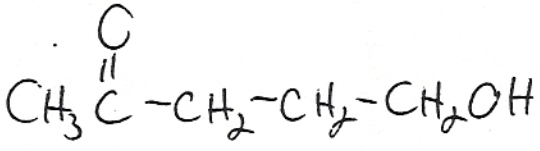


6. $C_5H_{10}O_2$

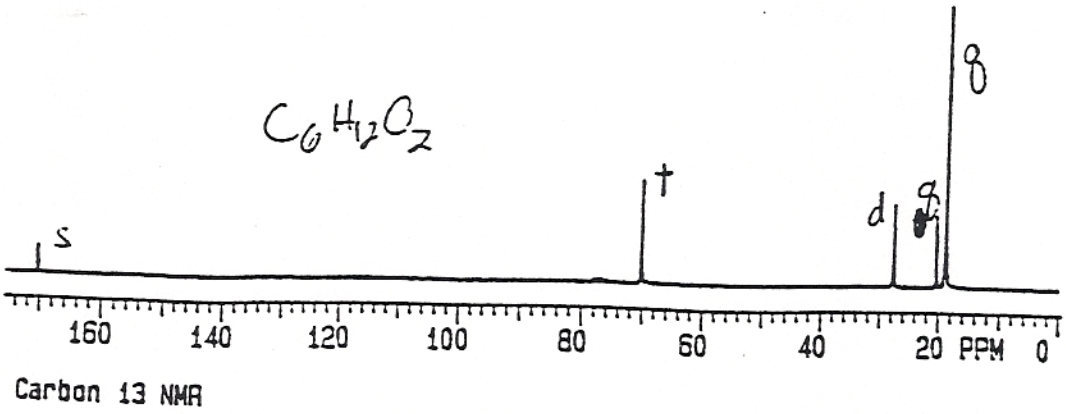
IR: 3300-3200, 1710
^{13}C NMR: 210 (s), 65 (t), 38 (t), 35 (t), 28 (q)



EU=1 C=O, OH

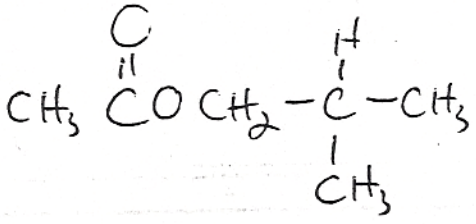


7. $C_6H_{12}O_2$ IR: 1745
(Note: There are two plausible solutions to this problem.)

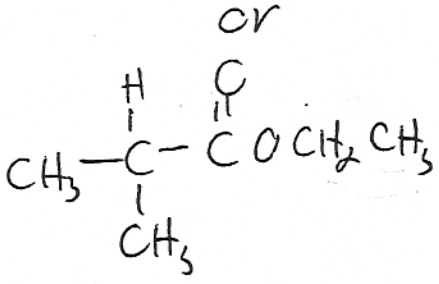


Carbon 13 NMR

EU=1 ester

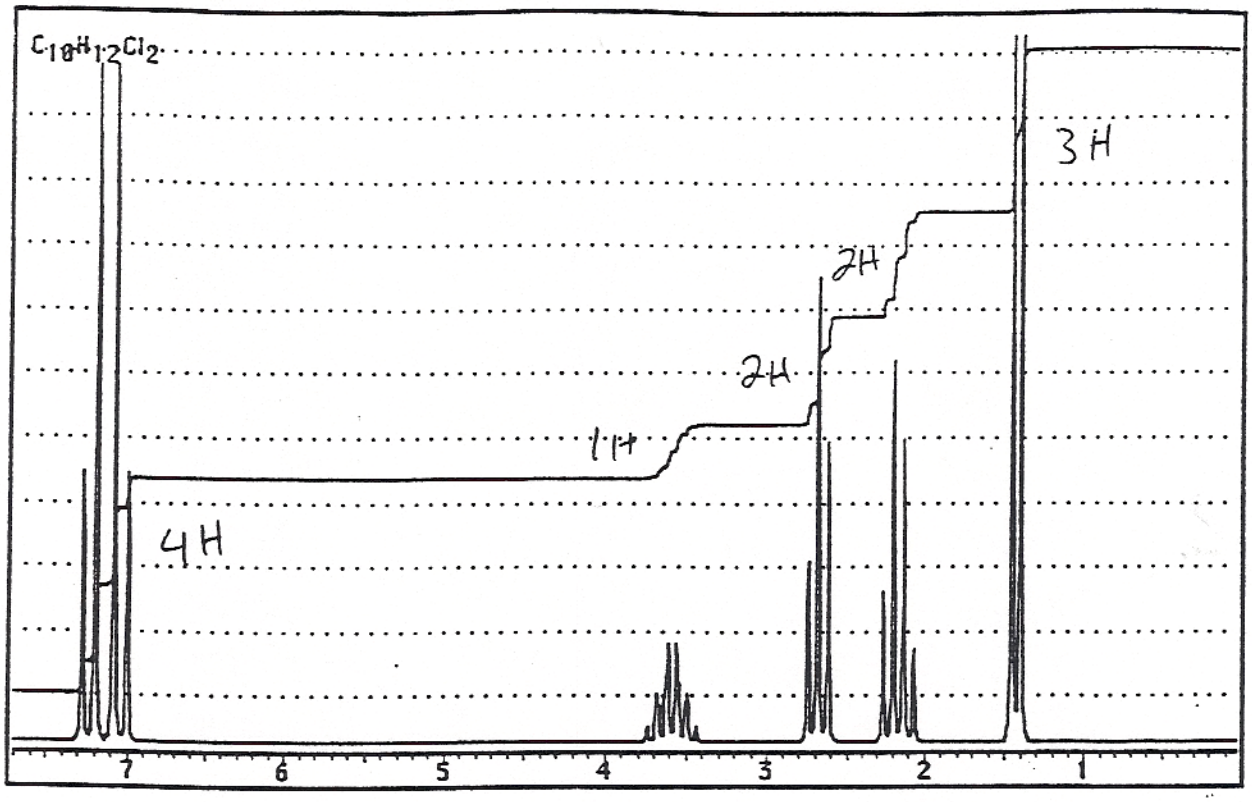


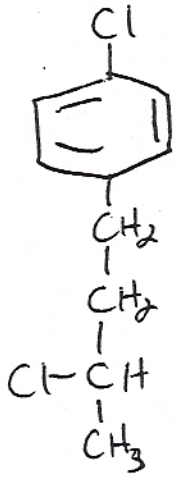
or



8. $C_{10}H_{12}Cl_2$ ^{13}C NMR 150 (s), 144 (s), 133 (d), 126 (d), 58 (d), 37 (t), 32 (t), 22 (q)

EU = 4





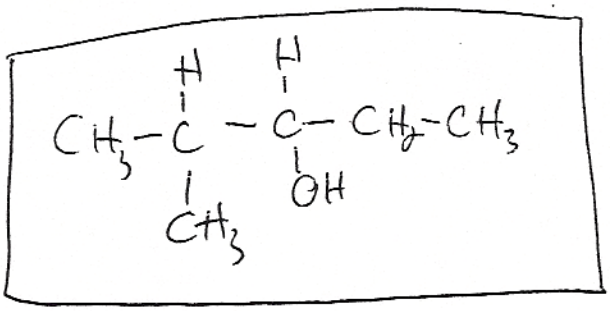
9. $C_6H_{14}O$

IR 3300-3200
^{13}C NMR 78 (d), 40 (d), 36 (t), 25 (q), 20 (q, extra tall)

6H, d, 1.0
3H, t, 1.2
2H, pentet, 1.4
1H, octet, 1.8
1H, broad s, 3.0
1H, q, 3.8

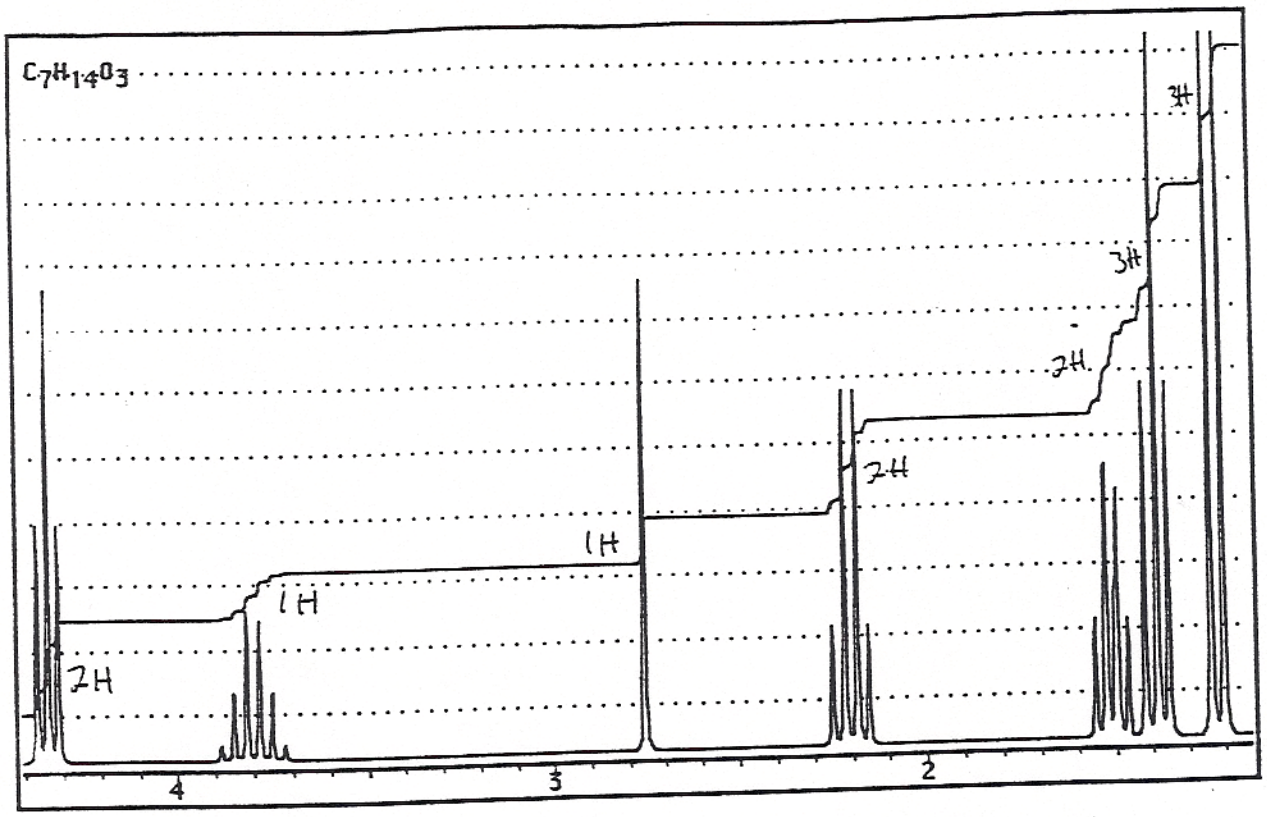
EU=0

OH

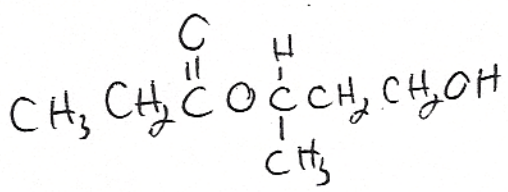


(2 acceptable answers)

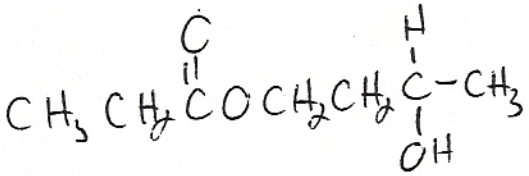
10. $C_7H_{14}O_3$ IR: 3300-3200, 1745
^{13}C NMR 180 (s), 75 (d), 65 (t), 38 (t), 30 (t), 25 (q), 20 (q)



EU=1 alcohol, ester

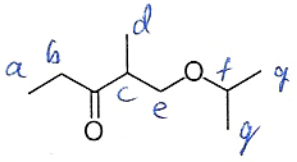


or



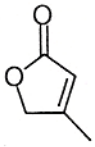
JASPERSE CHEM 360 TEST 2 VERSION 2
Ch 12-13 NMR, IR

1. Predict the ^{1}H NMR spectrum. Include approximate chemical shifts (1's, 2's, etc.), the integration, and the splitting (can use "s" for singlet; "d" for doublet; "t" for triplet; "q" for quartet, and "m" for multiplet, anything more complex than a quartet). Note: for signals that are symmetry equivalent, do not list them twice.



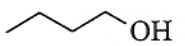
a 1's 3H t
b 2's 2H q
c 2's 1H m
d 1's 3H d
e 3's 2H d
f 3's 1H m
g 1's 6H d

2. Predict the ^{13}C NMR spectrum. Include the approximate chemical shifts (220-160, 160-100, 100-50, or 50-0) and the splitting (q, t, d, s).

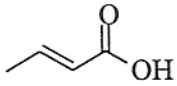


220-160 s
160-100 d
160-100 s
100-50 t
50-0 q

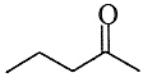
3. Match the following structures with the listed feature IR signals.



A 1710 C



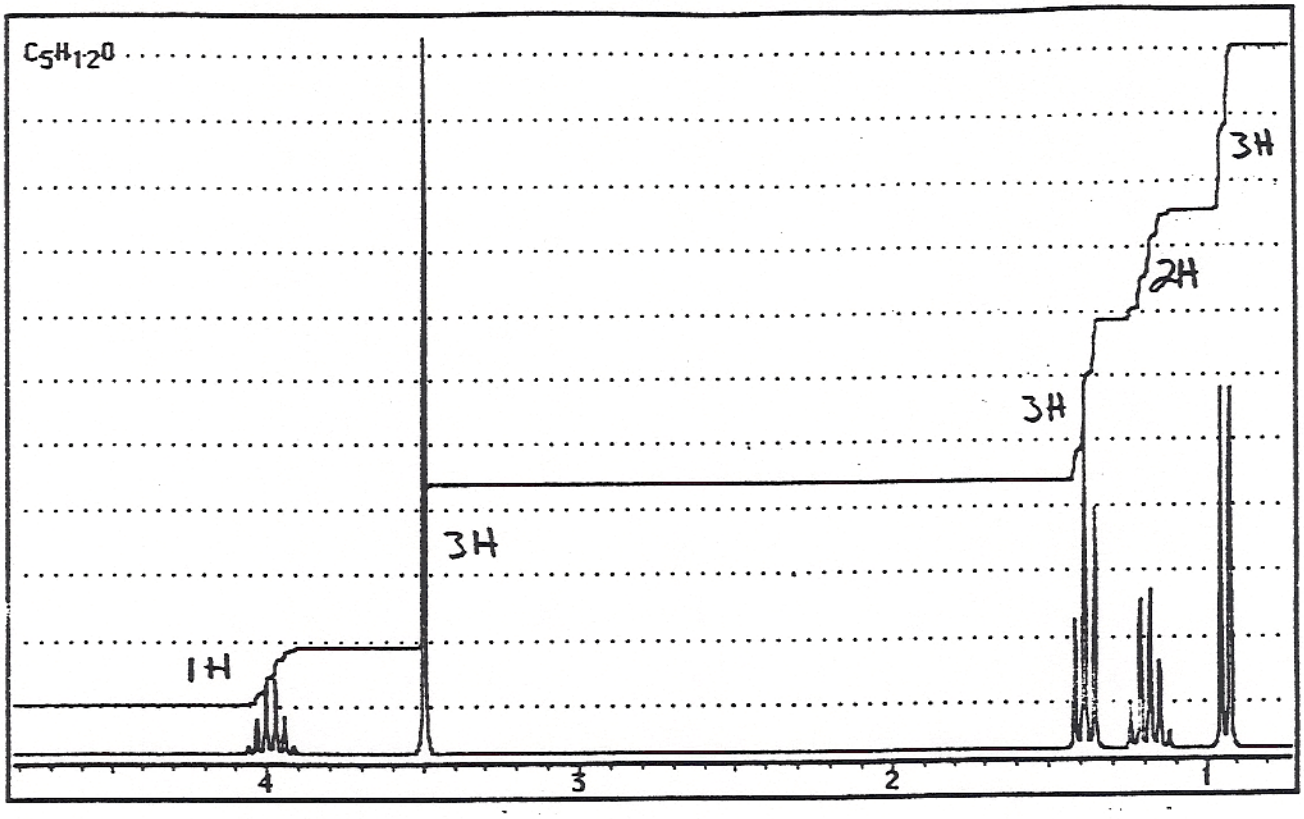
B 3300-3400 A

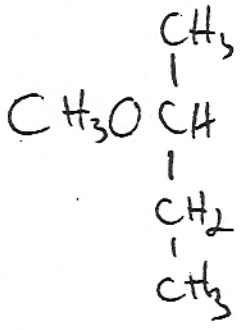


C 1680, 3300-2500 B

Solve the Structures for the Following. If you get a structure perfect, you will get full credit. If you do not get a structure perfect, you may still get some partial credit. Thus, it is in your interest to show some of your work, make a structure, or tell me what you know for sure.

4. $C_5H_{12}O$ IR: Nothing Interesting ⇒ ether

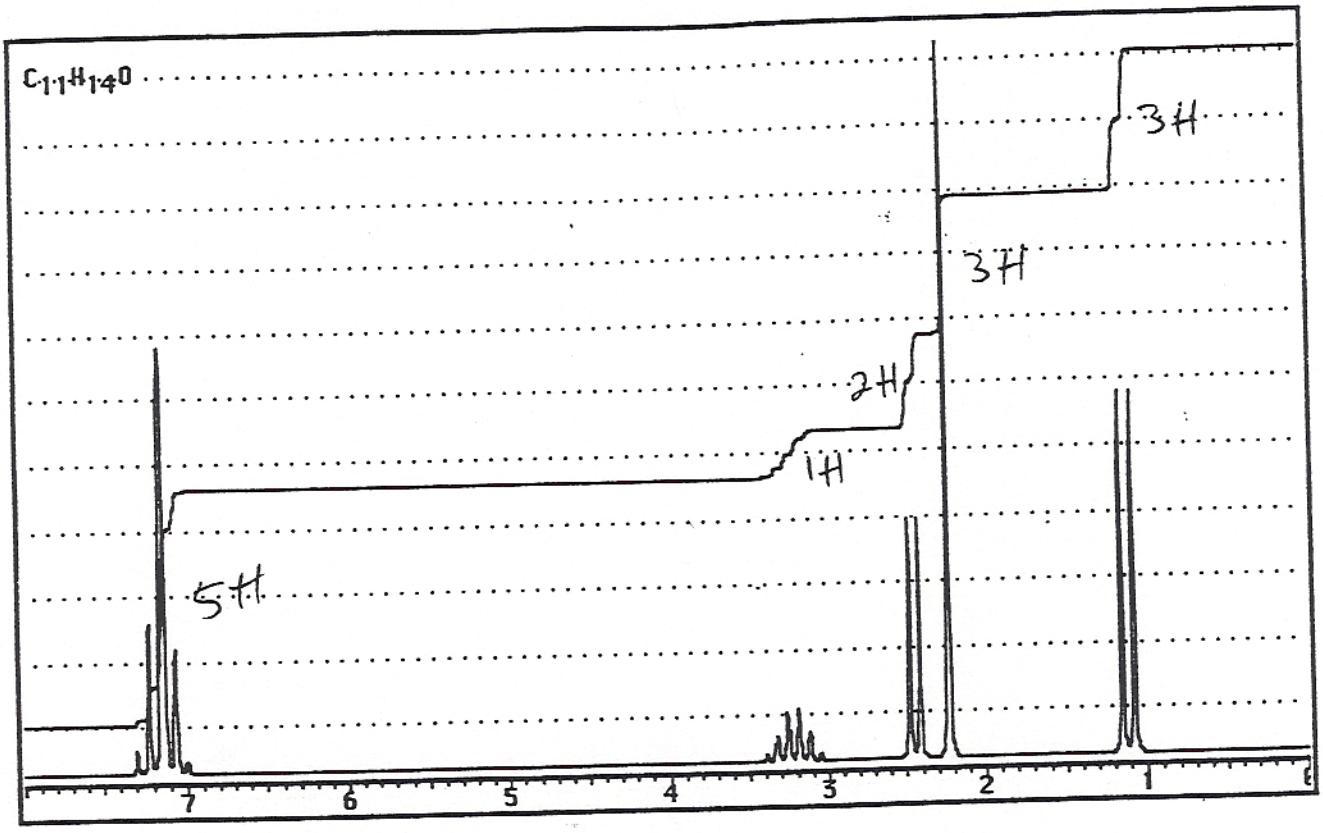


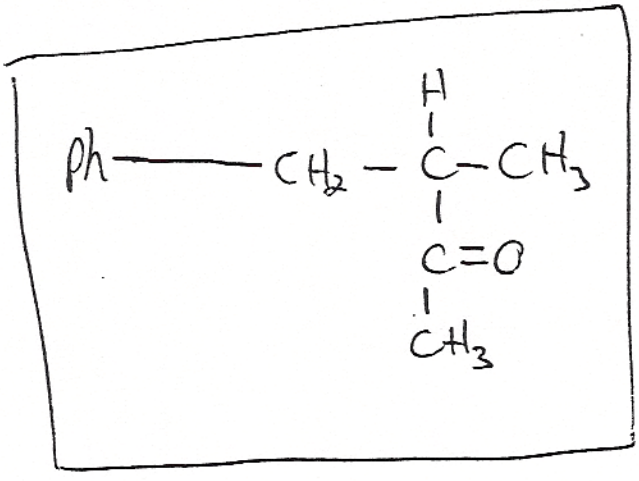


5. $C_{11}H_{14}O$ IR: 1710 C=O, not conjugated error (+)

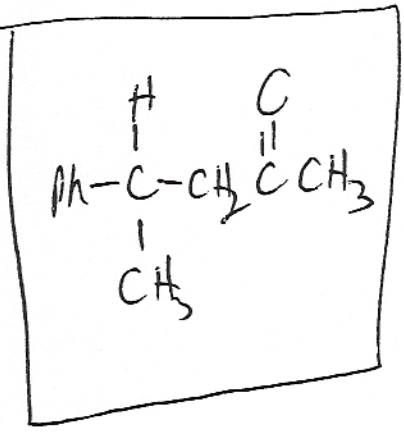
^{13}C NMR: 202 (s), 152 (s), 134 (d), 127 (d), 122 (d), 42 (d), 35 (q), 20 (q)

EU = 5



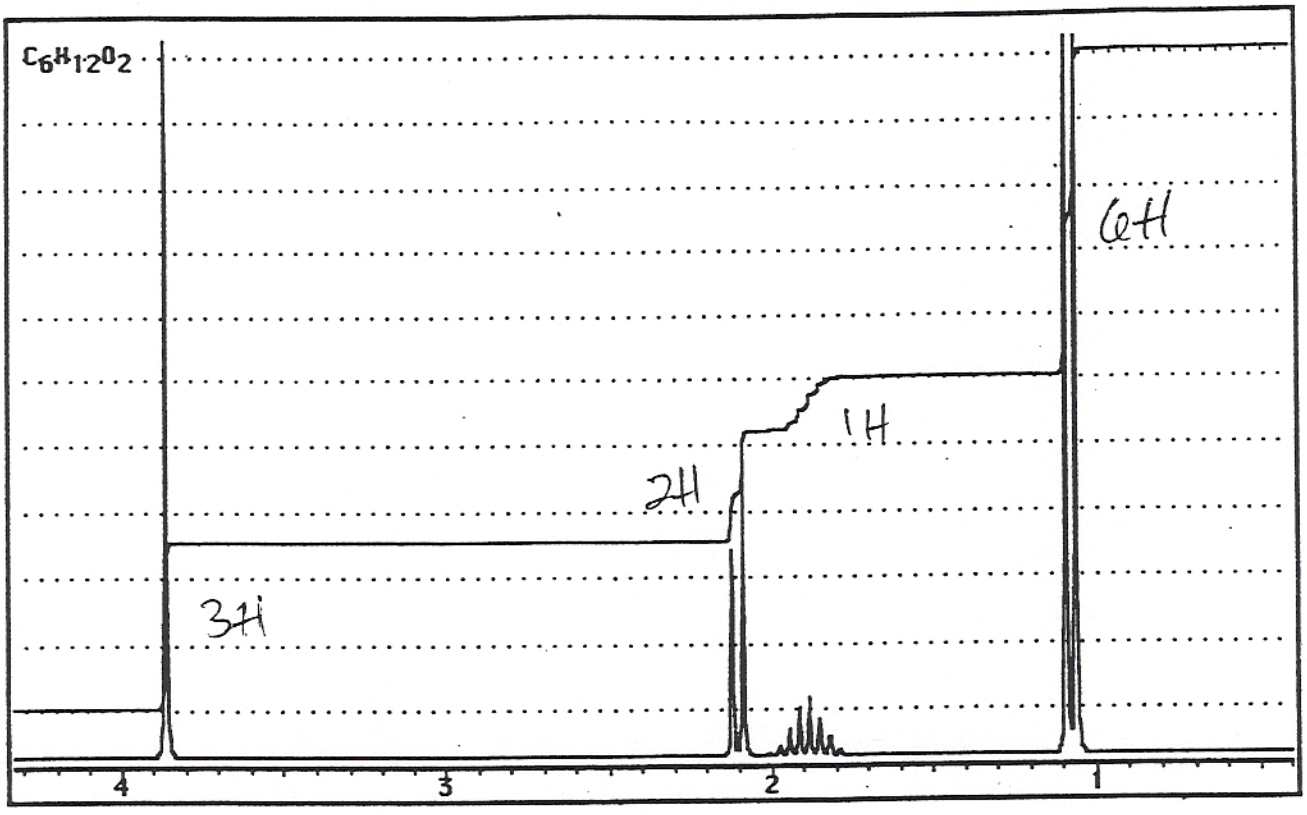


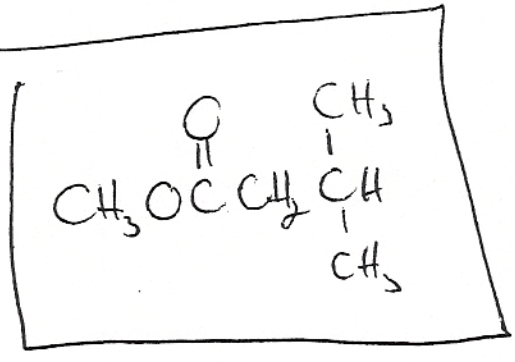
or



6. $C_6H_{12}O_2$ IR: 1740 ester

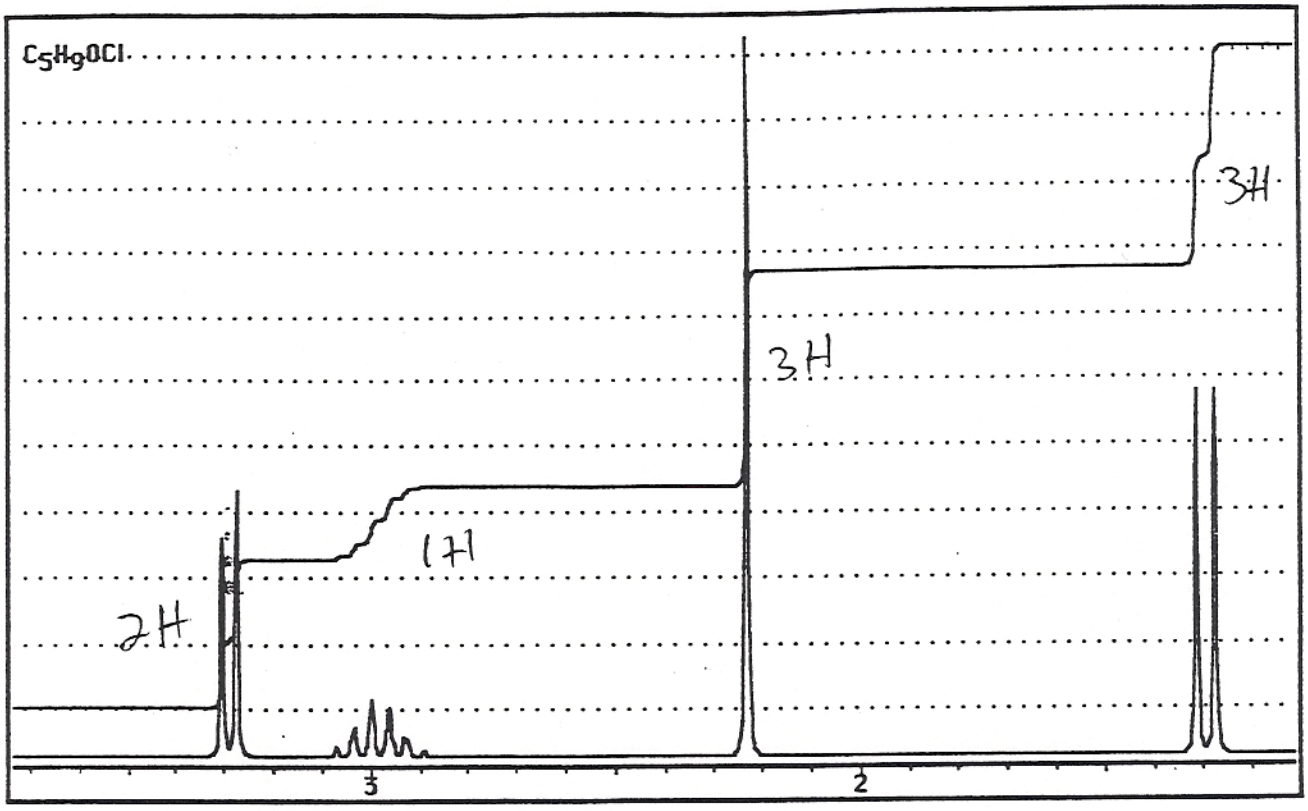
^{13}C NMR: 175 (s), 65 (q), 42 (t), 37 (d), 18 (q)

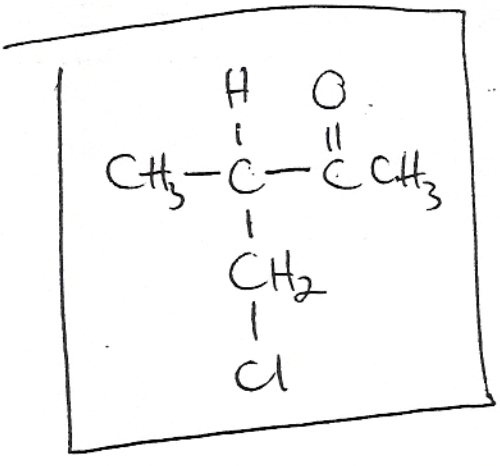


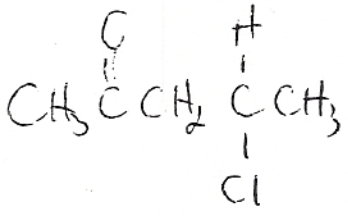


7. C_5H_9OCl IR: 1710

EU=1 C=O





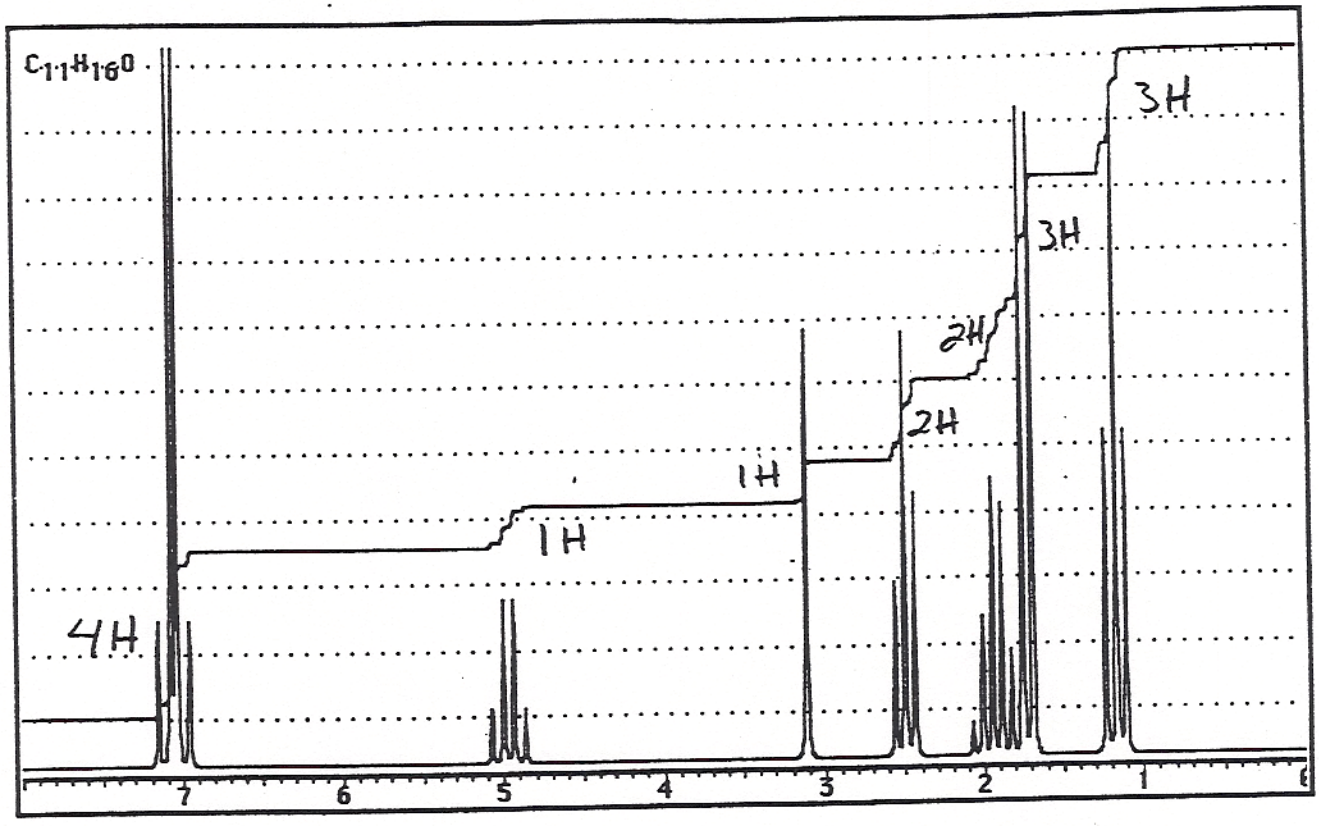


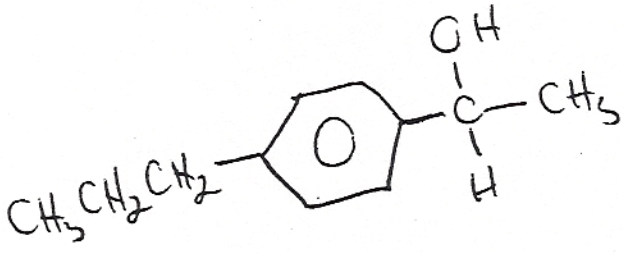
close, but poorer for chemical shift. Partial credit.

8. $C_{11}H_{16}O$ IR: 3300-3200 OH

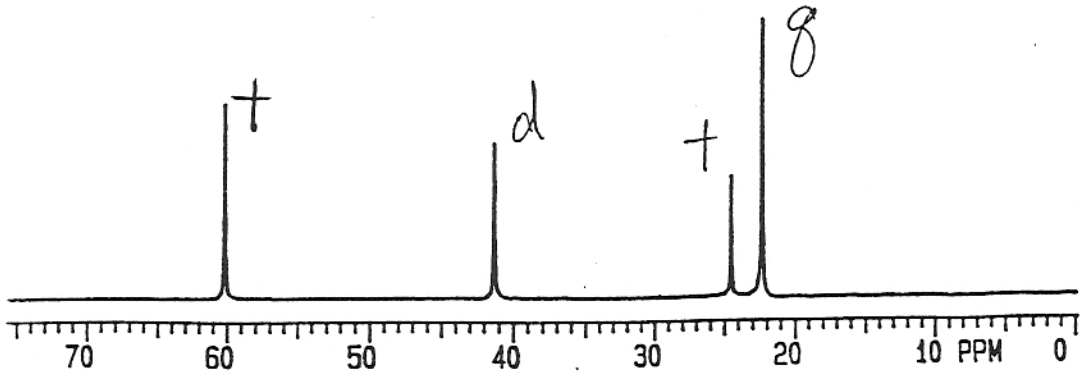
^{13}C NMR: 148 (s), 144 (s), 133 (d), 124 (d), 80 (d), 42 (t), 35 (t), 30 (q), 20 (q)

EU=4

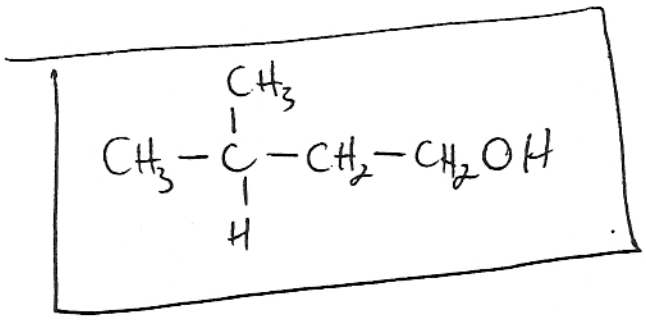




9. $C_5H_{12}O$

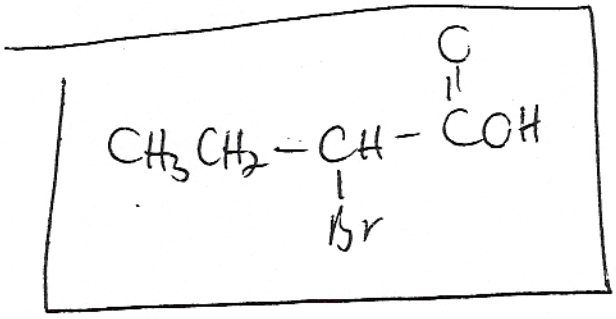


Carbon 13 NMR



10. $C_4H_7BrO_2$ IR: 3300-2500, 1710

3H, t, 1.08
2H, multiplet, 1.89
1H, t, 4.23
1H, s (broad), 10.97



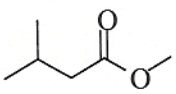
Chem 360 Jasperse Test 2 Version 3 Answers

JASPERSE CHEM 360 TEST 2 VERSION 3
Ch 12, 13 NMR, IR

1. Predict the:
   - ^{1}H NMR spectrum [include approximate chemical shifts (1's, 2's, 3's, 4's, 5's, etc.), integration, and splitting]
   - ^{13}C NMR spectrum [include approximate chemical shifts (0-50, 50-100, 100-150, or 150-220) and splitting]
   - identify any distinctive signals in the IR spectrum

Example:
$CH_3CH_2OCH_3$

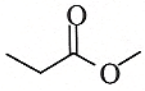
^{1}H NMR			^{13}C NMR	IR
1's	3H	t	0-50, q	none
3's	2H	q	50-100, t	
3's	3H	s	50-100, q	



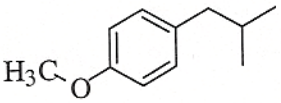
^{1}H NMR	^{13}C NMR	IR
1's 6H d	0-50 q	1700's
1's 1H m	0-50 d	(~1745)
2's 2H d	0-50 +	
3's 3H s	220-150 s	
	50-100 q	

2. For the following molecule,
   - Write how many "types" of H's there would be in the ^{1}H NMR spectrum (these are H's which might coincidentally overlap, but can't be assumed to be chemical shift equivalent)
   - Write how many different ^{13}C NMR absorptions you would expect, and
   - Write what the ^{13}C NMR splitting would be, i.e. singlet, doublet, triplet, or quartet for the ^{13}C NMR absorptions.

Example:



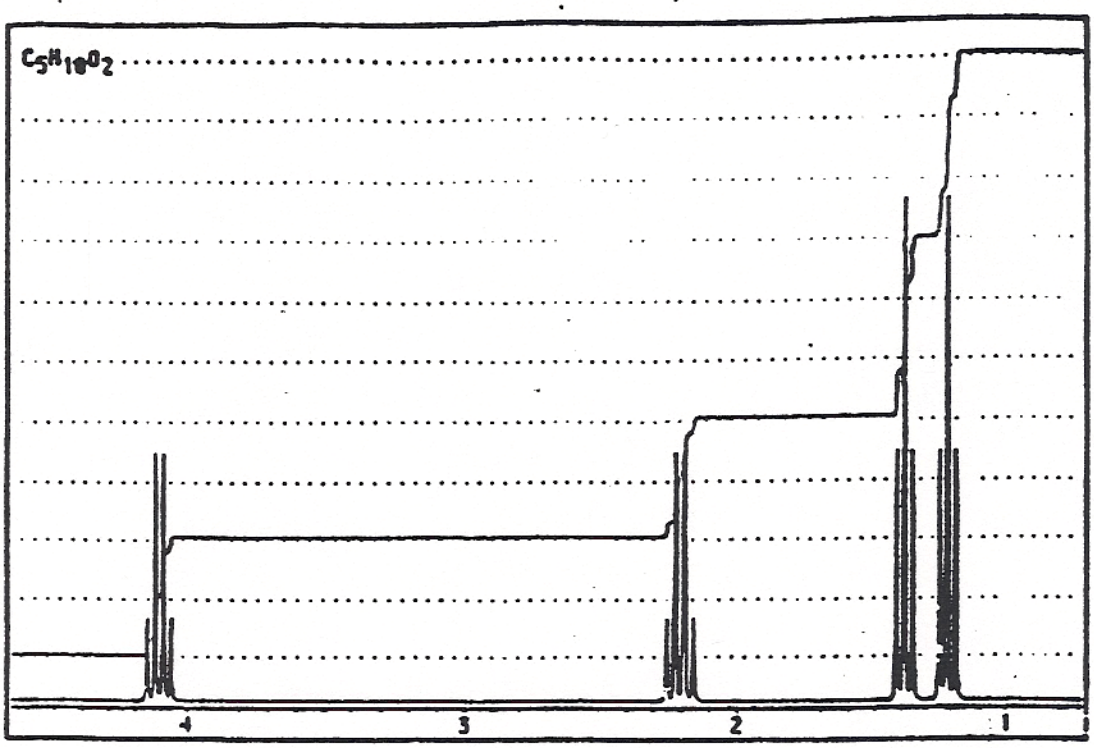
Number of Nonequivalent H's in H-NMR	Number of ^{13}C Absorptions in ^{13}C NMR	Expected Splittings in ^{13}C NMR
3	4	q, t, s, q

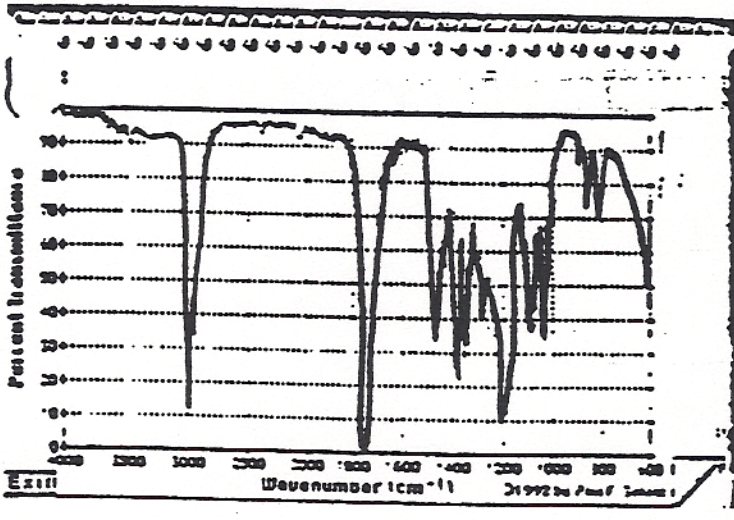


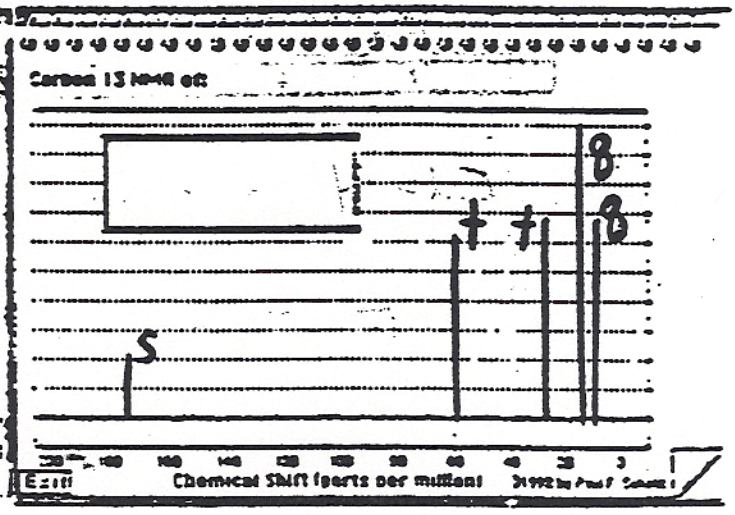
Number of Nonequivalent H's in H-NMR	Number of ^{13}C Absorptions in ^{13}C NMR	Expected Splittings in ^{13}C NMR
6	8	q, s, d d s + d q

Provide Structures Based on the Following Spectroscopic Data (8 points each)

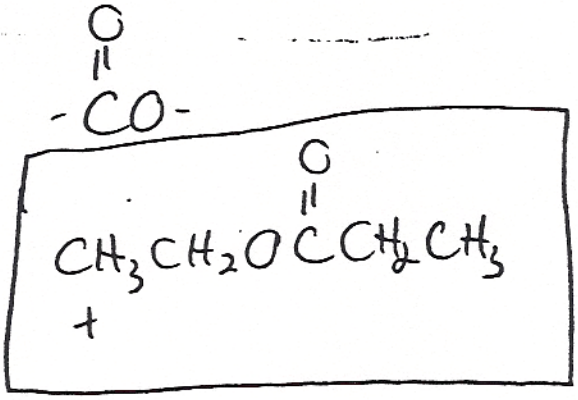
4. $C_5H_{10}O_2$







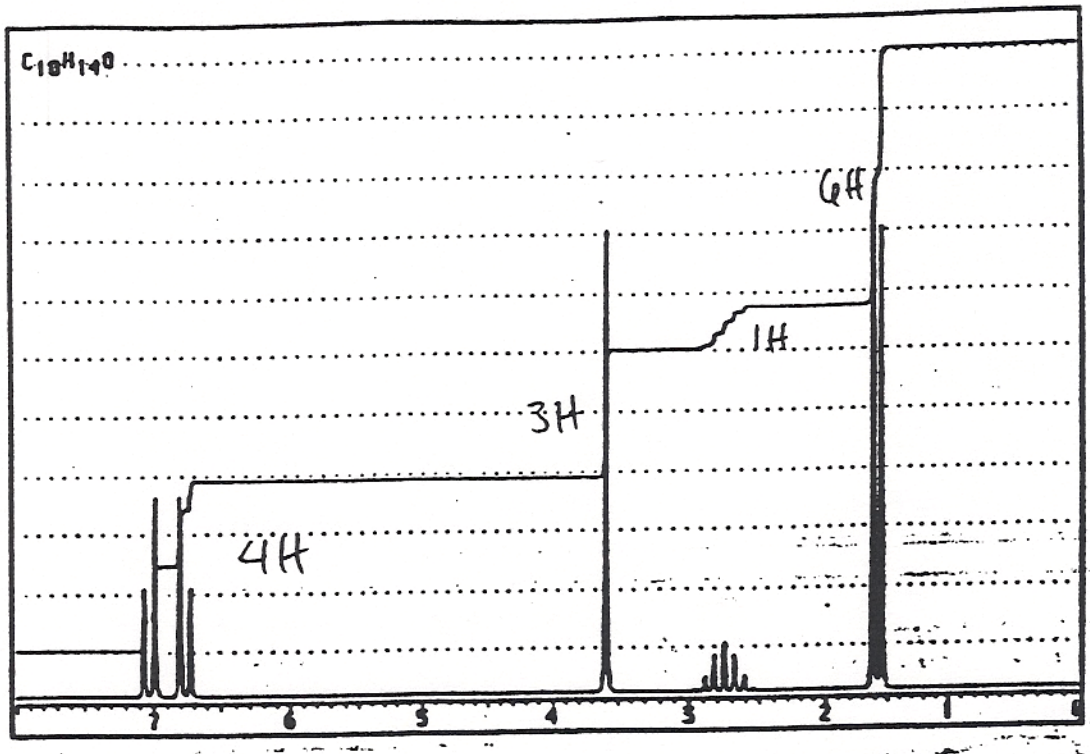
EU=1



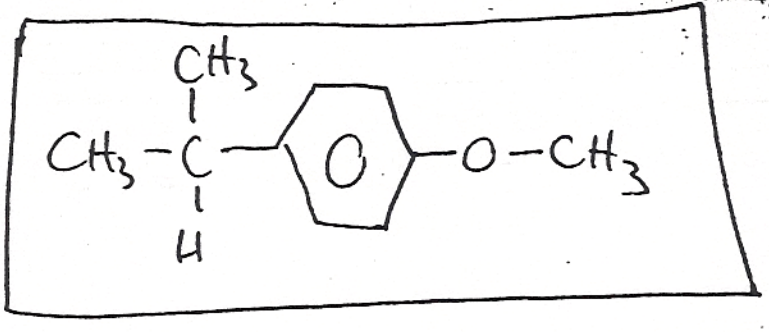
5. $C_{10}H_{14}O$

^{13}C NMR:

148	s	135	d	75	q	50	d
122	s	128	d			22	q



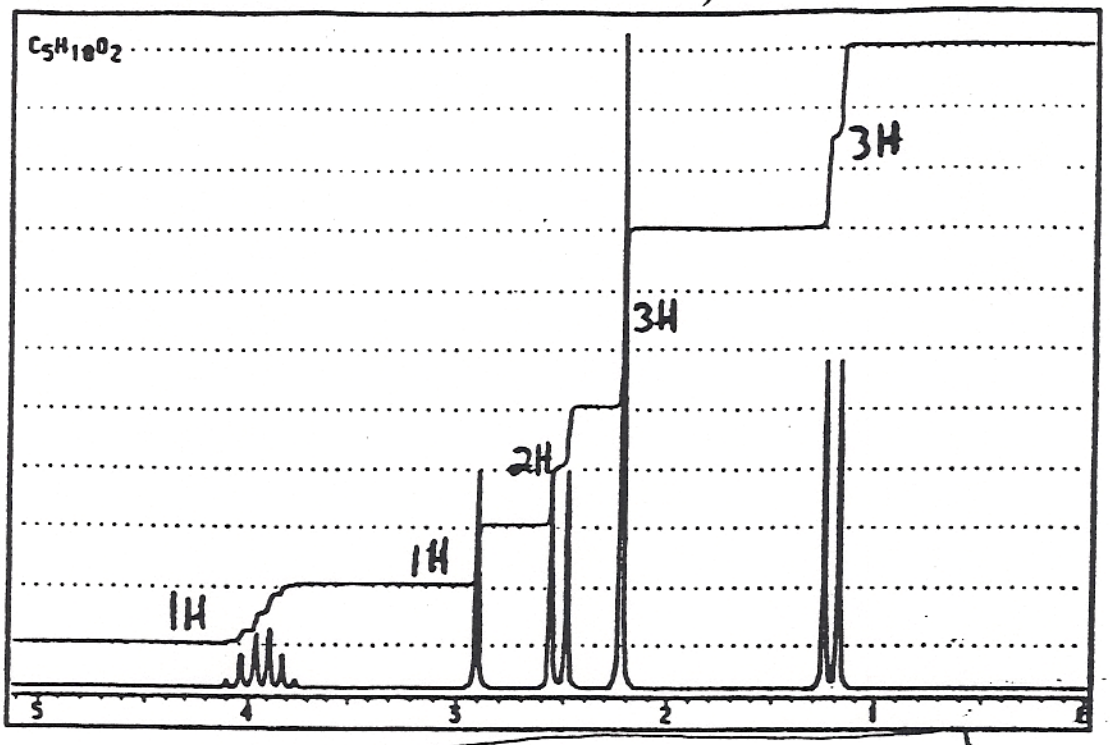
EU = 4 disubbed para, from ^{13}C

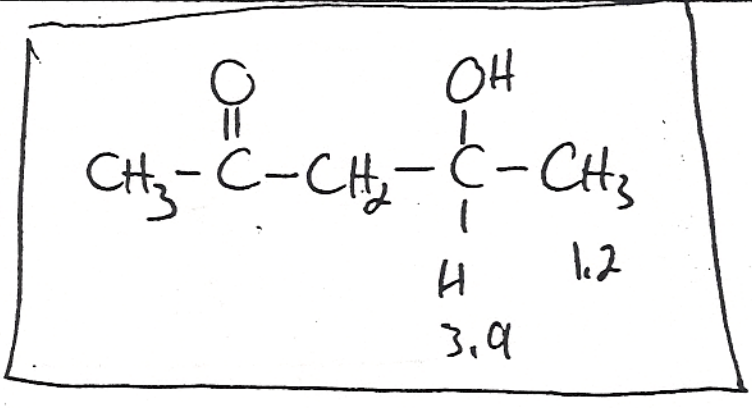


6. $C_5H_{10}O_2$

IR: 1710 (strong), 3300-3500 (broad, strong)

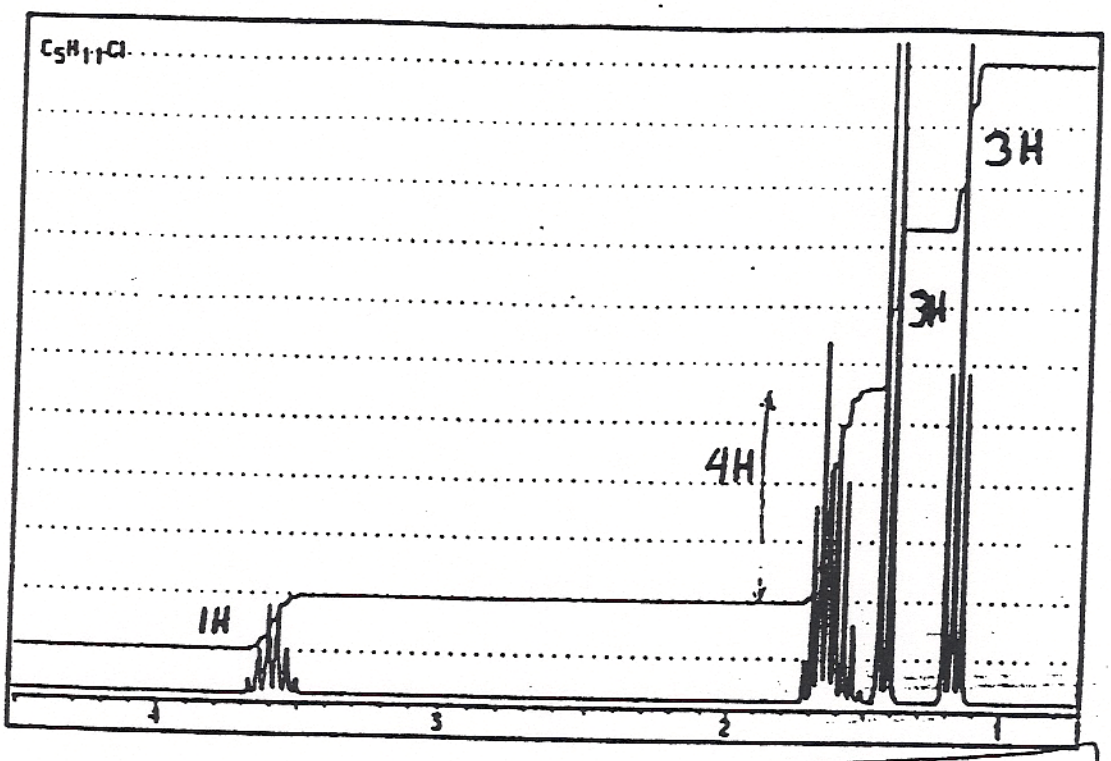
↳ C=O ↳ OH (not acid)

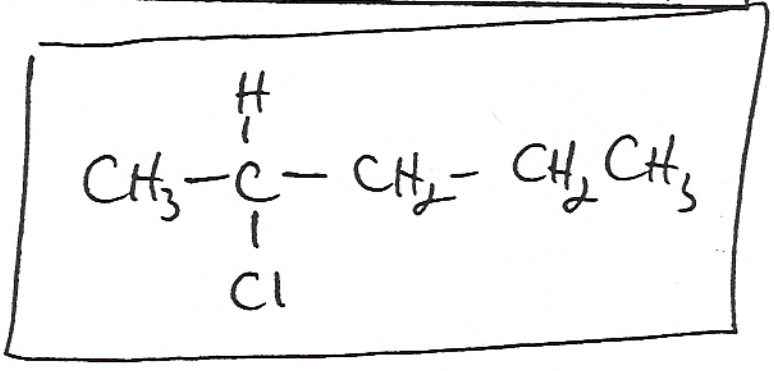




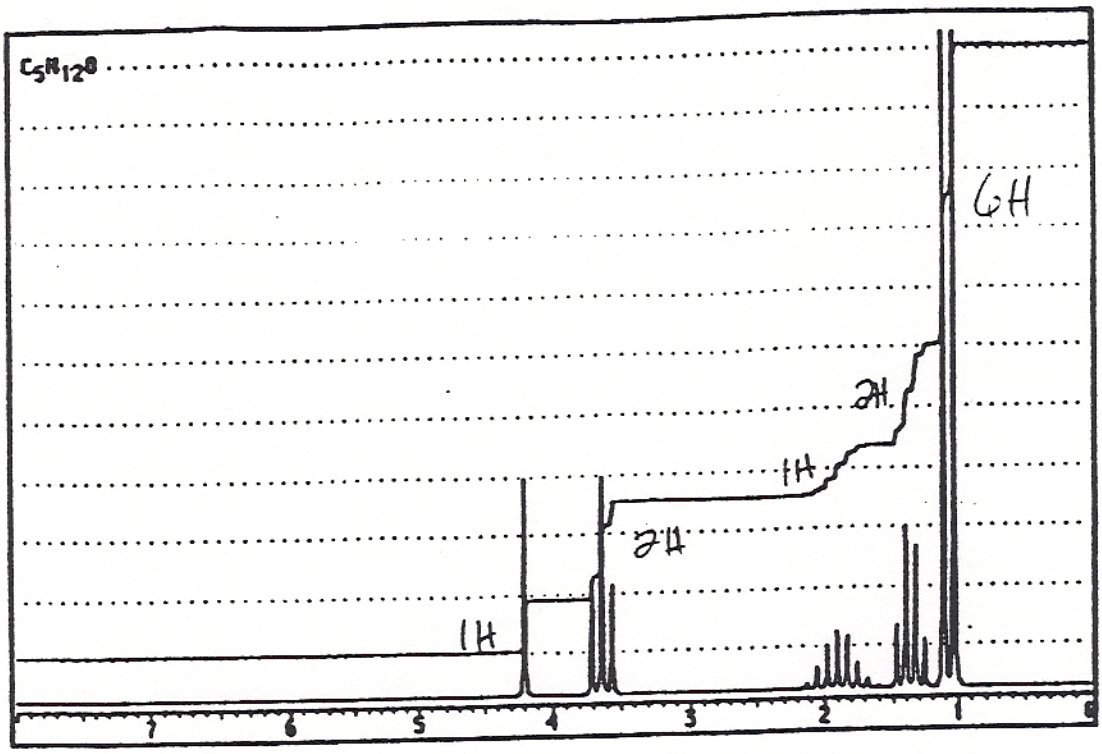
7. $C_5H_{11}Cl$

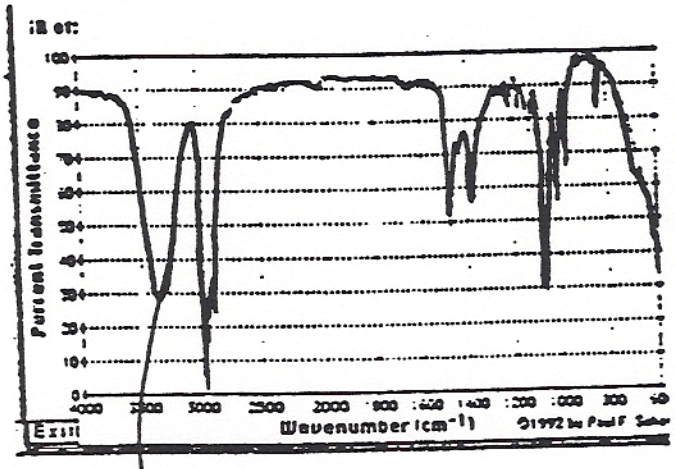
^{13}C NMR: 60 (d), 40 (t), 37 (t), 33 (q), 20 (q) no symmetry



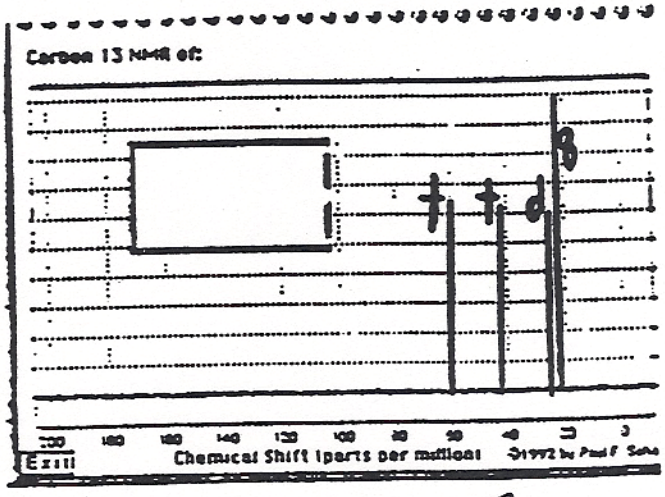


8. $C_5H_{12}O$

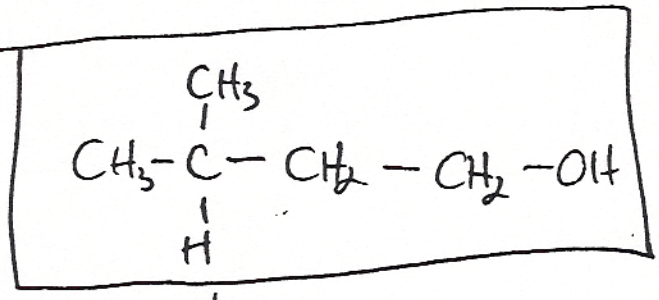




OH



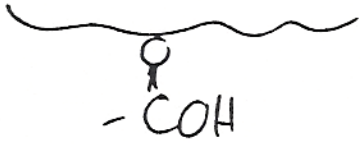
symmetry

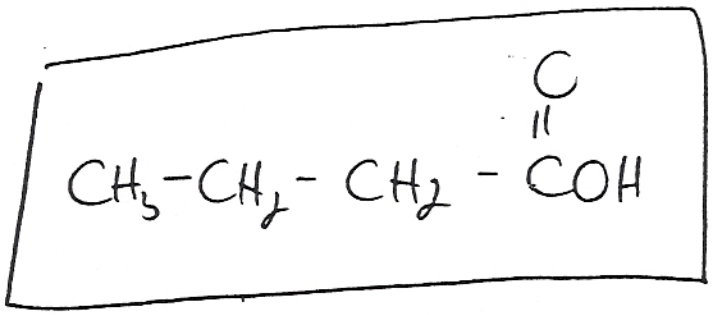


no other CH_3's, so other end must be OH

9. $C_4H_8O_2$ EU=1
triplet, 1.02, 3H
sextet, 1.43, 2H
triplet, 2.35, 2H
singlet, 10.95, 1H

IR 1715 cm^{-1} and broad 2500-3000





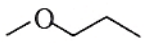
Jasperse
Chem 360
~~Version~~
Test 2
Version 4
Answers

JASPERSE CHEM 360 TEST 2 VERSION 4
Ch 12, 13 NMR, IR
NOTE: This Version is Longer than the Real Test Will Be

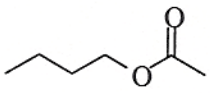
1. Predict the ^{1}H NMR spectra for the following molecules. Include predicted:
   - chemical shifts
   - integration
   - splitting pattern (singlet, doublet, triplet, quartet, etc., multiplet)

Example

3's, 2H, t
1's (or 2's), 2H, pentet (or multiplet)
3's, 2H, t

a. 

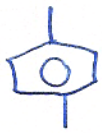
3's 3H s
3's 2H t
1's 2H m (or sextet)
1's 3H t

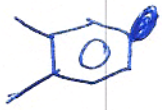
b. 

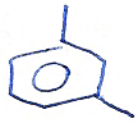
1's 3H t
1's 2H m (or sextet)
1's 2H p

3's 2H t
2's 3H s

2. Assign the dimethylbenzene isomer for which the ^{13}C NMR spectrum has:

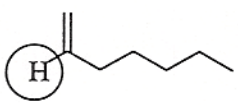
a. 3 signals (q, s, d)  max symmetry

b. 4 signals (q, s, d, d) 

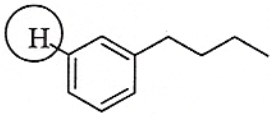
c. 5 signals (q, s, d, d, d) 

3. Match the circled proton or protons in the following compounds with the correct chemical shift.

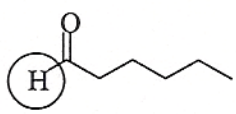
1.20 2.05 5.70 7.17 9.55



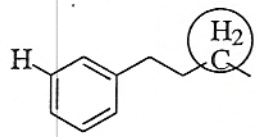
5.70



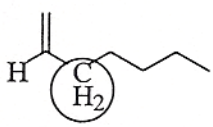
7.17



9.55



1.20



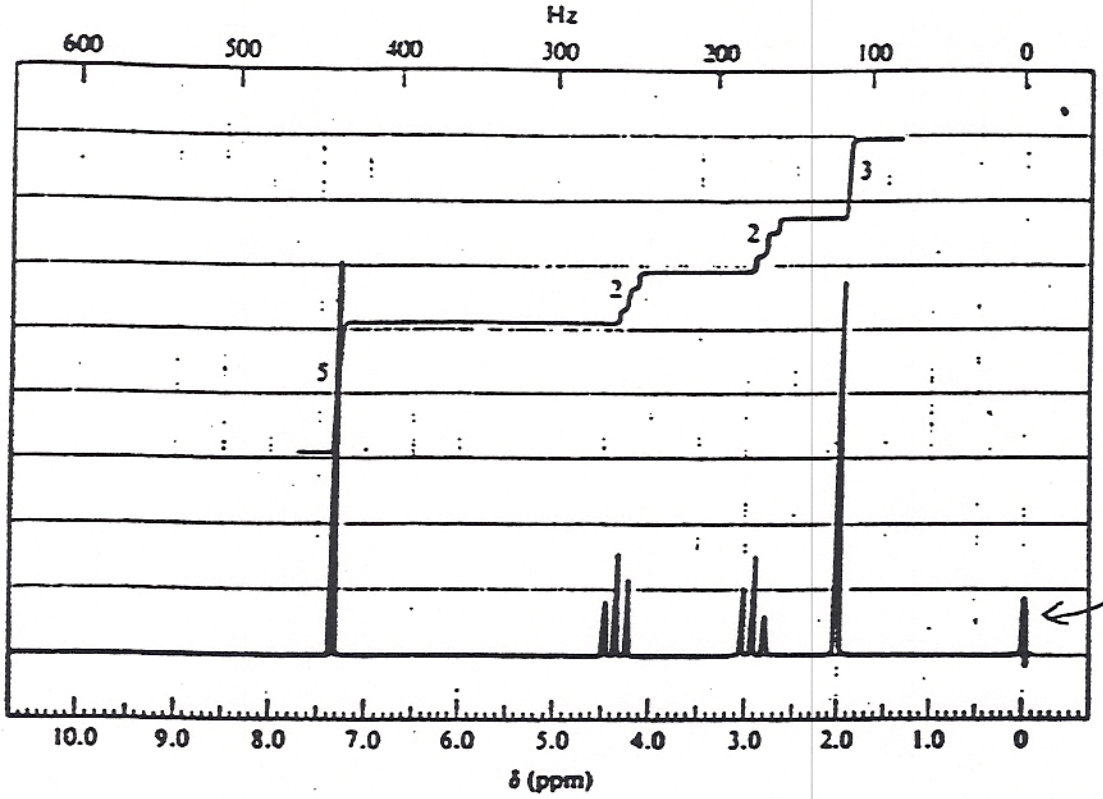
2.05

DRAW STRUCTURES FOR THE MOLECULES IN PROBLEMS 3–9

3. $C_{10}H_{12}O_2$

IR: 1740 (strong), 750 (strong), 700 (strong)

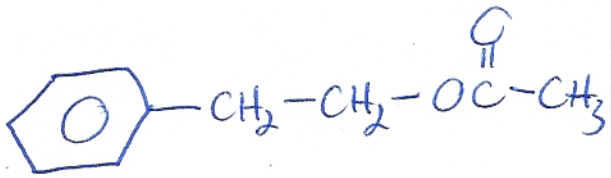
^{13}C NMR: 185 (s), 155 (s), 135 (d), 130 (d), 128 (d), ~~35~~ 65 (t), 28 (t), 20 (q)



Note: Signal at zero is reference signal, nothing in actual molecule.

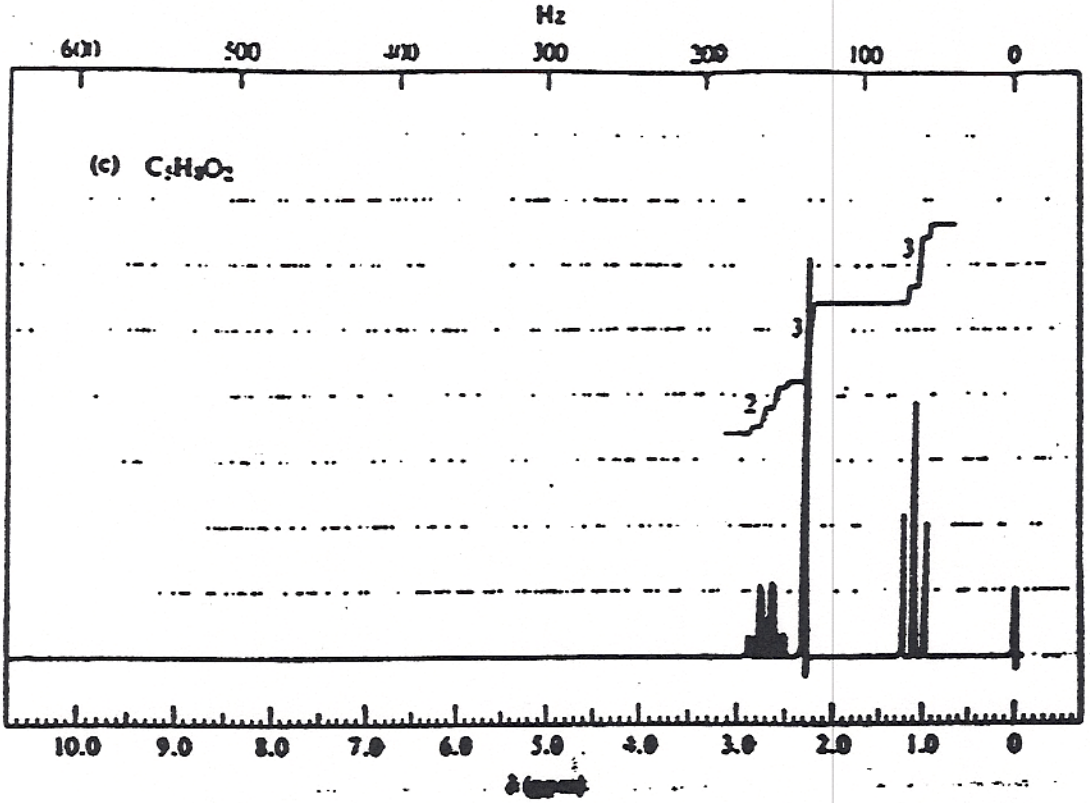
EU=5

IR ⇒ ester



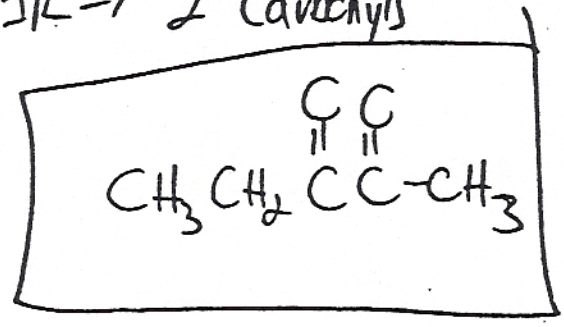
4. $C_5H_8O_2$

IR: 1720 (s), 1725 (s)



EU=2

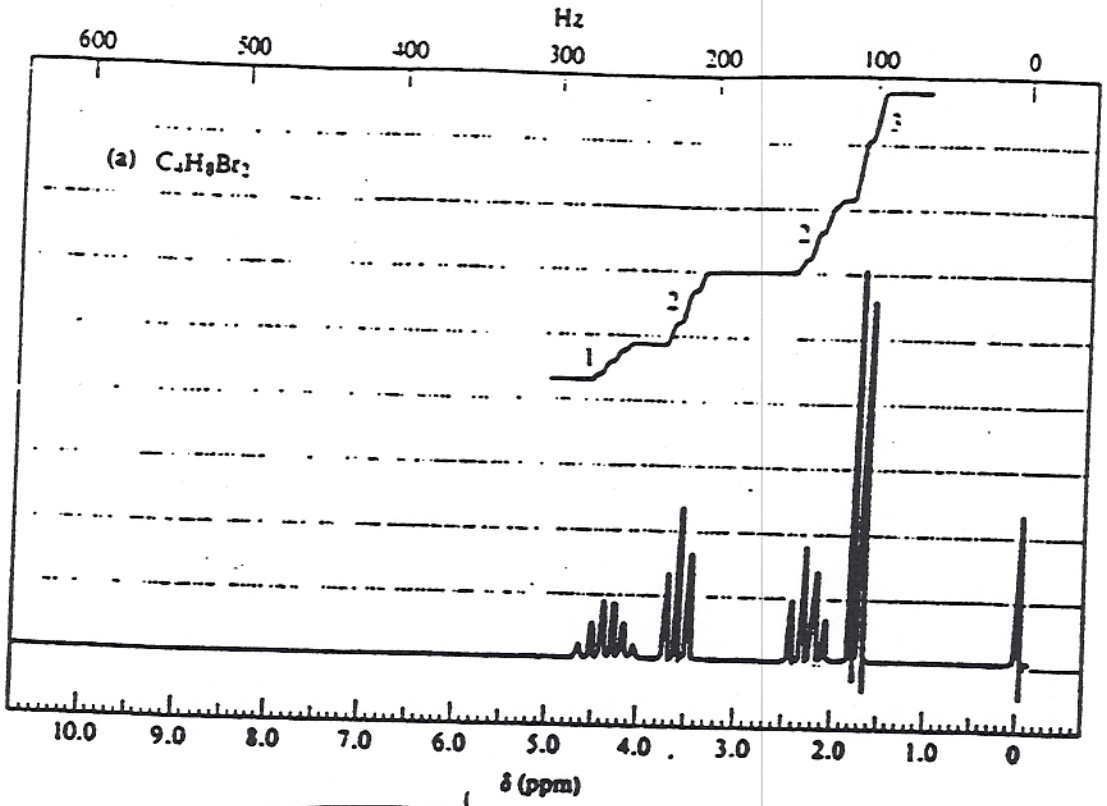
IR ⇒ 2 carbonyls

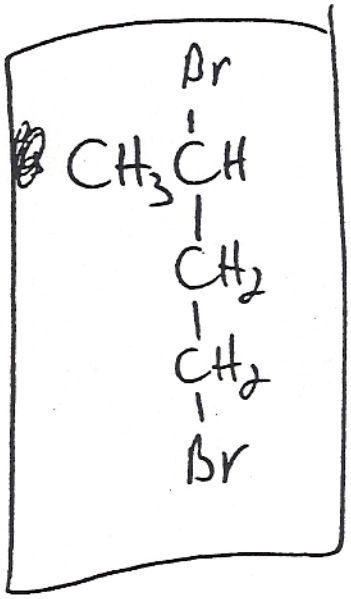


5. $C_4H_8Br_2$

IR: nothing interesting

^{13}C NMR: 45 (d), 37 (t), 24 (t), 18 (q)





(6.) $C_{11}H_{16}O$

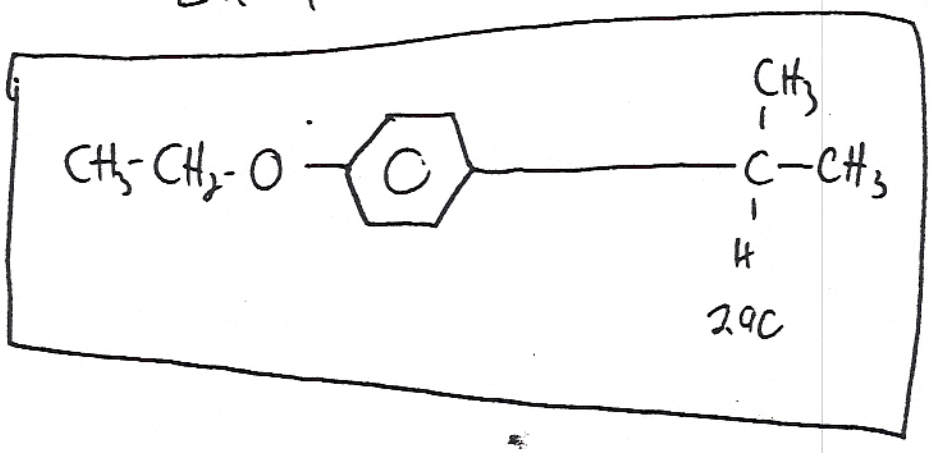
IR: 820 (strong) → disubbed

^{13}C: 145 (s), 132 (s), 128 (d), 120 (d), 75 (t), 35 (d), 20 (q), 18 (q)

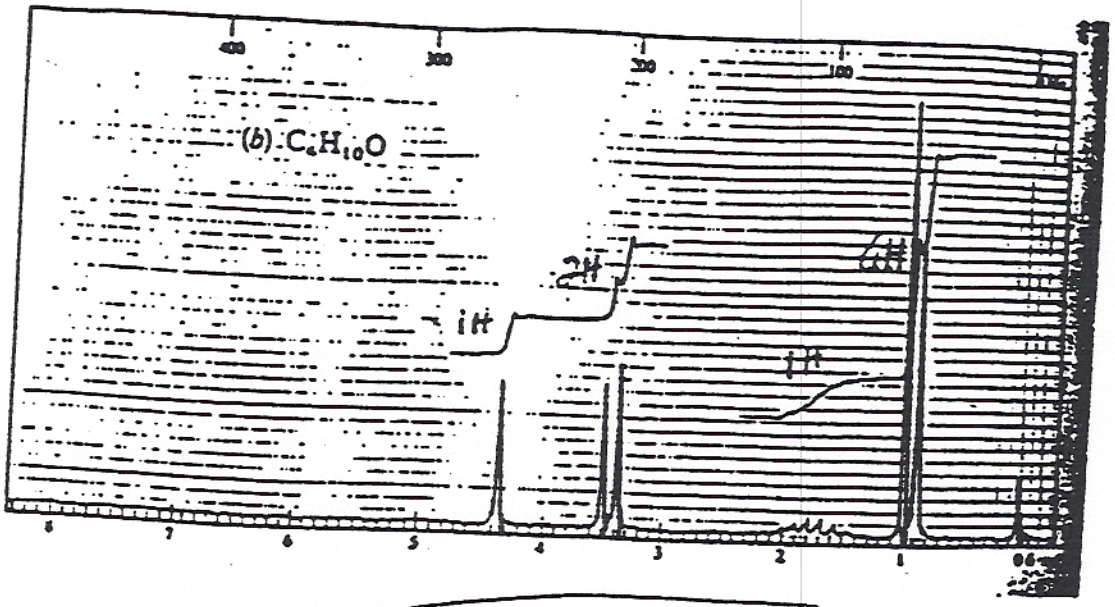
^{1}H NMR: 1.25 (6H, d), 1.30 (3H, t), 2.90 (m, 1H), 4.15 (2H, q), 6.66 (2H, d), 6.97 (2H, d)

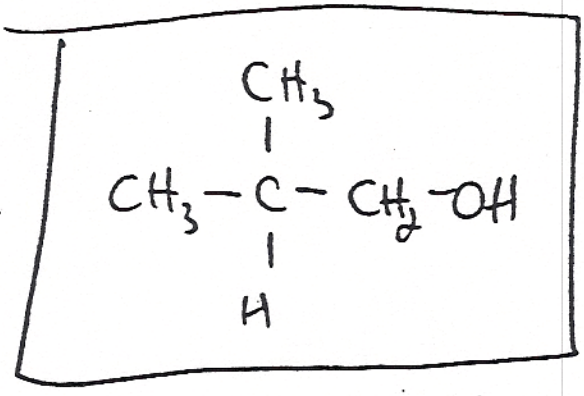
EU= 4

disubbed



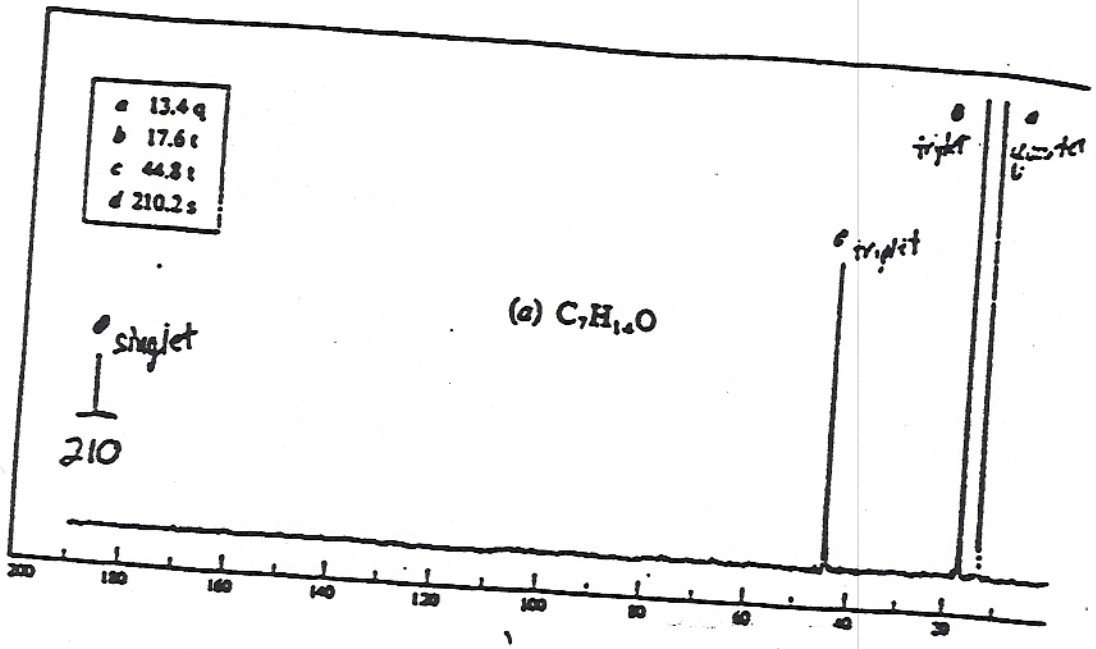
7. $C_4H_{10}O$

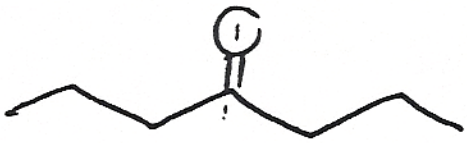




$C_7H_{14}O$

IR: 1710 (strong)





need symmetry!!

9

15. Show the structures for the following molecule, based on the spectroscopic information provided. (10 points)

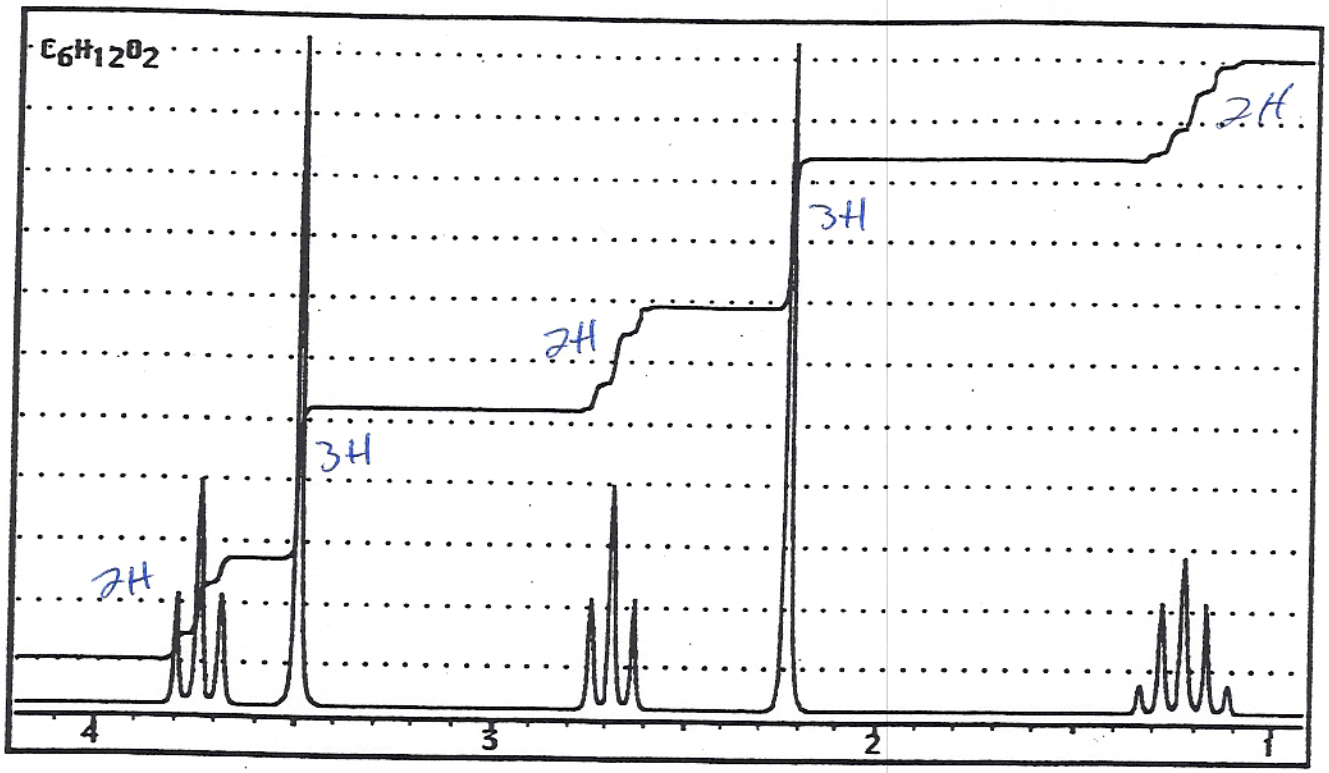
$C_6H_{12}O_2$ IR: 1710, strong ^{13}C NMR: 200 (s), 75 (t), 65 (q), 40 (t), 30 (t), 20 (q)

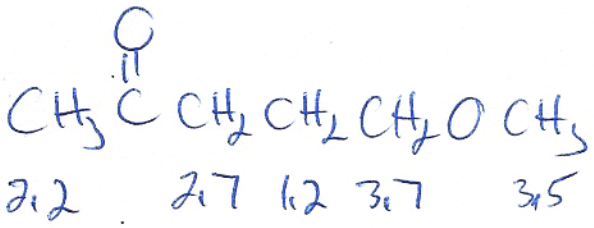
EU=1

C=O

no O-H

not ester





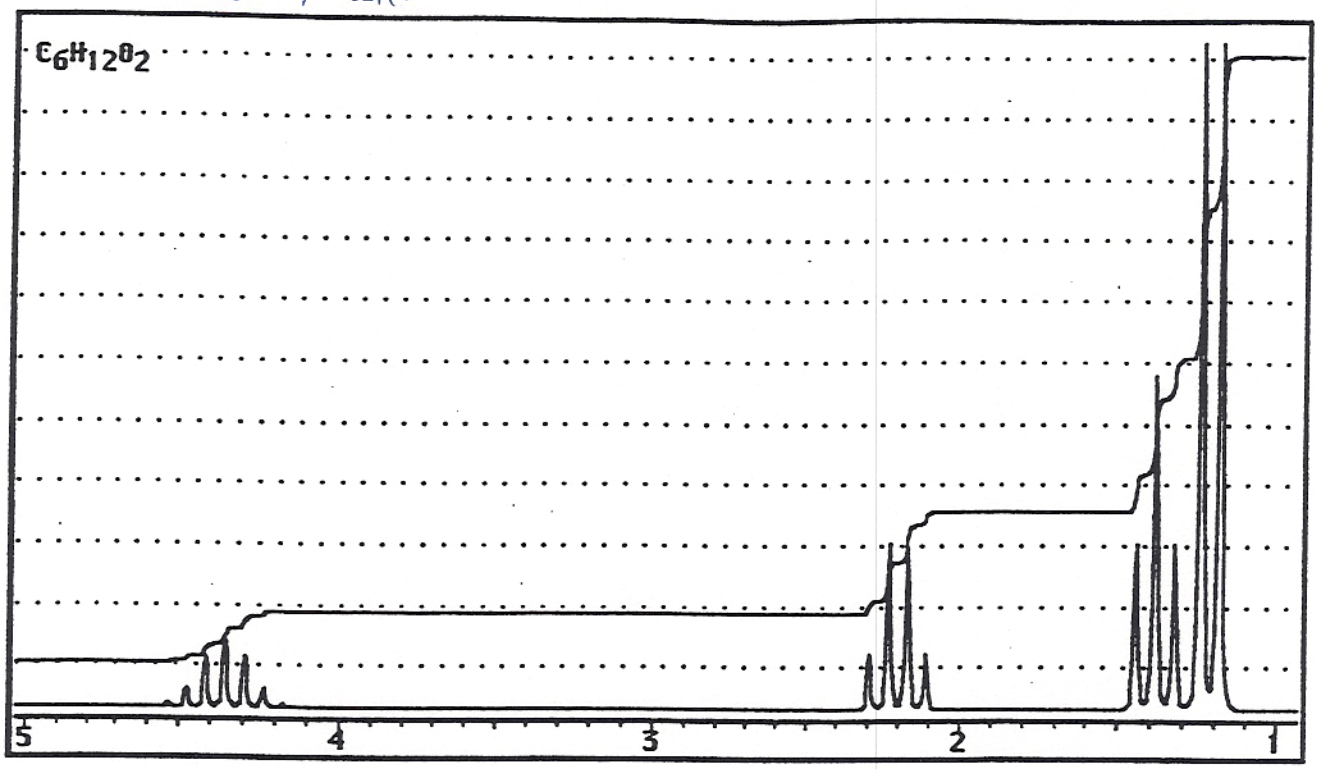
(10)

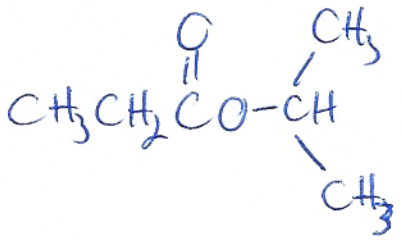
16. Show the structures for the following molecule, based on the spectroscopic information provided. (10 points)

$C_6H_{12}O_2$ IR: 1745, strong ^{13}C NMR: 20 (q), 30 (q), 48 (t), 78 (d), 185 (s)

EU=1 C=O, no OH

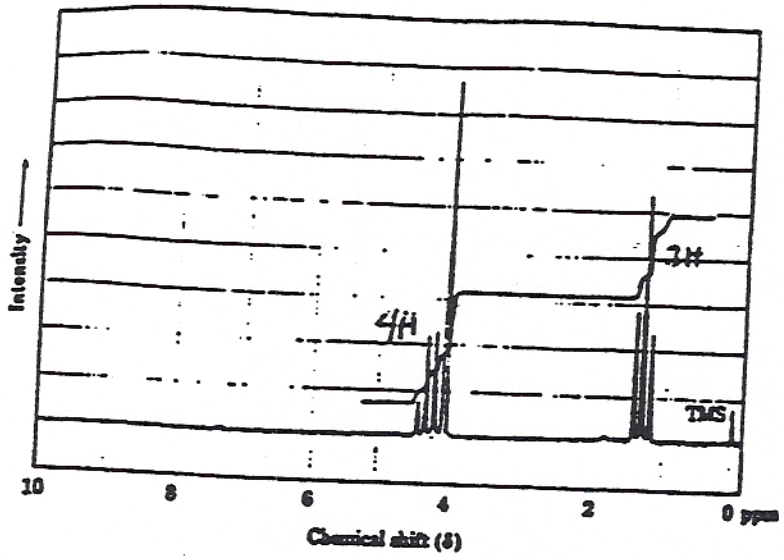
1745 → ester





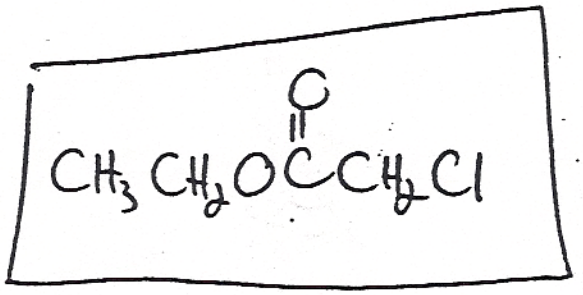
(9) $C_4H_7O_2Cl$

IR: 1740



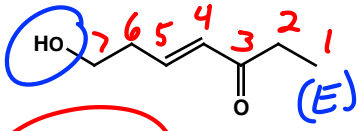
EU = 1

IR ⇒ ester

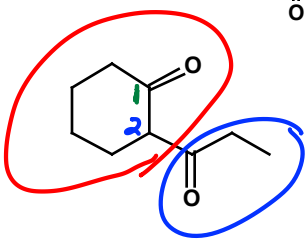


JASPERSE CHEM 360 TEST 3 VERSION 1
Ch 18 Ketones and Aldehydes
Ch 22 Additions and Conensations of Enols and Enolate Ions

1. Provide the Name for the Following (6 points)



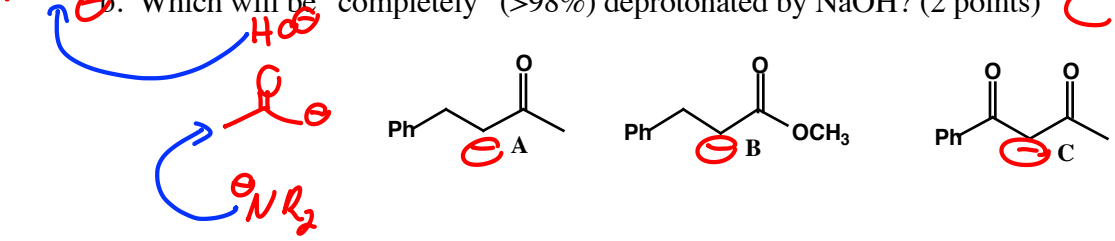
(E)-7-hydroxyhept-4-en-3-one



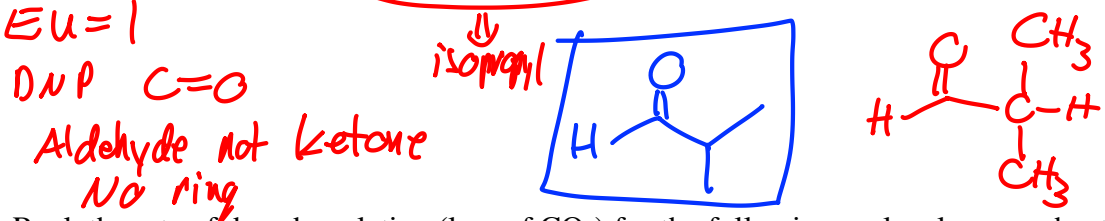
2-propanoylcyclohexanone

2. Of the following structures,
a. Which will be "completely" (>98%) deprotonated by LDA (LiN-iPr$_2$)? (2 points)
LDA deprotonates mono carbonyls
b. Which will be "completely" (>98%) deprotonated by NaOH? (2 points)

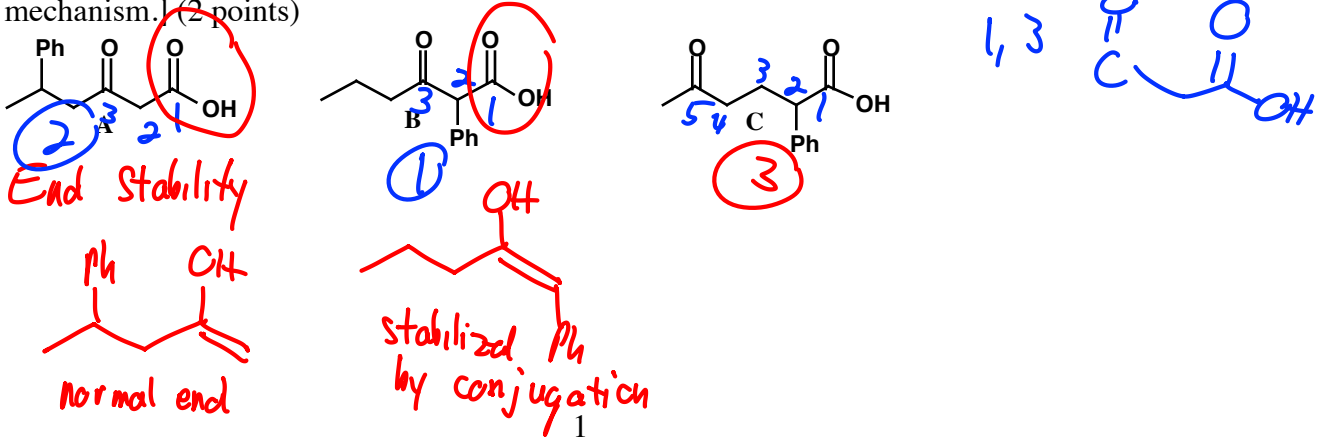
Oxyanion => dicarbonyls



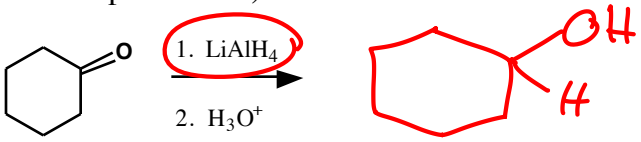
3. An unknown **X** has formula C_4H_8O. It gives 1) an orange precipitate upon treatment with 2,4-dinitrophenylhydrazine (2,4-DNP) and it gives 2) a silver mirror upon treatment with Tollen's reagent [$Ag(NH_3)_2^+OH^-$]. 3) It does not react with Br_2 in dichloromethane solvent. 4) Included in the ^{1}H NMR (incomplete) is a 6H doublet at 1.2 ppm. What is **X**? (4 points)

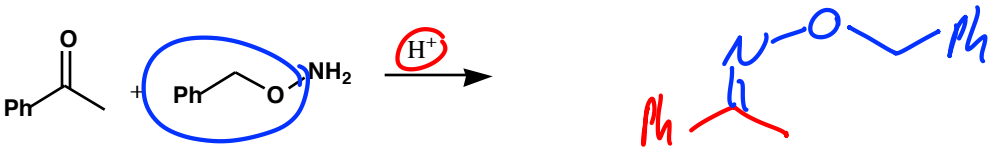


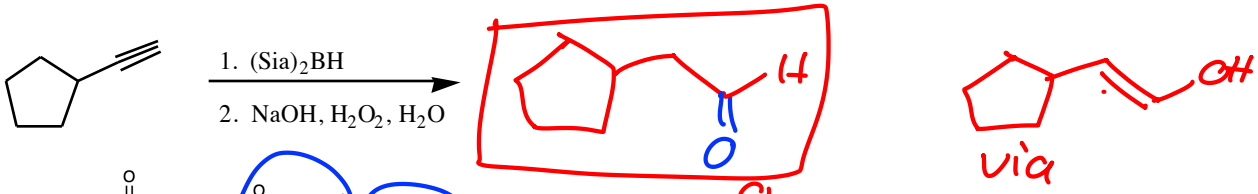
4. Rank the rate of decarboxylation (loss of CO_2) for the following molecules upon heating, with 1 being highest, 2 being next, and 3 being not at all. [Hint: Two out of the three will react, one will not, so you should be able to identify the unreactive isomer. To compare the reactivity of the two reactive isomers, the phenyl substituent impacts the relative stabilities in the key step of the mechanism.] (2 points)

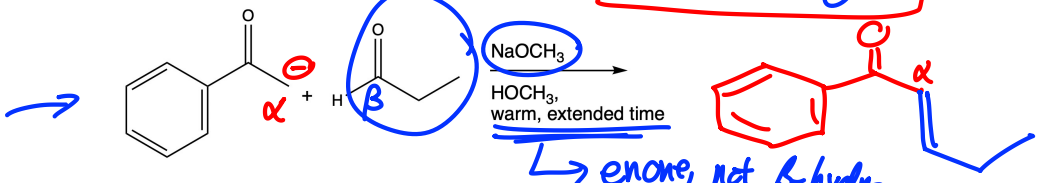


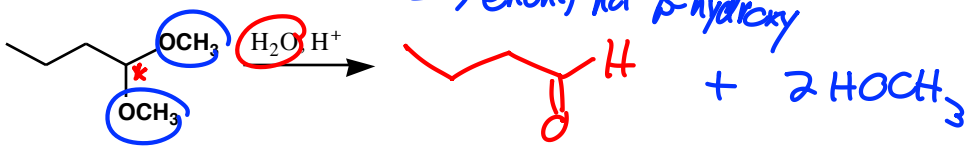
5. Synthesis Reactions. Draw the feature product of the following reactions (need not show any byproducts). NOTE: In every case, the product should be a stable, isolable **product**; an "intermediate" structure will not receive full credit. (2 or 3 points each; 1st 7 worth 2 points; last 5 worth 3 points each)

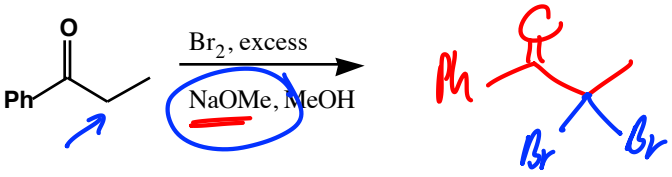


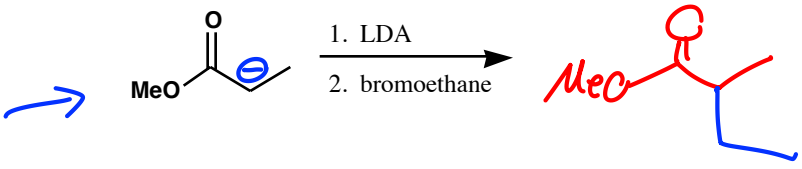


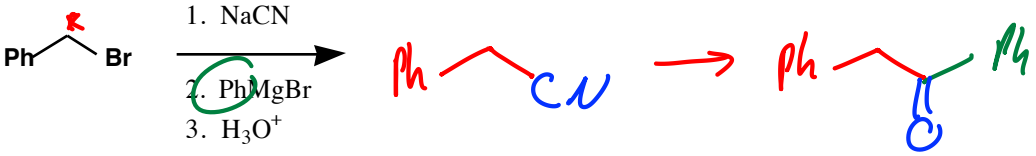


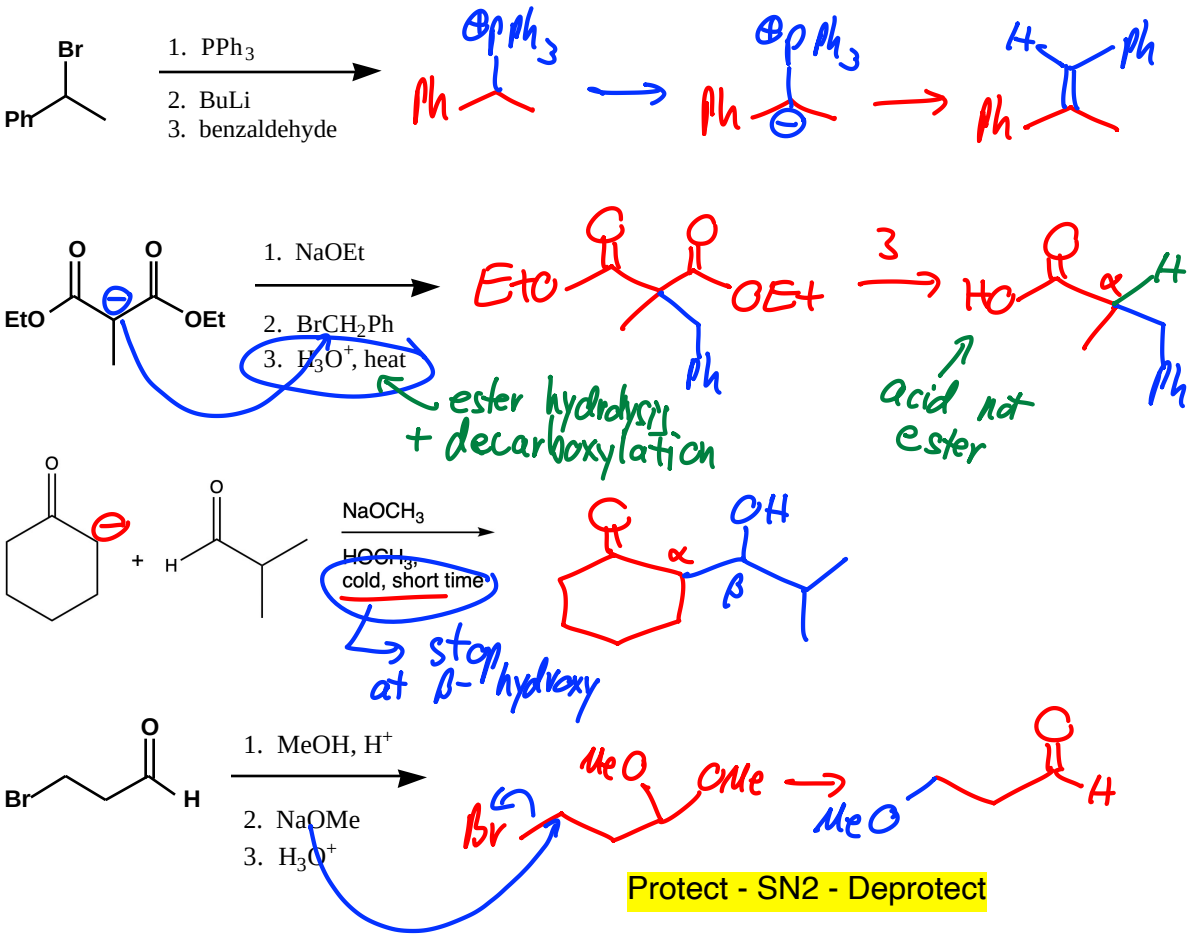




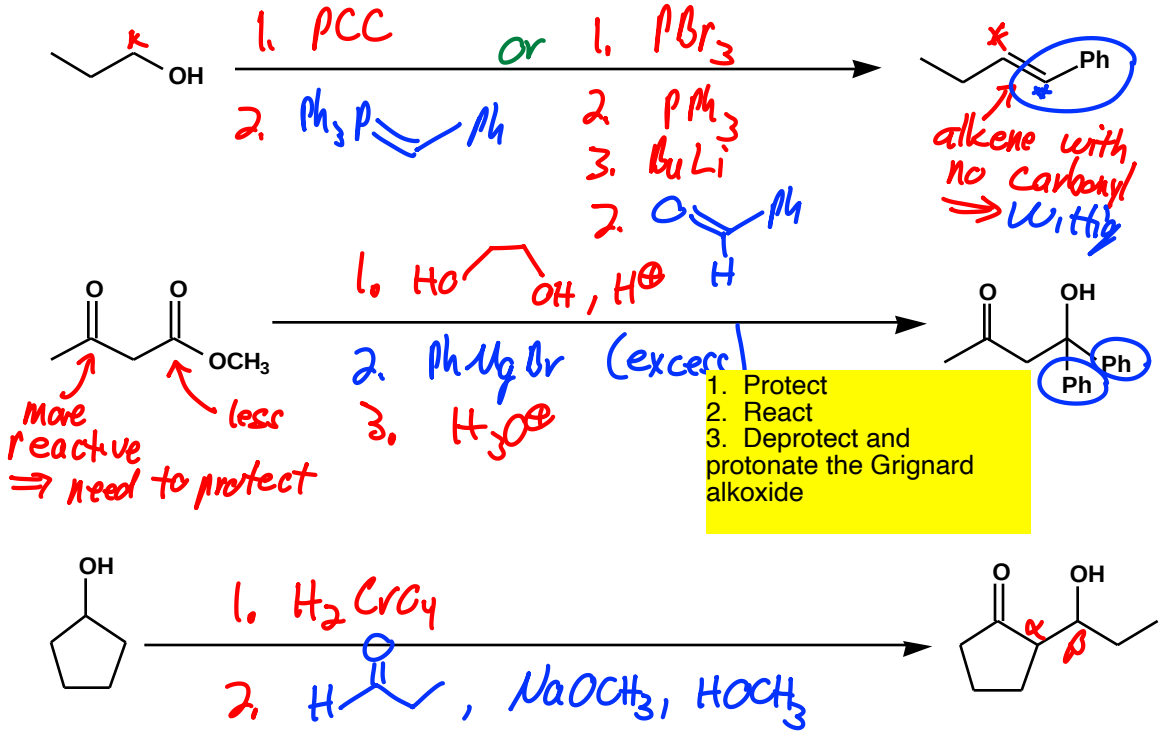




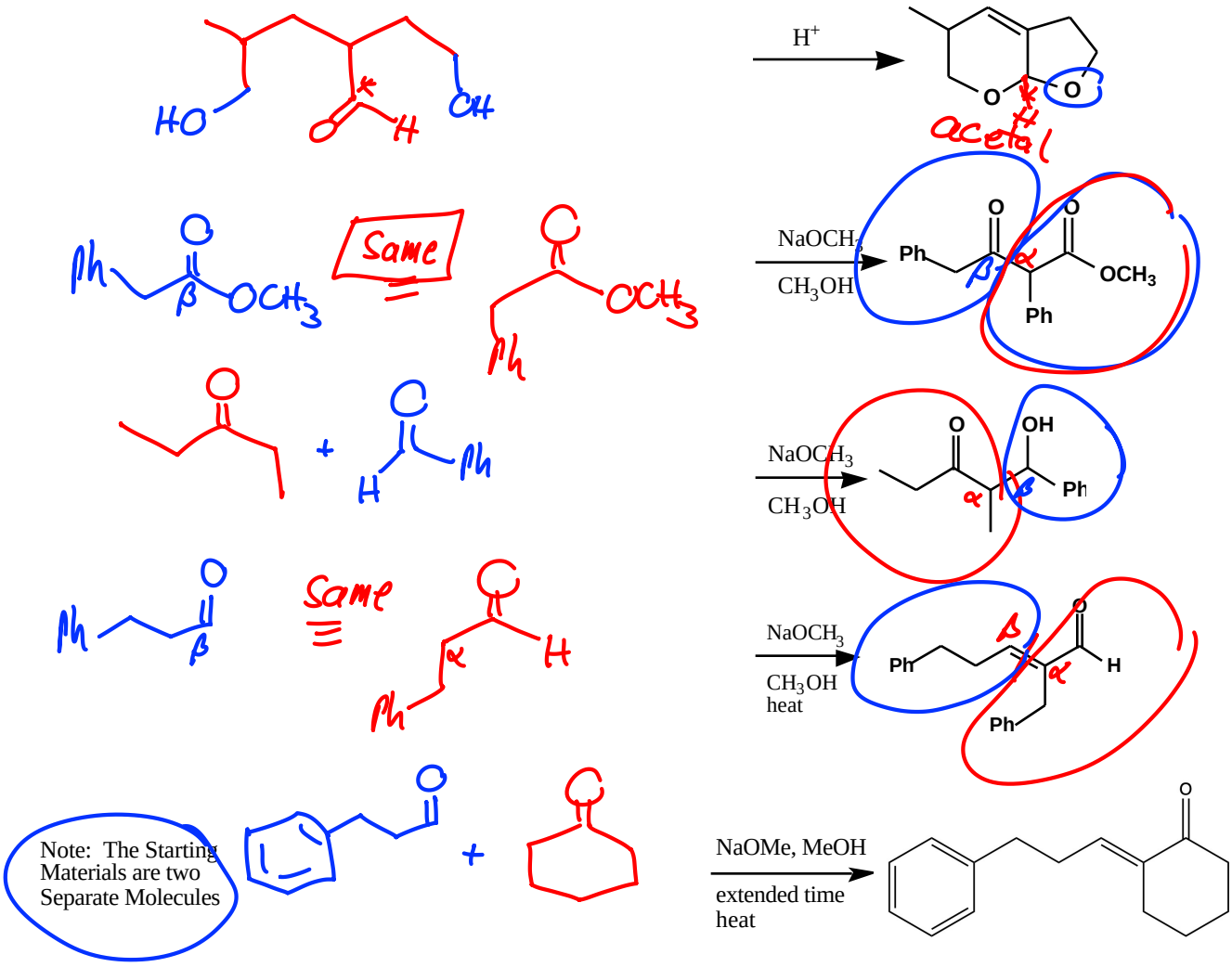




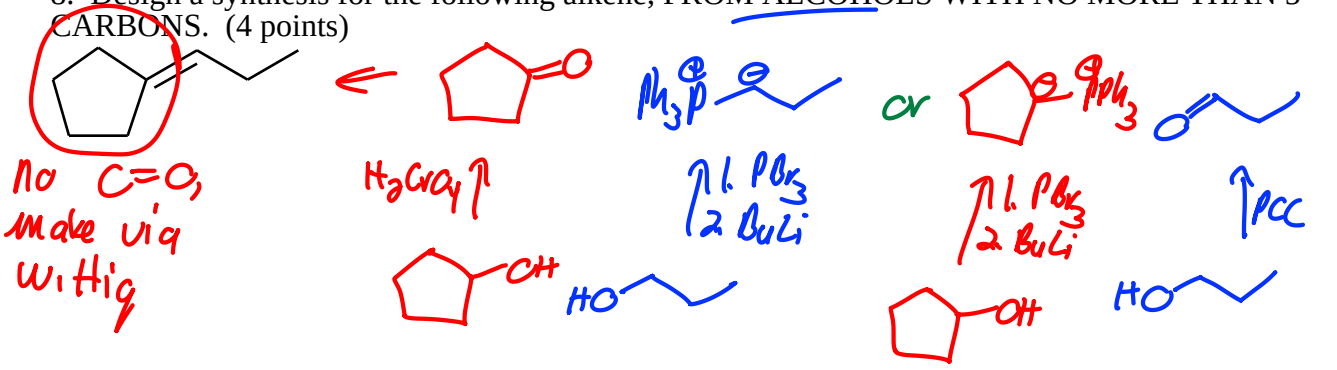
6. Provide Reagents for the Following Transformations: (4 points each)



7. Put in the starting materials from which the following structures would be produced. Depending on the product, the appropriate starting material may be either a single molecule, two of the same molecule, or two different molecules. For the last problem, you are required to start from two separate molecules. (2 points each)

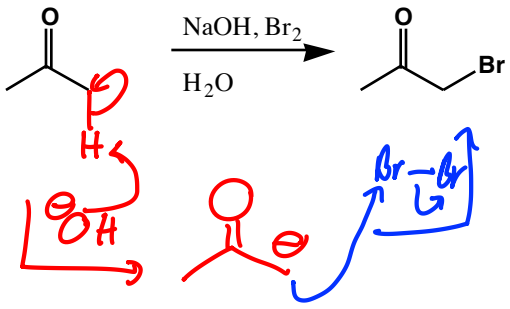


8. Design a synthesis for the following alkene, FROM ALCOHOLS WITH NO MORE THAN 5 CARBONS. (4 points)

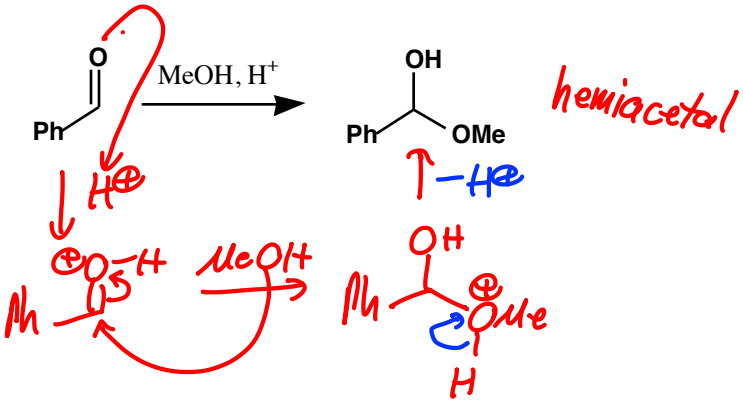


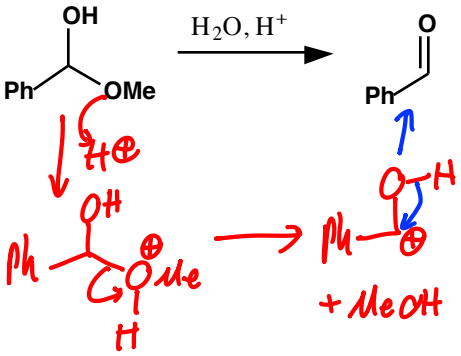
Either solution is fine, you'd not need to show both! :)

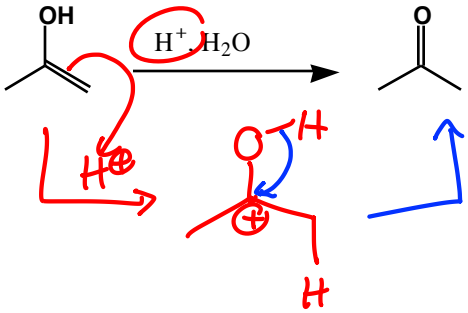
9. Provide Mechanisms for the Following Transformations. [Note: Some of these do not represent "clean" reactions; the product shown might go on to further reactions, or the reaction might be reversible, or the product might not be isolable. But that shouldn't prevent you from drawing the mechanism for the transformation indicated!] (3 points each)

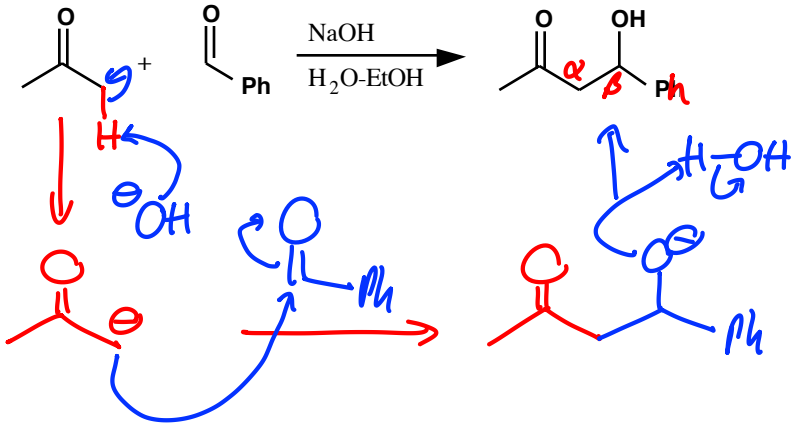


1. Deprotonate
2. React with Br2 electrophile

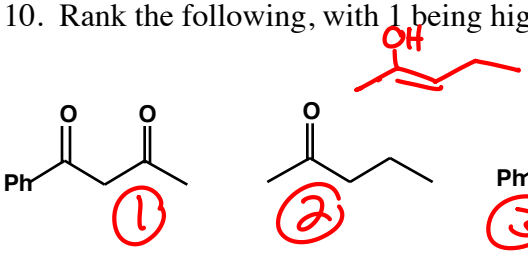








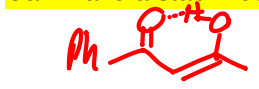
10. Rank the following, with 1 being highest, or most. (2 points each)

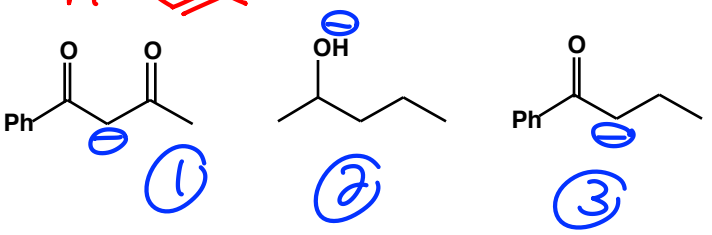


Relative amount in the "enol" form at equilibrium

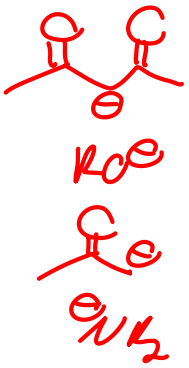
Can make a stabilized enol

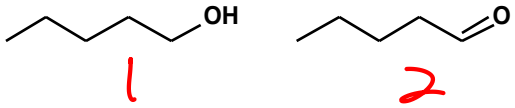
No alpha-H, no enol possible



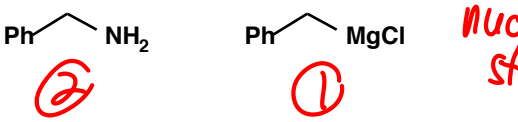


Acidity



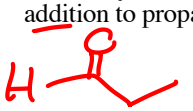


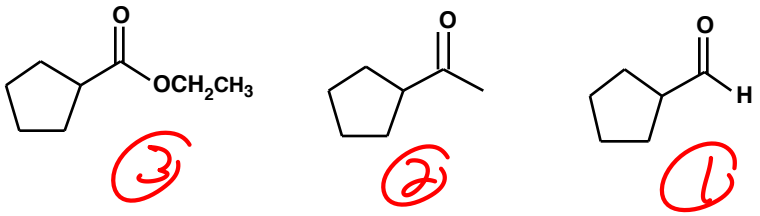
Boiling Point



Nucleophile strength

Reactivity toward addition to propanal



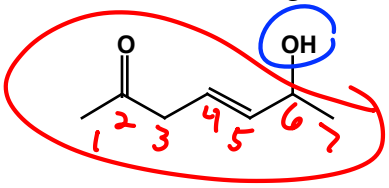


Reactivity toward either MeOH/H^+ or PhLi (pattern is the same with either one)

Aldehyde > ketone > ester

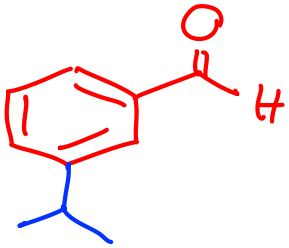
JASPERSE CHEM 360 TEST 3 VERSION 2
Ch 18 Ketones and Aldehydes
Ch 22 Additions and Conensations of Enols and Enolate Ions

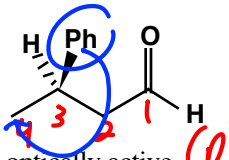
1. Nomenclature. Provide the structure or the name for the following. If stereochemistry is a factor, do not neglect it. (6 pt)



(E)-6-hydroxyhept-4-en-2-one

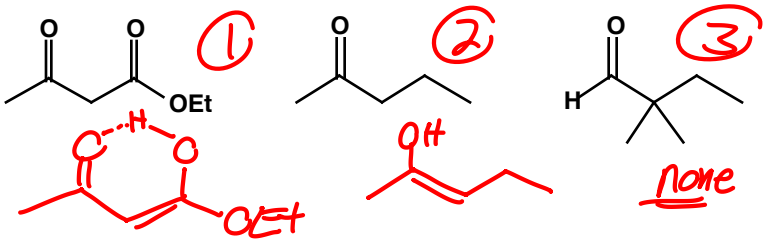
3-isopropylbenzaldehyde





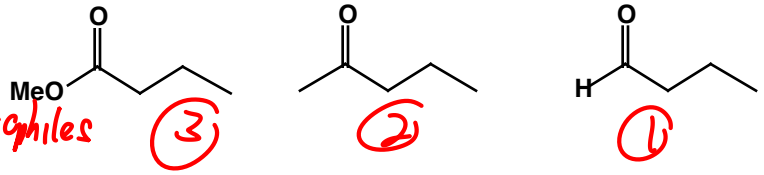
optically active (R)-3-phenylbutanal

2. Rank the following, with 1 being highest, or most. (6 pt)

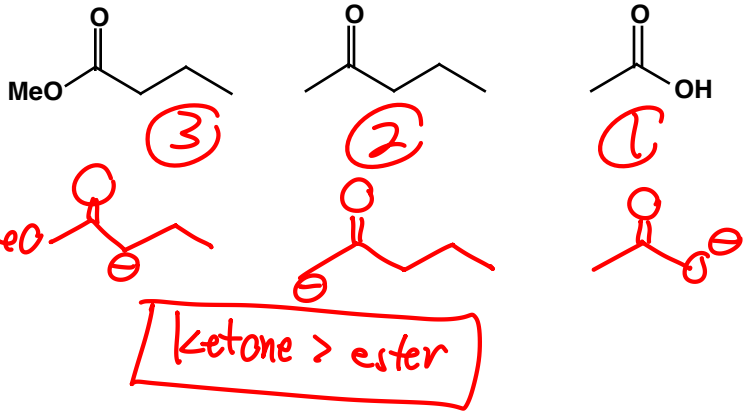


Equilibrium concentration of enol ⇒ need α-H

As Electrophiles



Reactivity toward MeMgBr



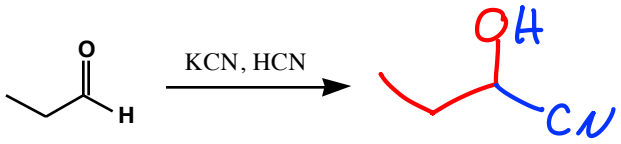
Acidity

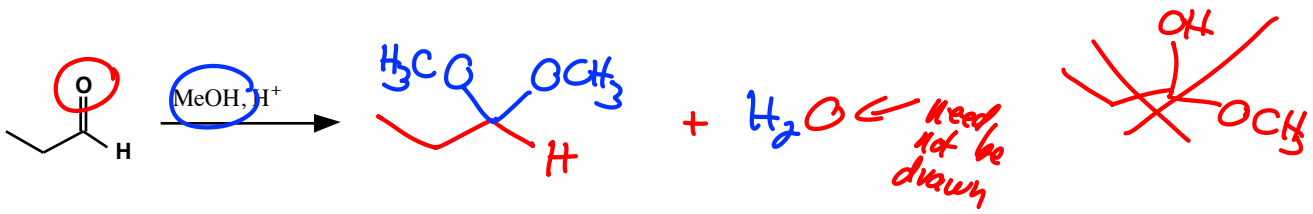
Ketone > ester

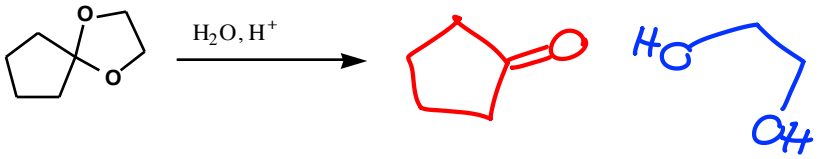
3. Draw the products for the following reactions (3 pt each)

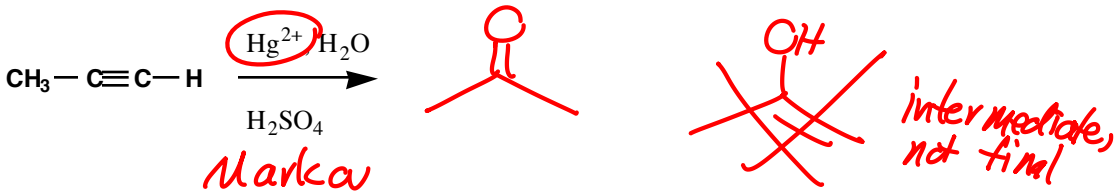
Carbonyl reactant:
1. Addition acidic?
2. Addition anionic?
3. Enolate Anionic

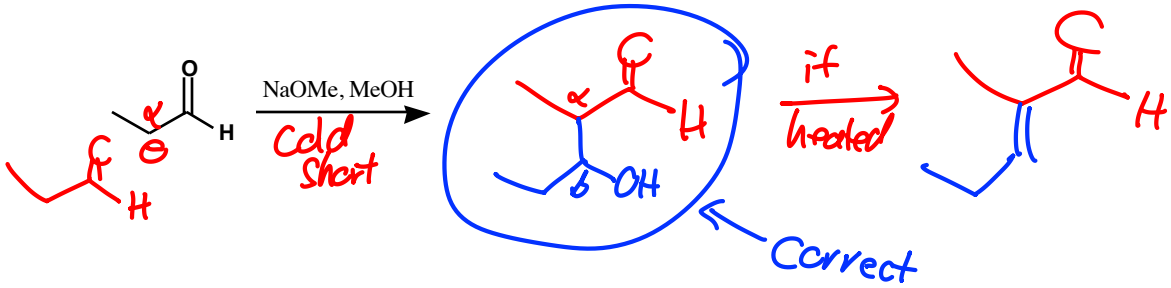
Products must be isolable, stable.

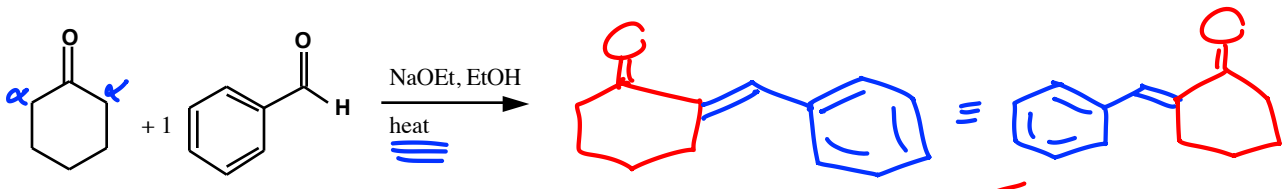


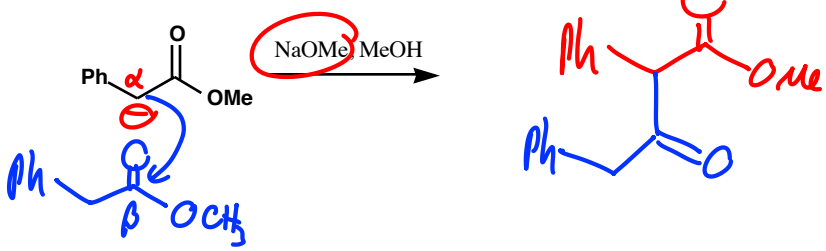




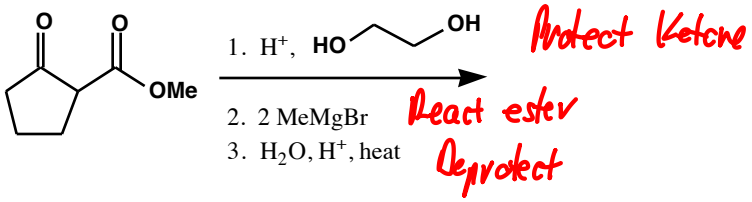


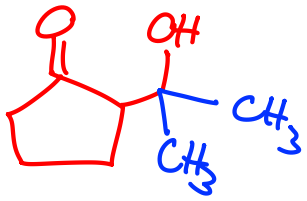


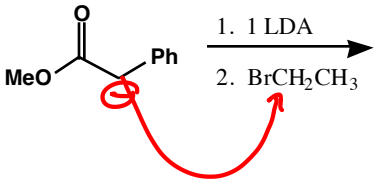


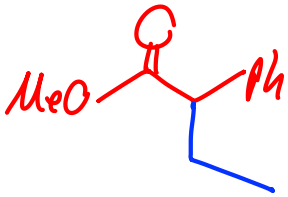


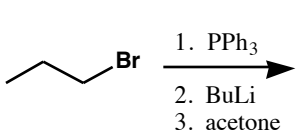
4. Draw the products for the following multistep reactions. (3 pt each)

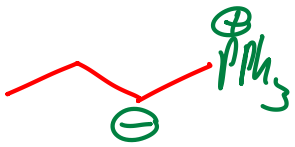


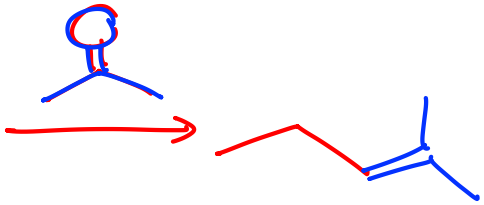


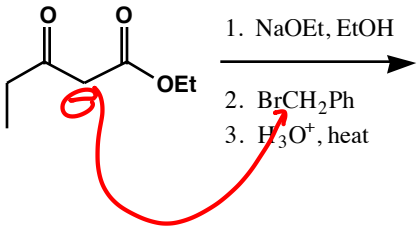


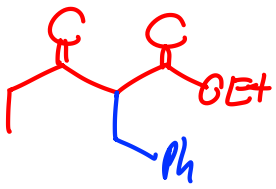


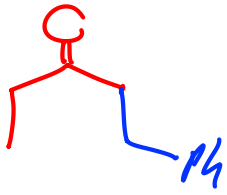




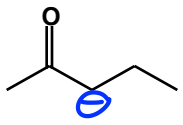


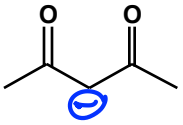
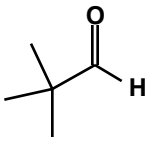






5. For the following chemicals, describe the extent to which each would be deprotonated by LDA (LiN-iPr_2) or by NaOH at equilibrium. Fill in all 6 boxes. Options are complete deprotonation (A), a little deprotonation (B), and no deprotonation (C). (6 pt)

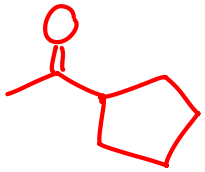


	LDA	NaOH
	A	B
	A	A
 no α-H	C	C

Options:
A = completely (~100%)
B = a little, but not much (< 10% but not 0%)
C = none at all (0%)

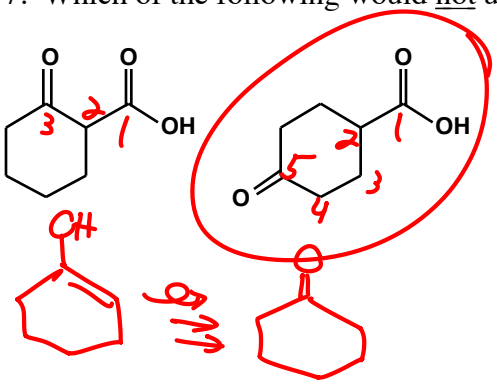
6. Suggest a plausible structure consistent with the following information. (5 pt)
a. It reacts positively with 2,4-dinitrophenylhydrazine. ald or ketone
b. It reacts positively with NaOH/I_2, the iodoform test methyl ketone
c. It does not react with Tollen's reagent [$Ag(NH_3)_2^+OH^-$]. not aldehyde
d. It does not react with Br_2 in dichloromethane solvent. no alkene
e. Chemical formula is **$C_7H_{12}O$** 16-12=4H short 2 EU
f. It's ^{13}C spectrum shows 5 carbons (1 singlet, 1 doublet, 2 triplets, and 1 quartet)

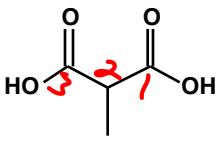
2 EU
1 C=O methyl ketone
1 ring



other solutions but needs C=O and a ring

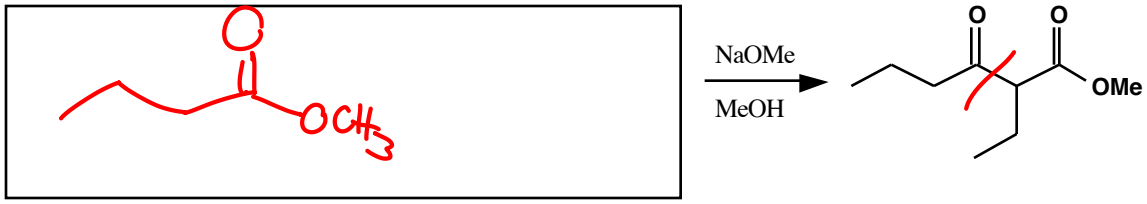
7. Which of the following would not undergo decarboxylation (loss of CO_2) upon heating? (2 pt)

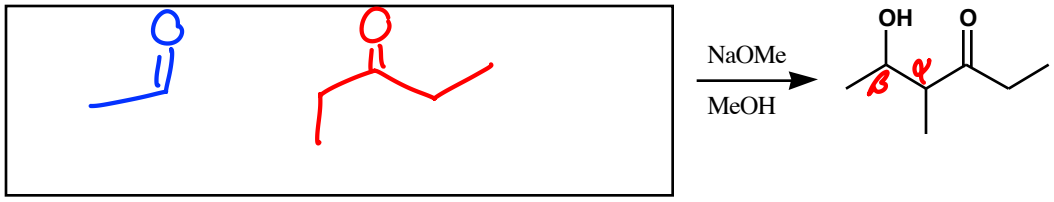


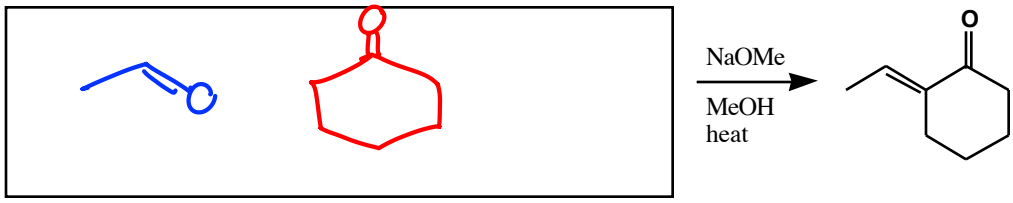


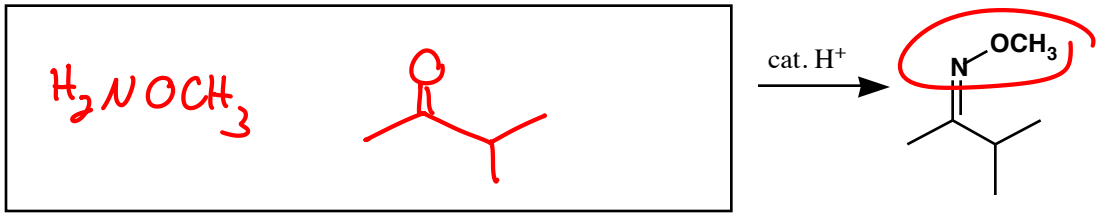
1,3 carbonyl acid only way to go through enol mech

8. Put in the starting materials from which the following would be made. (3 each)

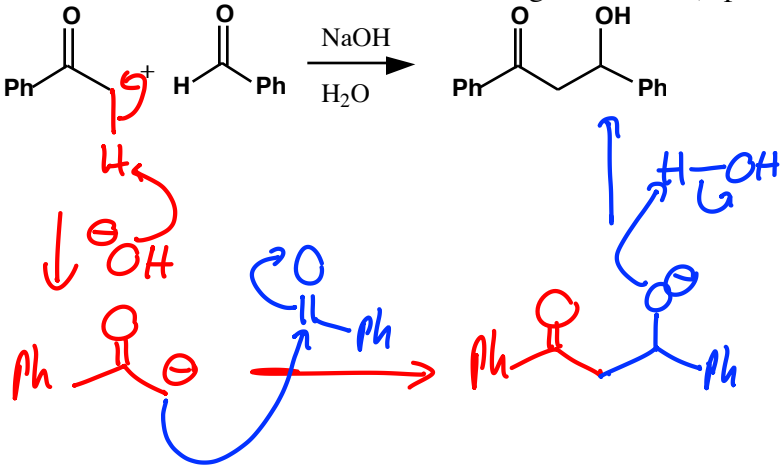




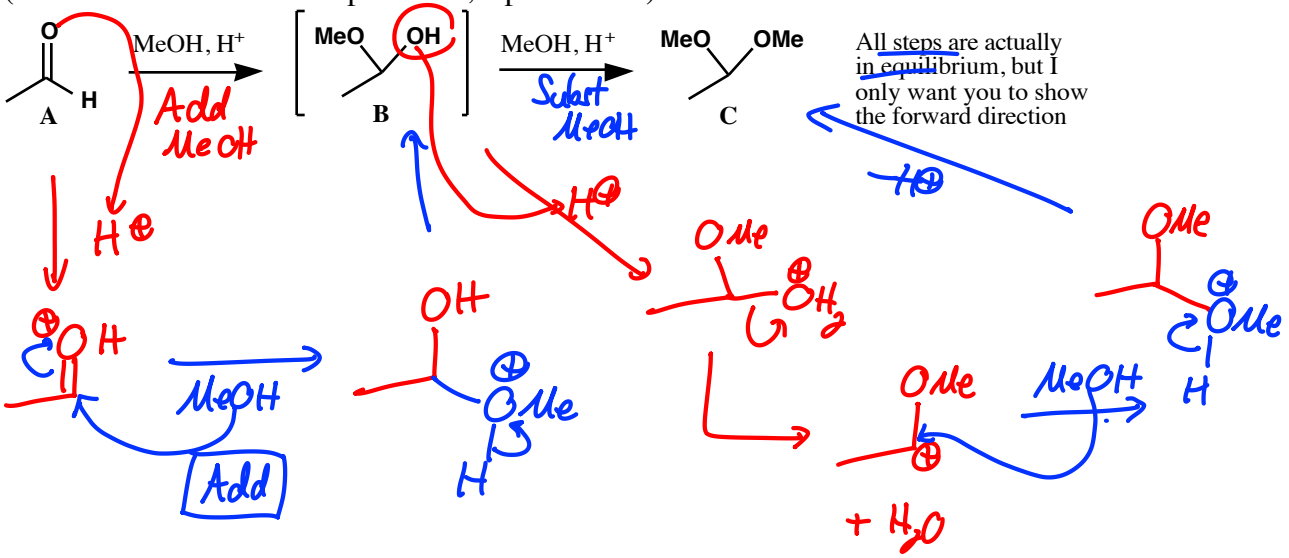


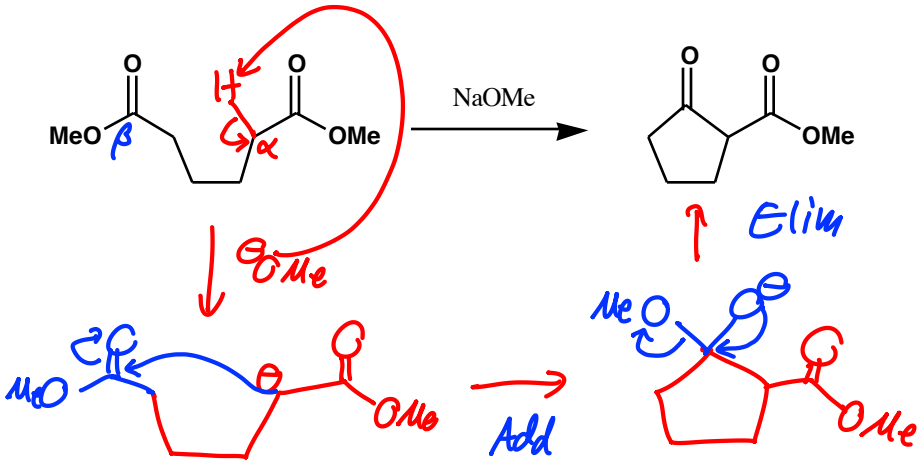


9. Draw the mechanisms for the following reactions. (4 pt each)

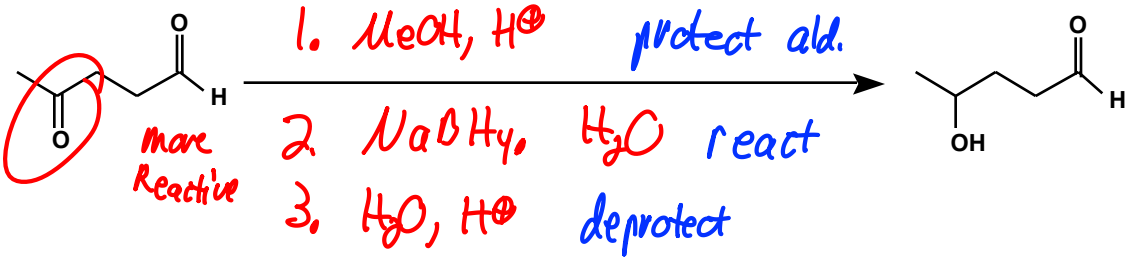


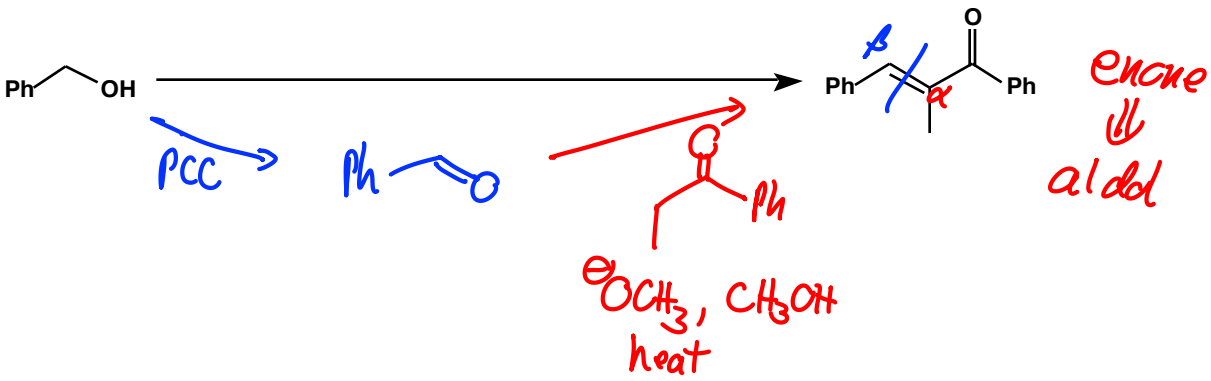
(Note: this one counts as 2 problems, 8 points total)



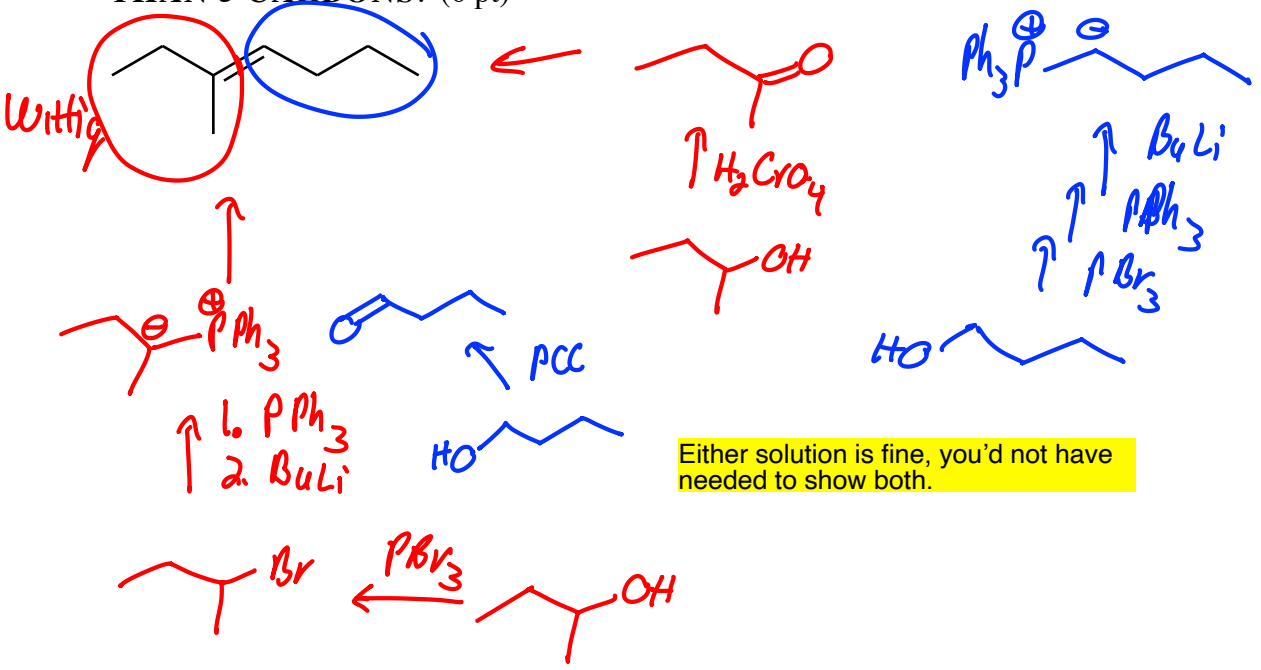


10. Provide reagents for the following transformations. (4 pt each)





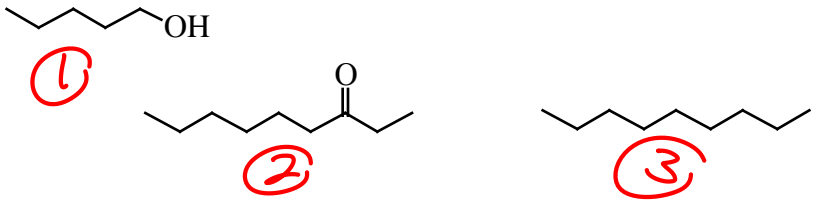
11. Design a synthesis for the following alkene **FROM ALCOHOLS WITH NO MORE THAN 5 CARBONS**. (6 pt)



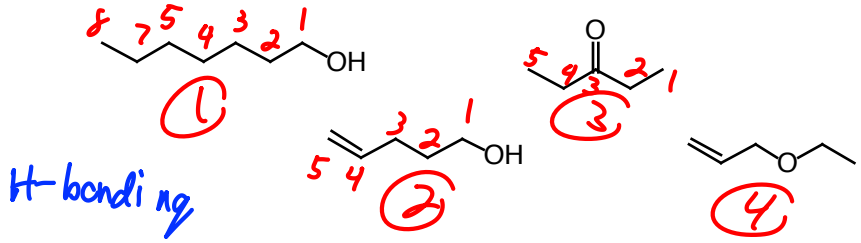
Either solution is fine, you'd not have needed to show both.

JASPERSE CHEM 360 TEST 3 VERSION 3
Ch 18 Ketones and Aldehydes
Ch 22 Additions and Conensations of Enols and Enolate Ions

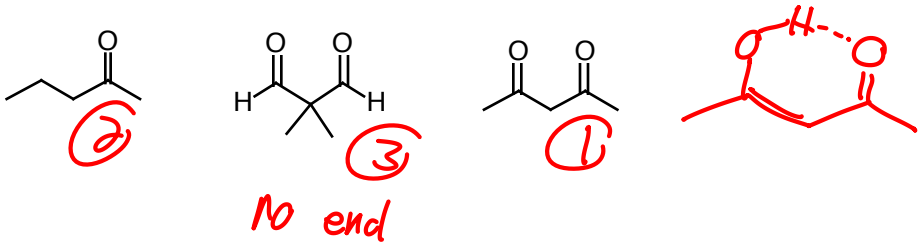
1. Physical Properties.
   a. Rank the following according to solubility in water, 1 being most soluble, 4 being least soluble.



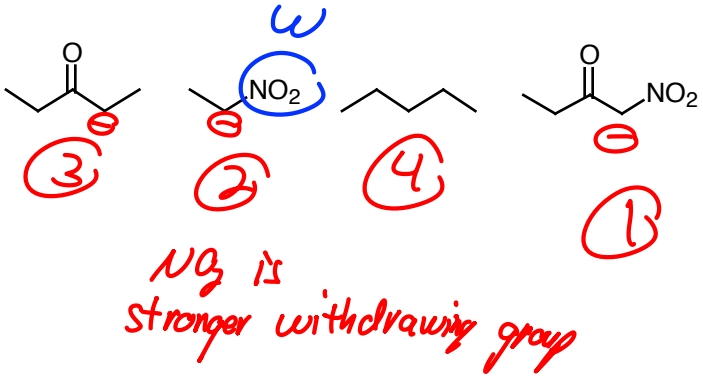
b. Rank the following according to boiling point, 1 being highest boiling, 4 lowest boiling.



c. Rank the following according to equilibrium enol content, 1 having the most and 3 the least enol.

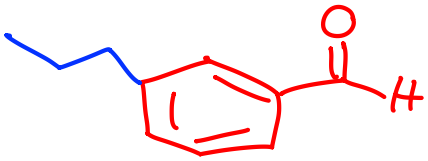


d. Rank the following according to acidity, 1 being most acidic and 4 least acidic.

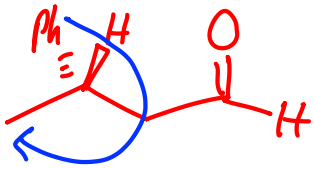


2. **Nomenclature**. Provide Either the Name or the Structure for the Following Chemicals. (10 points)

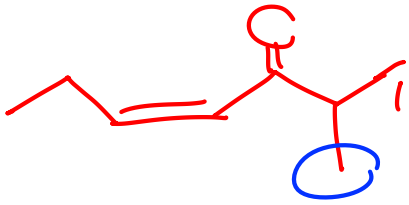
a. 3-propylbenzaldehyde



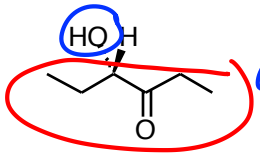
b. (S)-3-phenylbutanal



c. (Z)-2-methyl-4-hepten-3-one

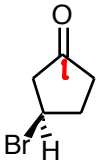


d.



(S)-4-hydroxy hexan-3-one

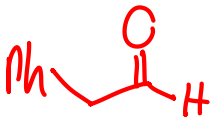
e.

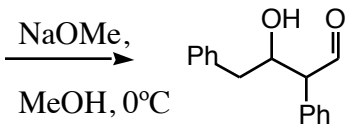


(R)-3-bromo cyclopentanone

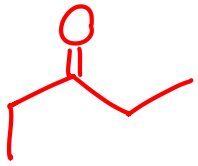
3. Identify the starting carbonyl compound or compounds from which the following aldol-type reaction products are formed. (12 points)

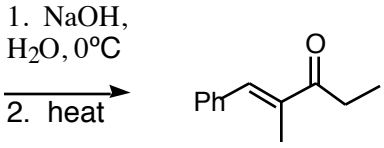
a.



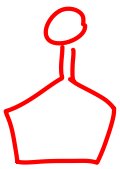


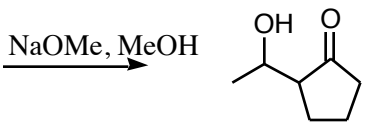
b.



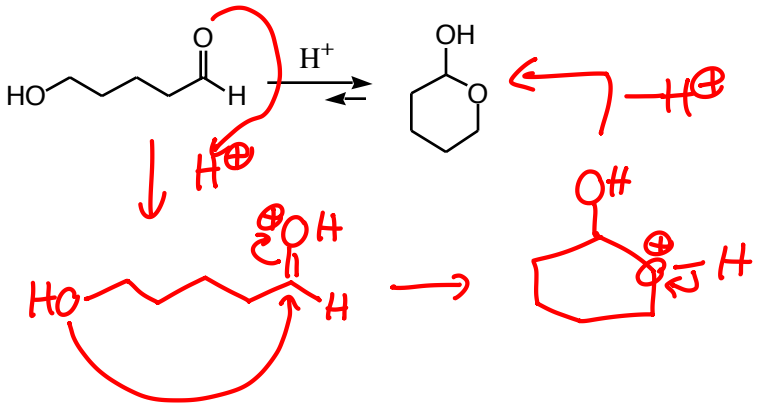


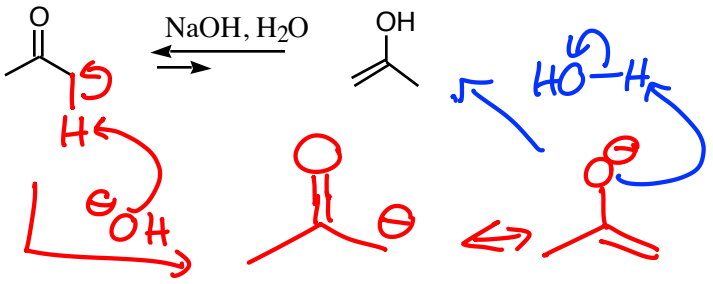
c.

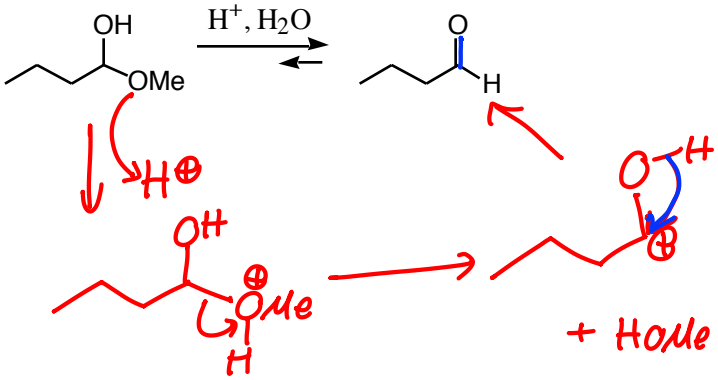


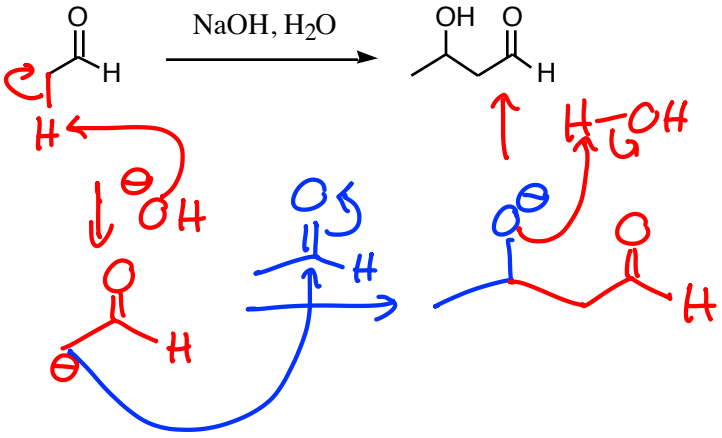


4. Draw the mechanisms for the following transformations.

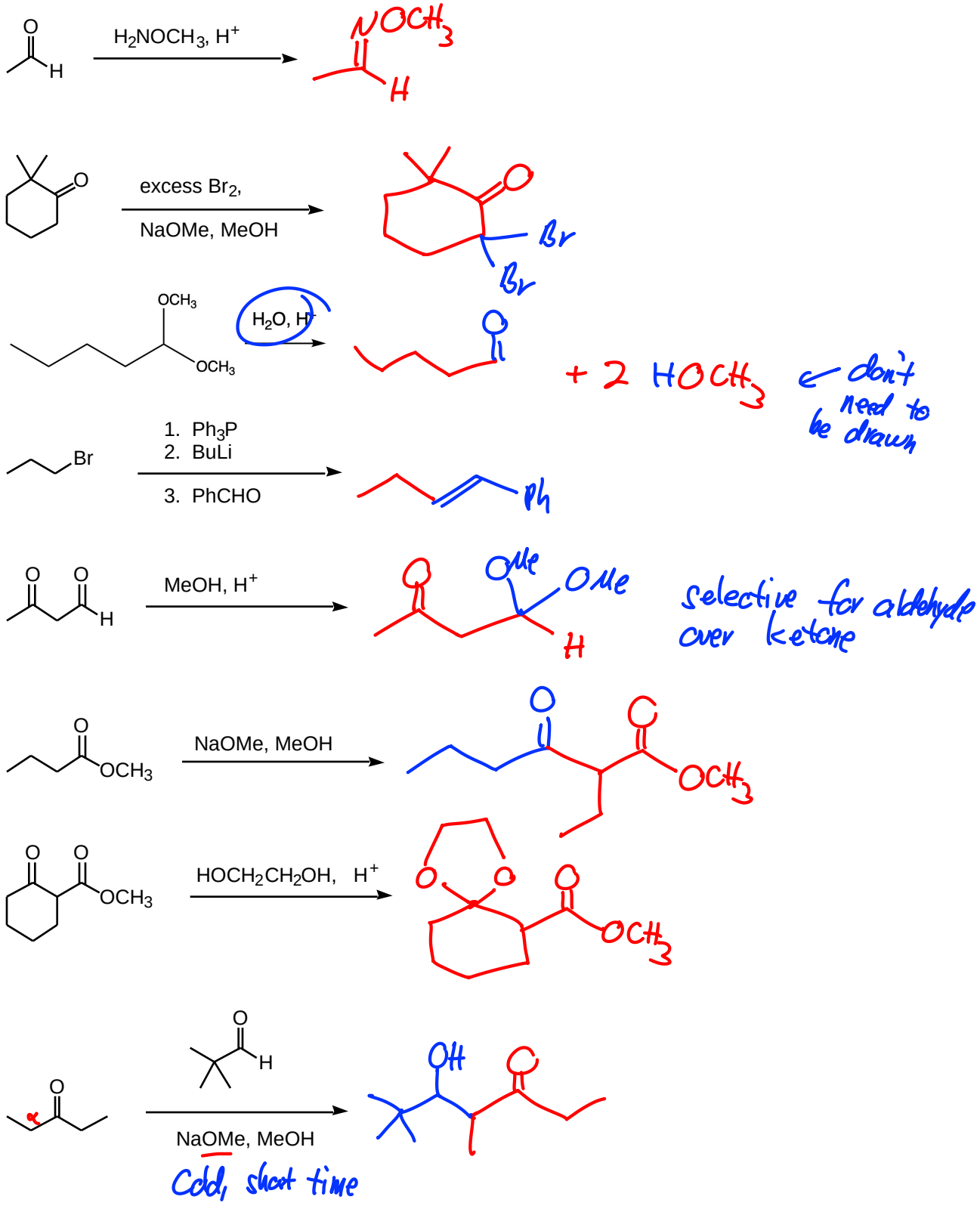


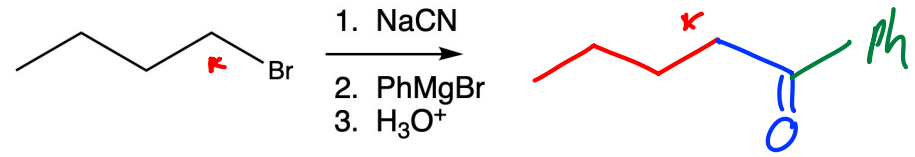


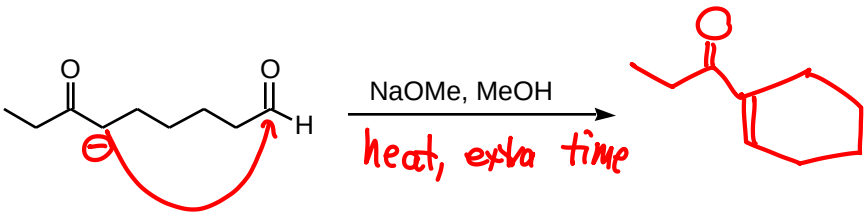


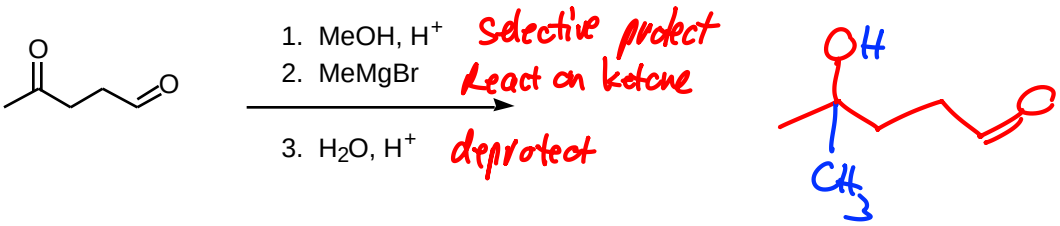


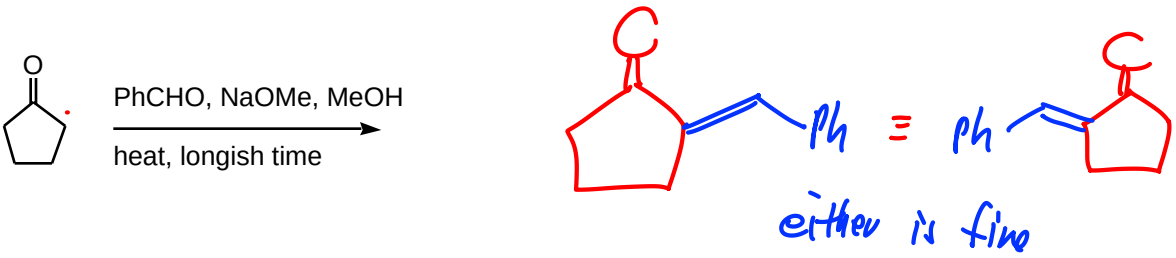
5. Draw the products for the following reactions. (2 points each)

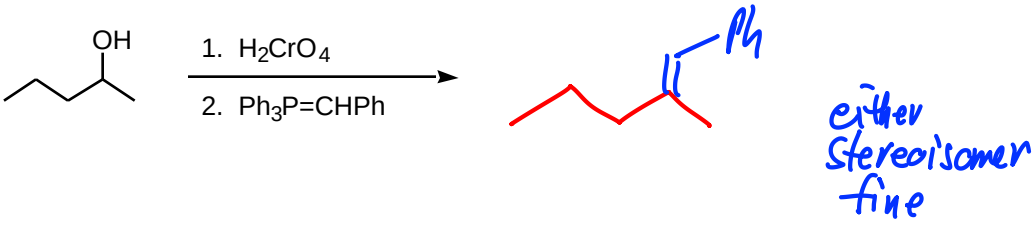



1. NaCN
2. PhMgBr
3. H_3O^+
Br
Ph
O

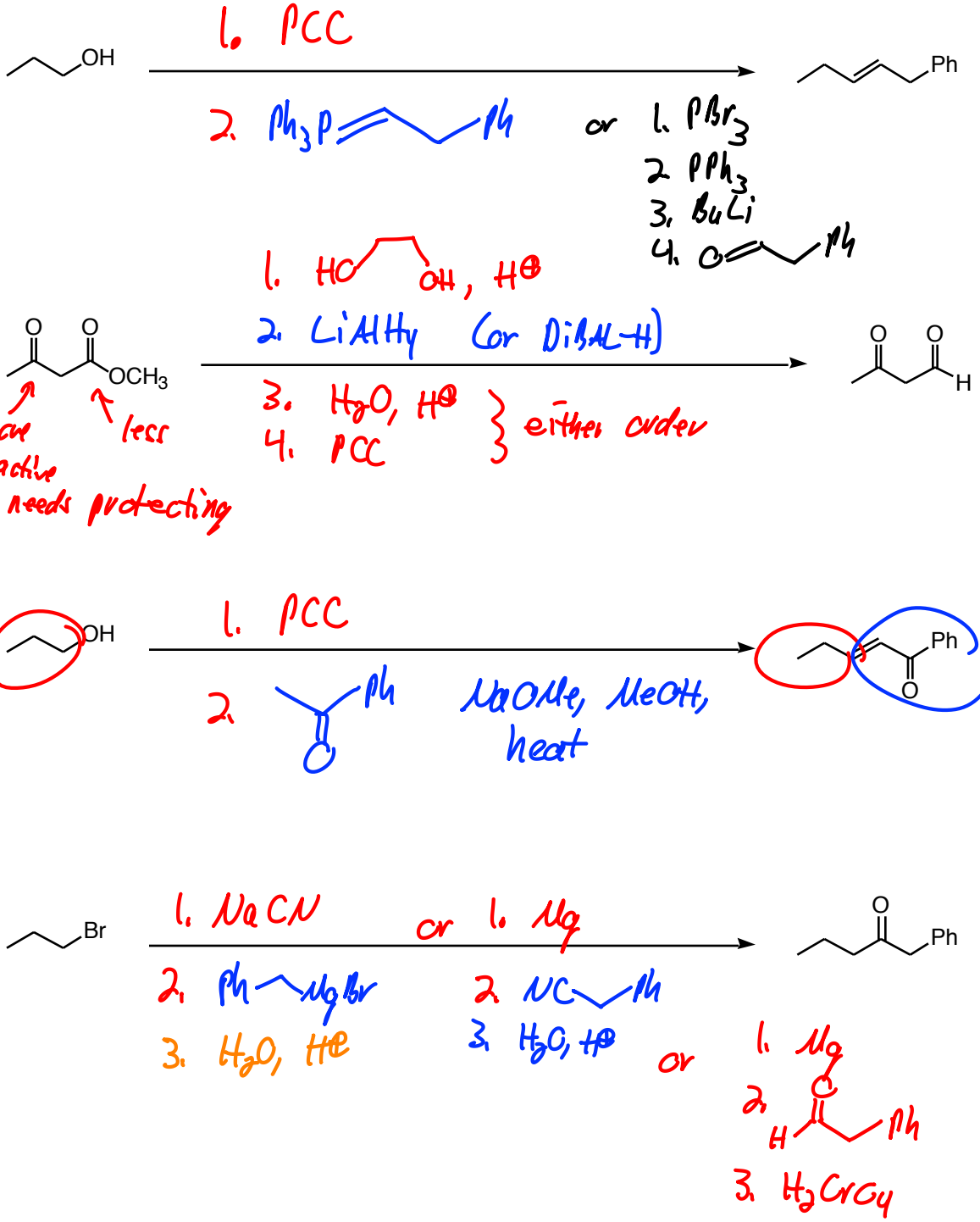

O
O
H
NaOMe, MeOH
heat, extra time


O
O
1. MeOH, H^+
2. MeMgBr
3. H_2O, H^+
selective protect
react on ketone
deprotect
OH
CH_3


O
PhCHO, NaOMe, MeOH
heat, longish time
Ph
Ph
either is fine

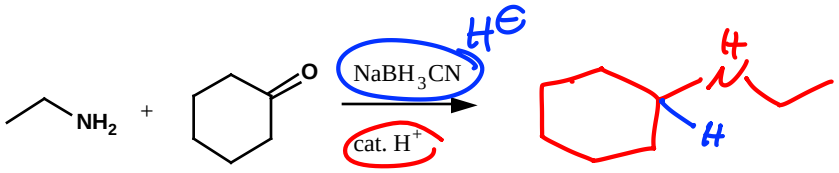

OH
1. H_2CrO_4
2. Ph_3P=CHPh
Ph
either stereoisomer fine

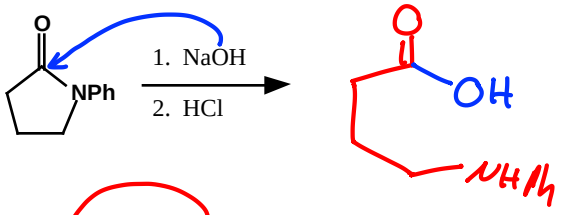
6. Provide the needed reagents for the following transformations. You may use anything you wish. The transformations can be completed within 2-4 steps.

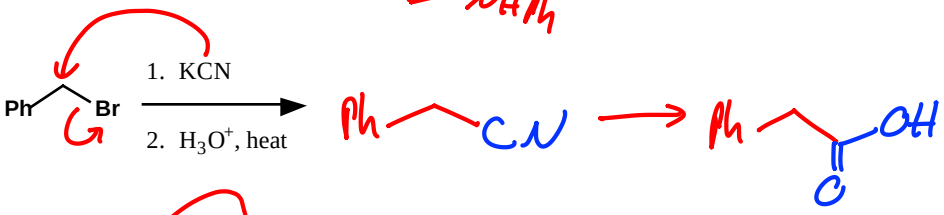


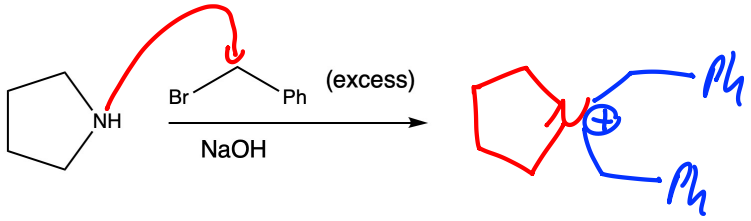
JASPERSE CHEM 360 TEST 4 VERSION 1
Ch 19 Amines
Ch 20 Carboxylic Acids
Ch 21 Carboxylic Acid Derivatieves

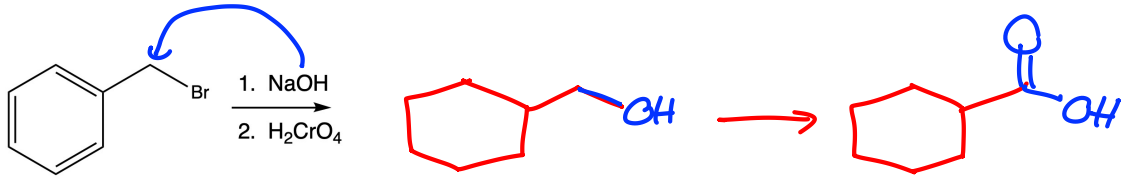
1. Synthesis Reactions. Draw the feature product of the following reactions. (3 pts each)

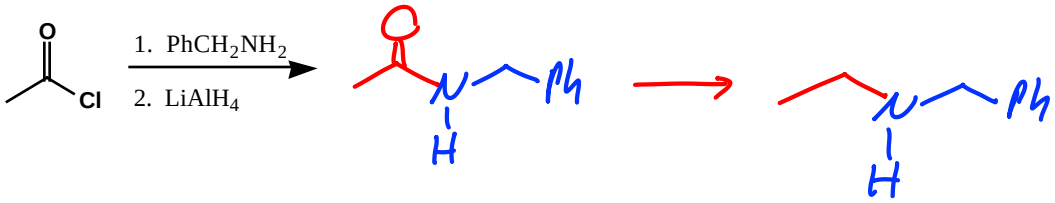


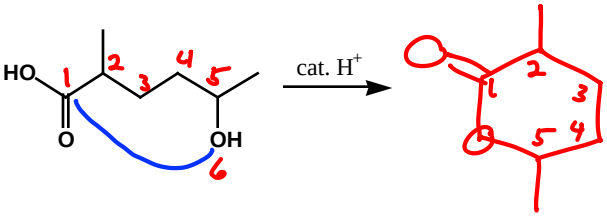


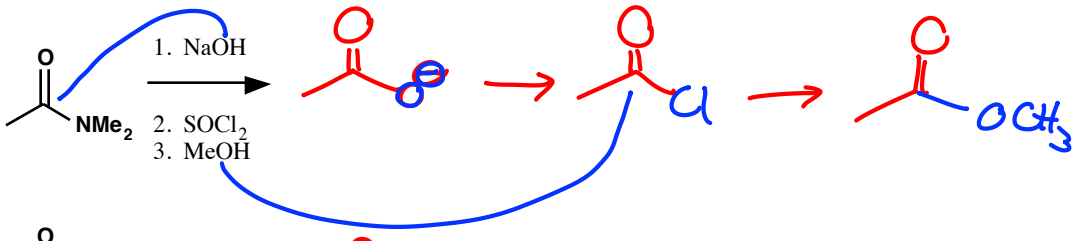


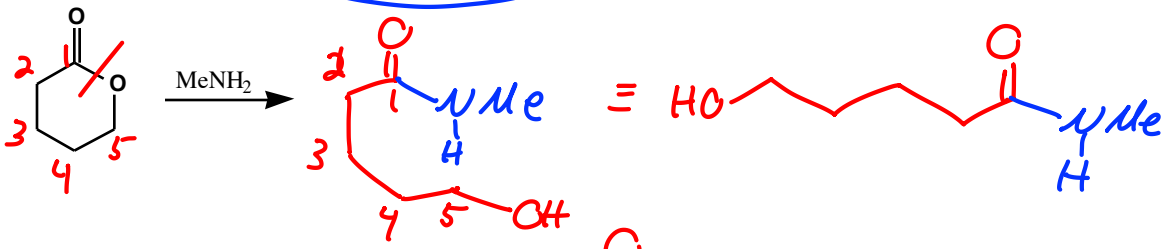


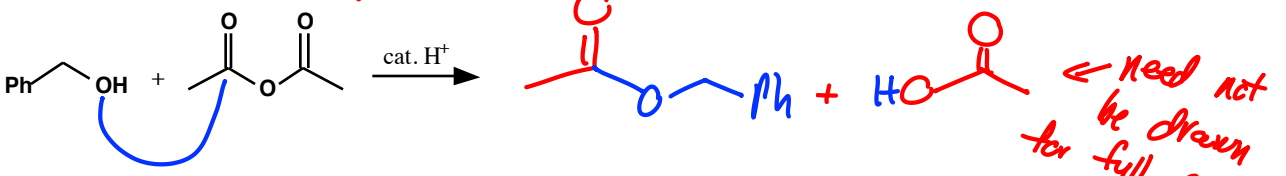




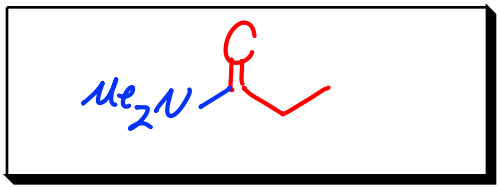


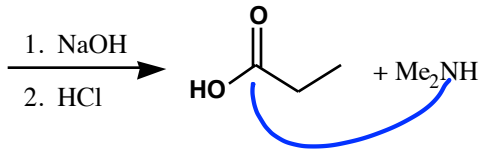


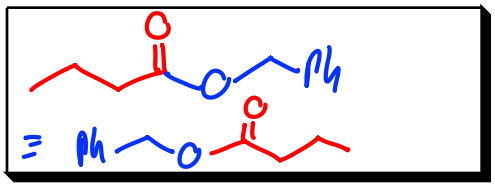


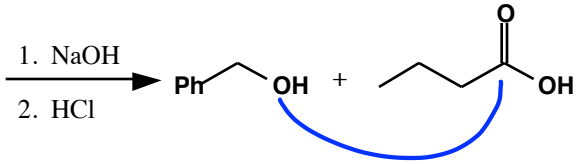


2. Draw the starting materials for the following hydrolysis reactions. (2 pts each)





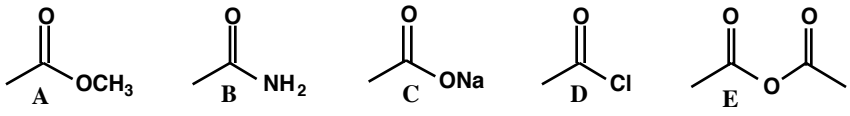




3. a) Which one(s) of the following will react spontaneously with H_2O? (2 pts) D, E

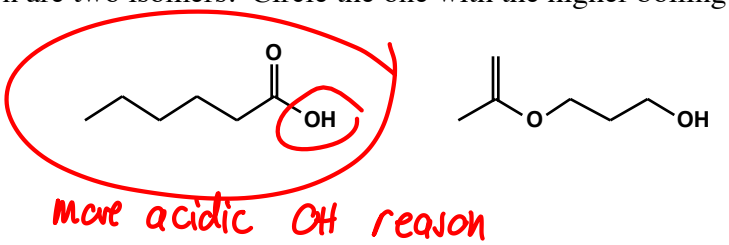
b) Which one(s) will react spontaneously with Me_2NH? (2 pts) D, E, A
[Note: there may be more than one that reacts.]

Cl
A
E
N
O

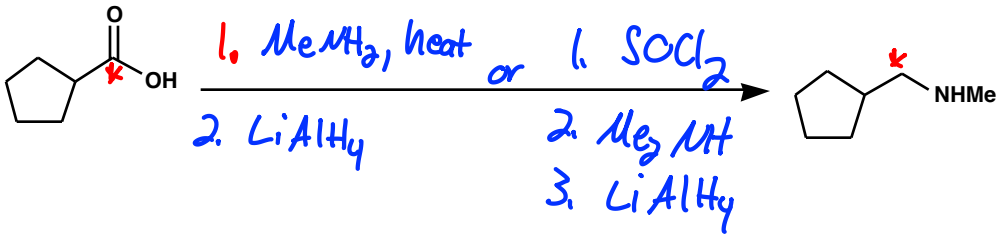


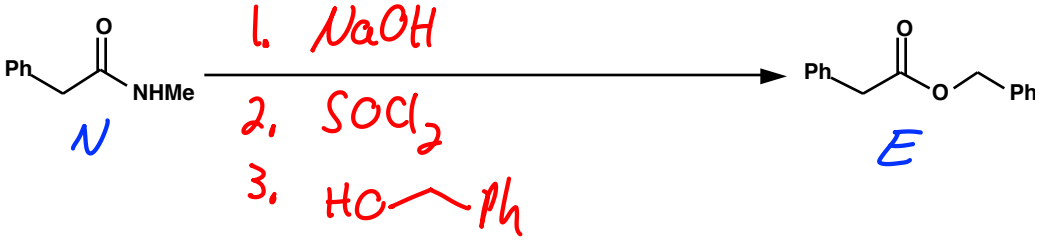
E N O Cl A

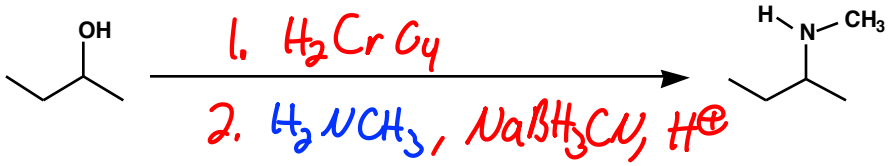
4. Shown are two isomers. Circle the one with the higher boiling point. (2 points)

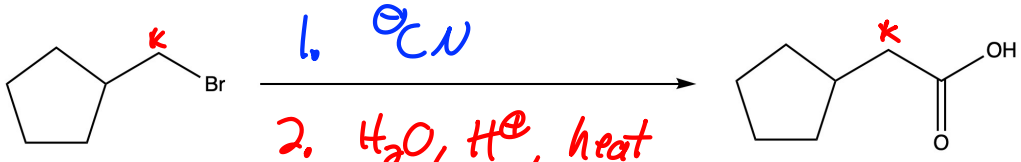


5. Provide Reagents for the Following Transformations (4 pts each)

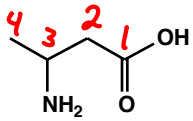






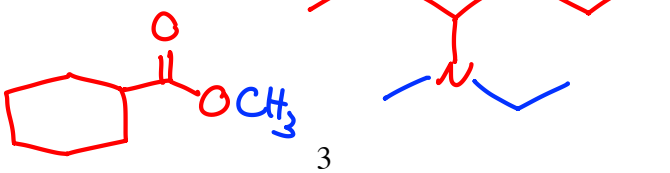


6. Name the Following or Draw the Structure (2 pts each)

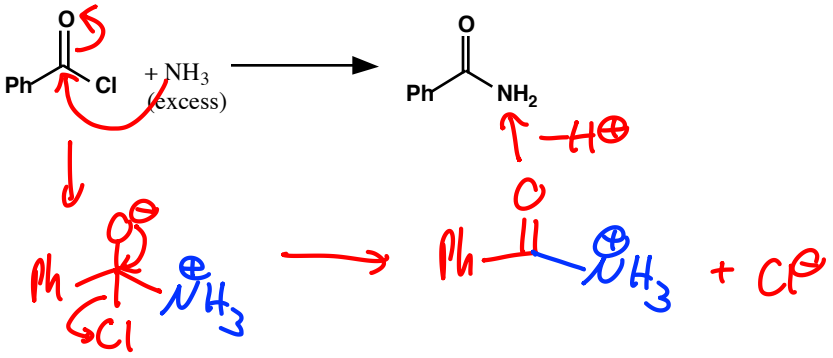
a. 

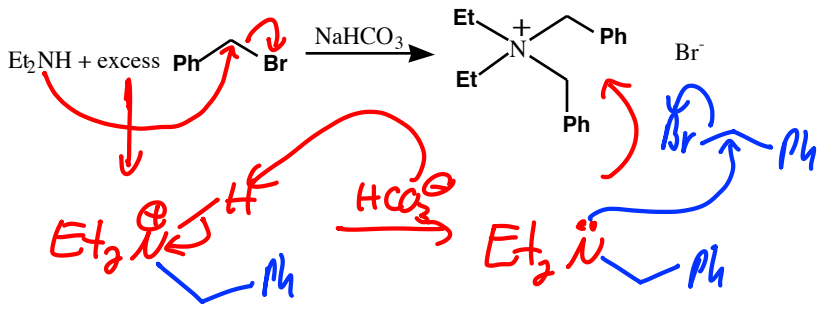
3-amino butanoic acid

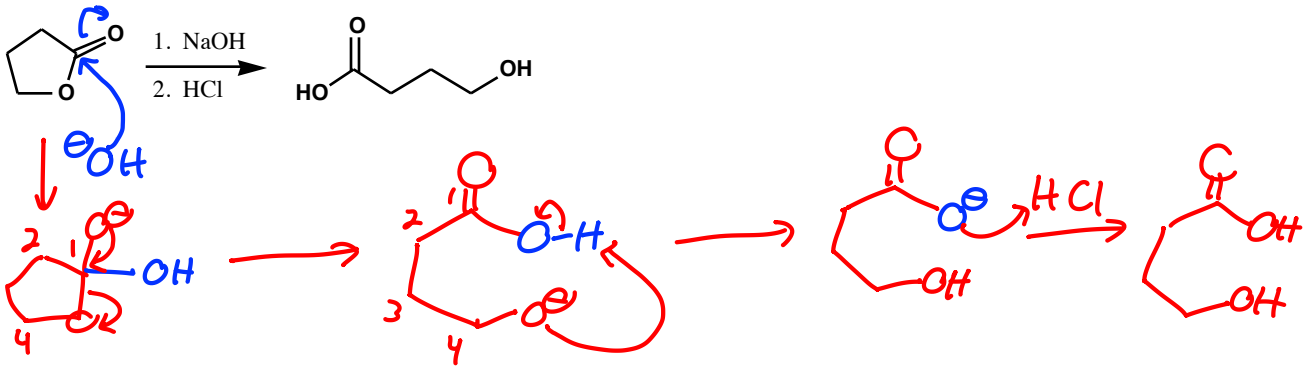
b. N-methyl-N-ethyl-3-hexanamine

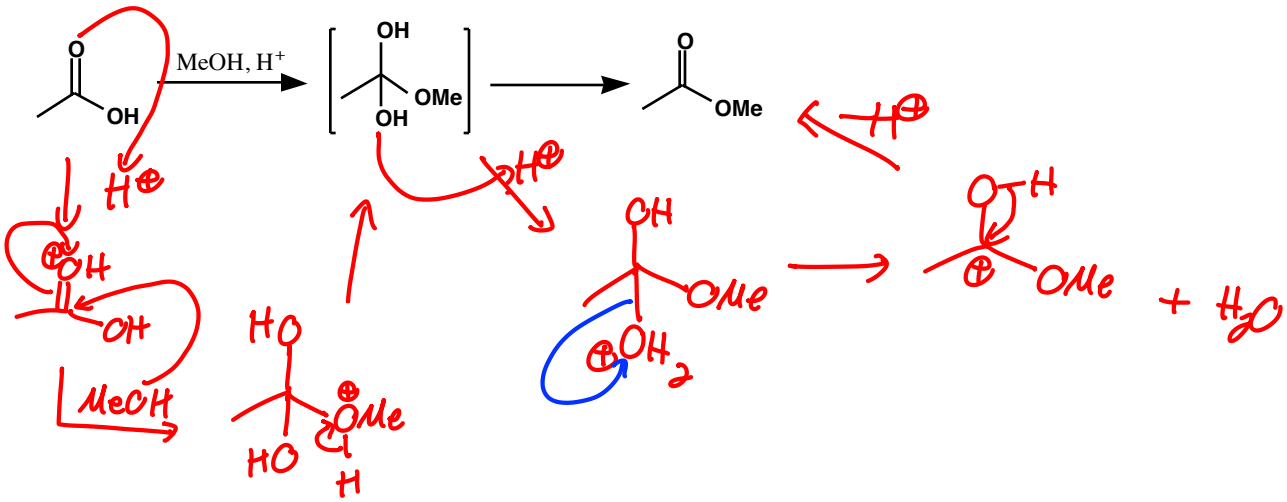
c. methyl benzoate 

7. Provide Mechanisms for the Following Reactions. (Note: In some cases, these may be "partial" reactions.) (16 points)







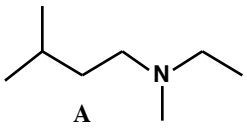


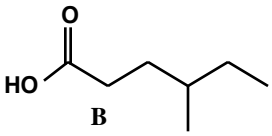
8. Which (if any) after being dissolved in diethyl ether, will: (4 points)

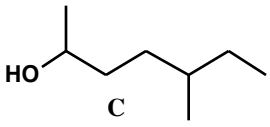
a) Extract into $NaOH/H_2O$? B

b) Extract into HCl/H_2O? A

c) Extract into neutral water? none





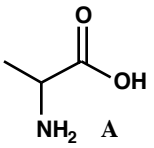


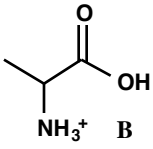
9. Of the following, which form would exist at: (4 points)

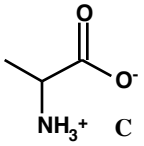
a) pH = 2 (acidic) B

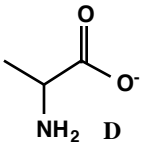
b) pH = 7 (neutral) C

c) pH = 12 (basic) D

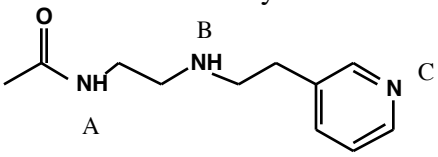








10. Rank the basicity of the three Nitrogen atoms, from most to least (1 most, 3 least). (2 pts)

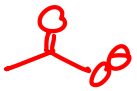


B > C > A

sp^3 sp^2 p lone pair

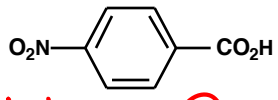
11. Rank the acidity of the following, 1 being most acidic, 3 being least (2 pts each)

a. ethanoic acid 1 $CH_3NH_3^+Cl^-$ 2 ethanol 3

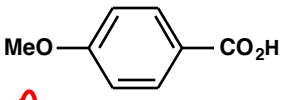


amine

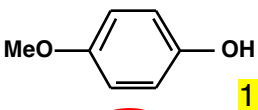
b.



W 1



D 2



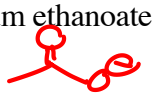
3

1. Donor/Withdrawer factor
2. RCO2H > phenol

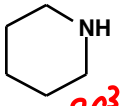
12. Rank the following in order of increasing basicity (2 points each)

a. NH_3 2 sp^3 CH_3NH_2 1 sp^3 $PhNH_2$ 3 p

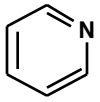
b. $NaOH$ 1 CH_3NH_2 2 sodium ethanoate 3



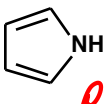
c.



1 sp^3



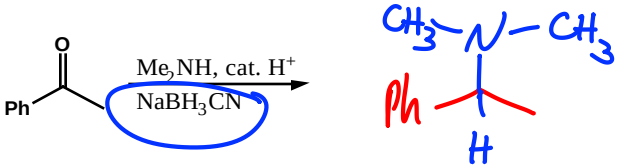
2 sp^2

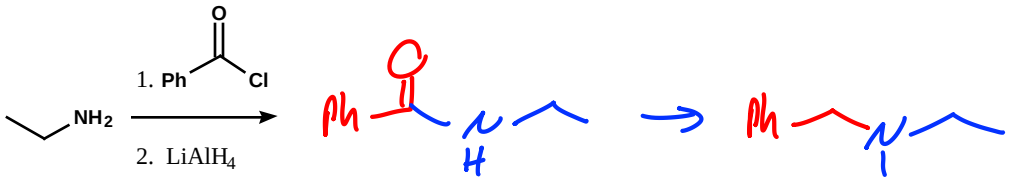


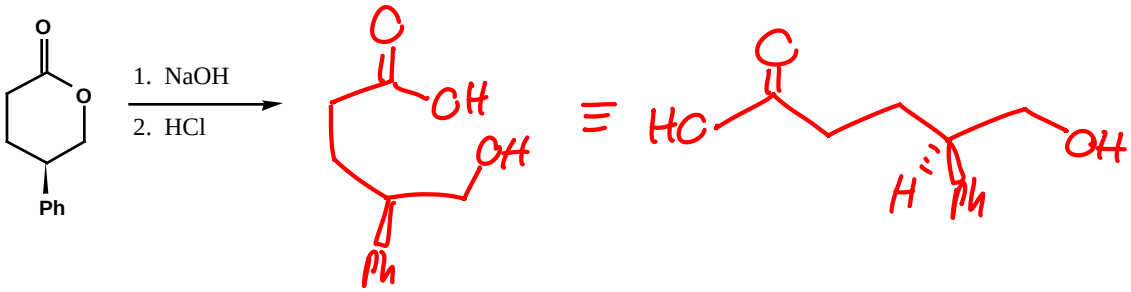
3 p

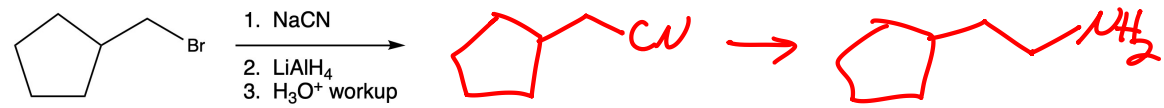
JASPERSE CHEM 360 TEST 4 VERSION 2
Ch 19-21 Amines, Carboxylic Acids, Carboxylic Acid Derivatives

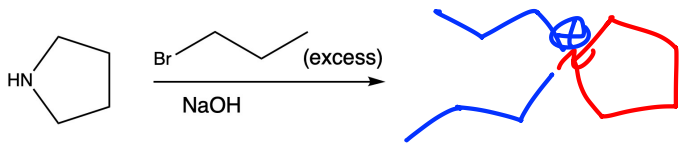
1. Synthesis Reactions. Draw the feature product of the following reactions (need not show any byproducts). (22 points, 2 points each)

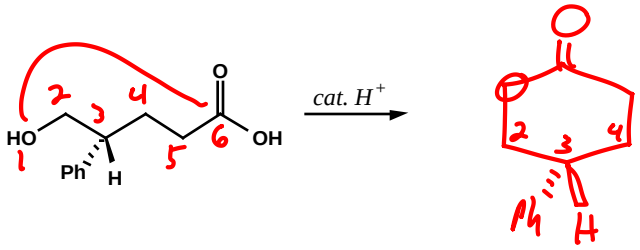


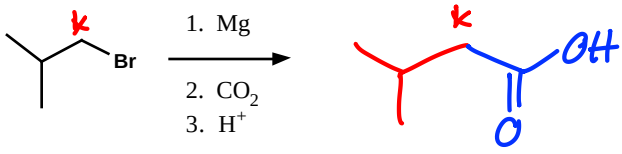


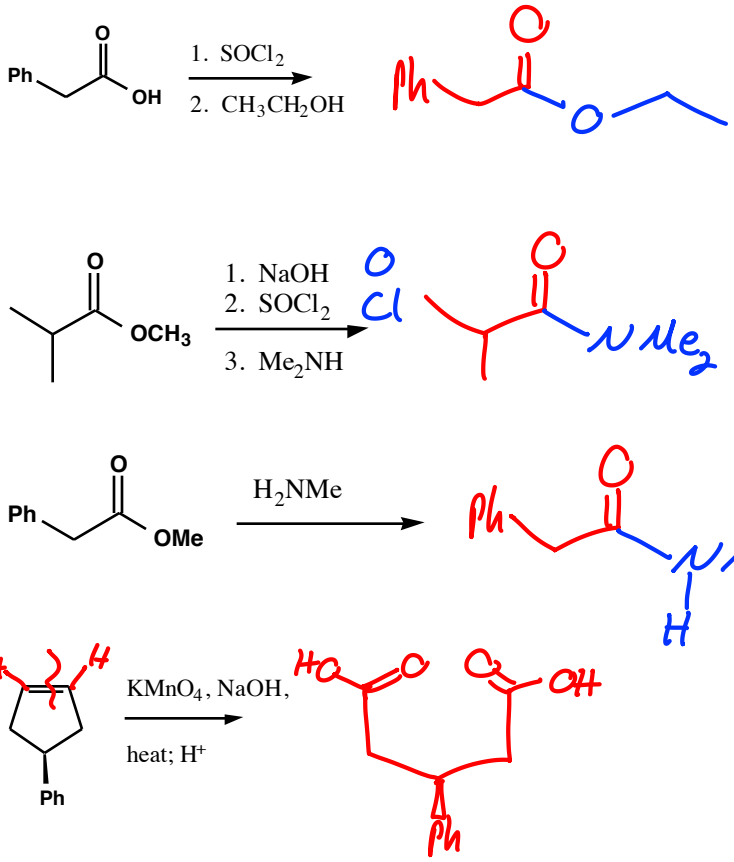






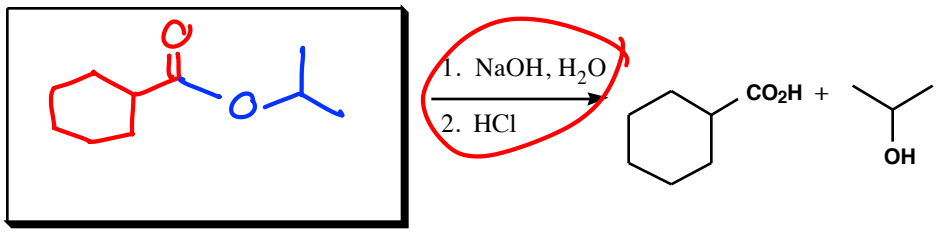




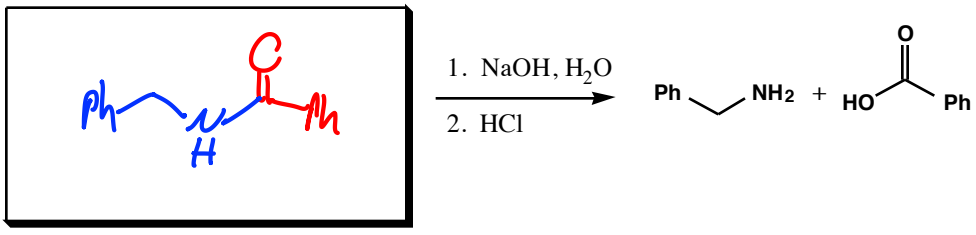


2. Hydrolysis Reactions. Draw the starting materials for the following hydrolysis reactions. (4 points)

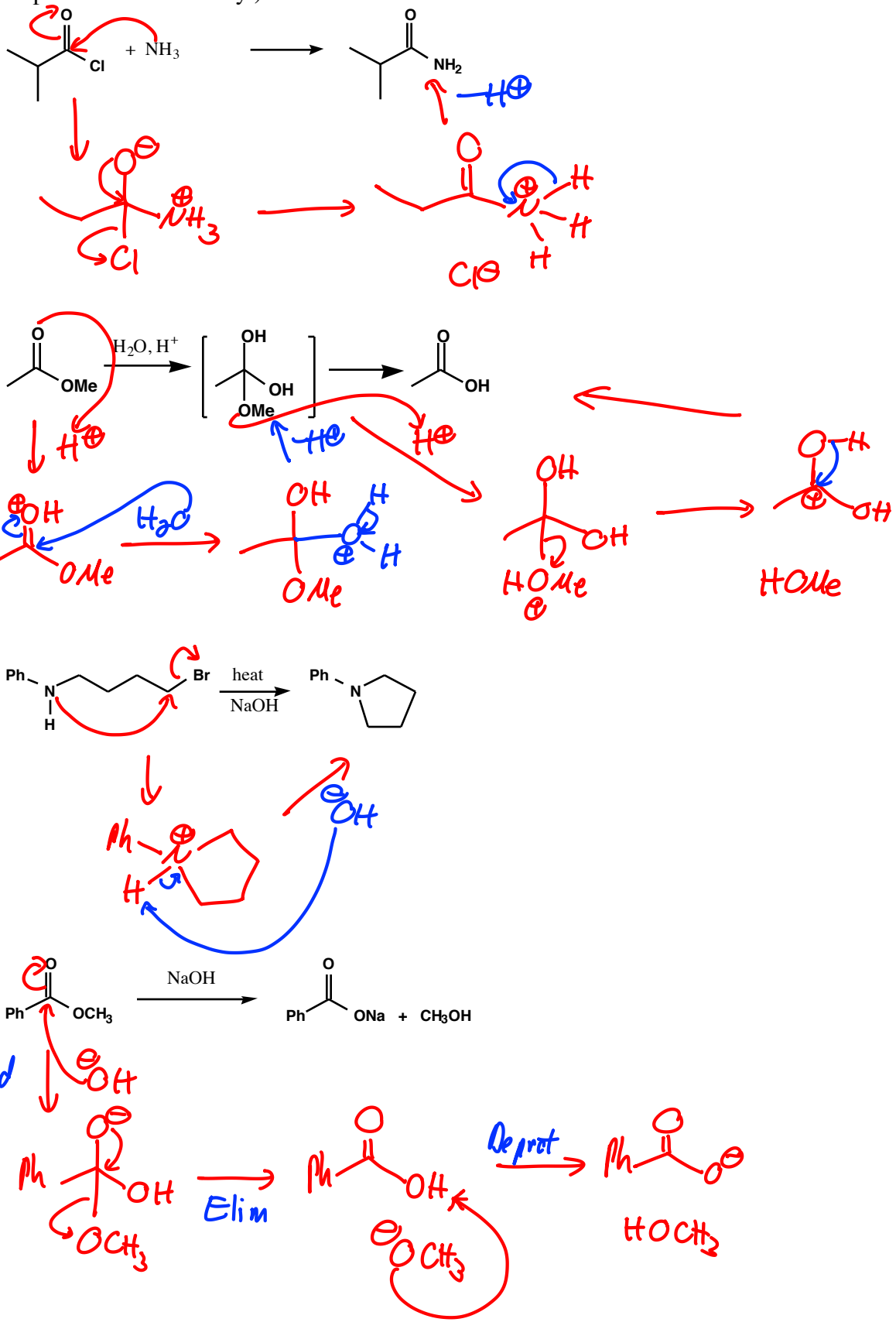
a.



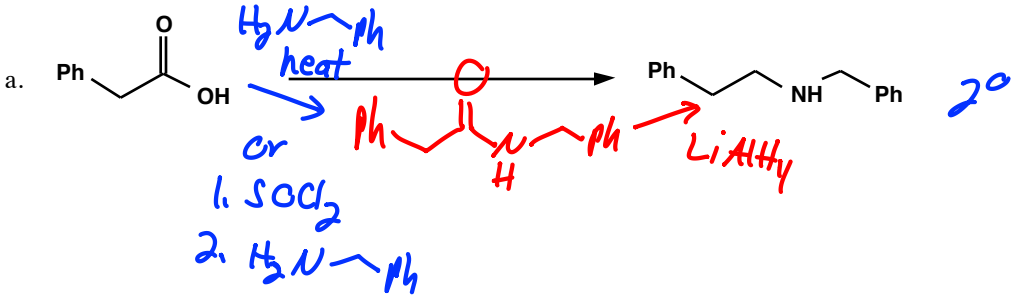
b.

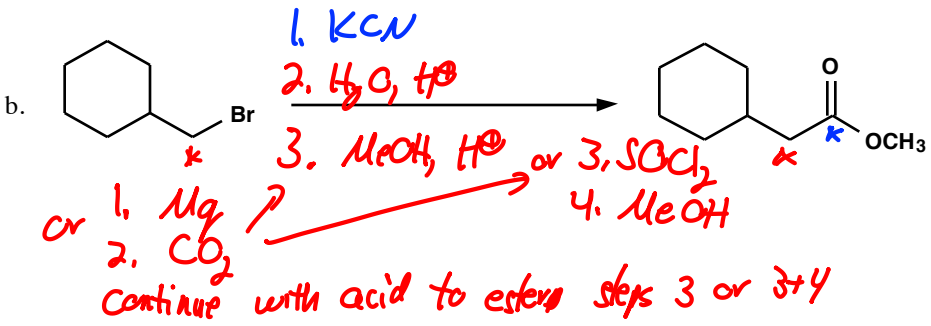


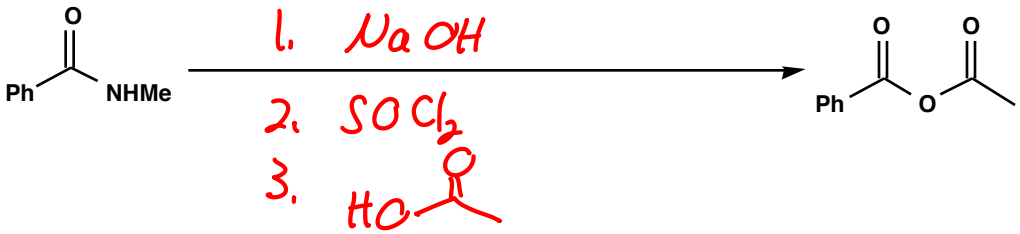
3. Draw the Mechanisms for the following reactions. (16 points total. Some are relatively trivial, so point values will vary.)



4. Provide Reagents for the following Transformations (12 points)

a. 

b. 

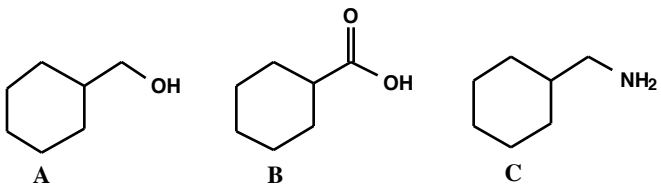
uphill 

5. Which (if any) after being dissolved in diethyl ether, will: (6 points. Note: The answers may be none or more than one, you tell me!)

a) Extract into $NaOH/H_2O$? B Hydroxide ionize/extra acids or phenols

b) Extract into HCl/H_2O? C HCl/Water ionized/extracts amines

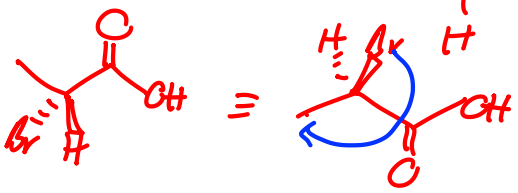
c) Extract into water? none Neutral water doesn't ionize any



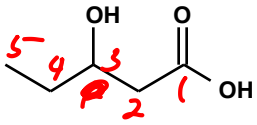
6. Nomenclature. Provide Either the Name or the Structure for the Following Chemicals. (8 points)

a. N-propyl-5-methylhexan-1-amine

b. (R)-2-bromopropanoic acid

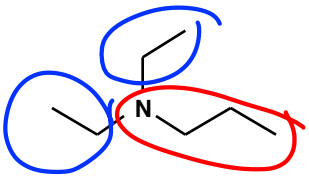


d.



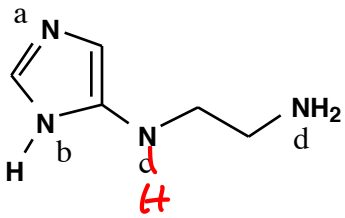
3-hydroxypentanoic acid

e.



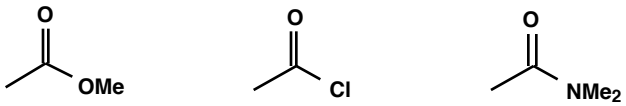
N,N-diethylpropan-1-amine

7. For each nitrogen a-d, identify the hybridization of the nitrogen atom, and identify the hybridization of the nitrogen lone pair. (6 points, 2 points off for 1st error, 1 for each additional)



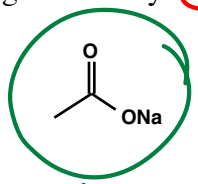
Nitrogen Atom	Hybridization of the Nitrogen Atom	Hybridization of the Nitrogen Lone Pair	
a	sp^2	sp^2	Double-bonded N
b	sp^2	p	Conjugated-N
c	sp^2	p	Conjugated-N
d	sp^3	sp^3	isolated

8. Rank the following according to their reactivity toward NaOH/H_2O hydrolysis, from 1 (most) to 3 (least). (2 points)

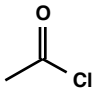


2 1 3

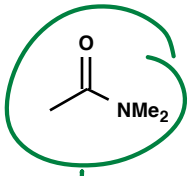
9. Circle the compounds, if any, (may be none, one, or more than one) that would not react with methanol to give a methyl ester (4 points)



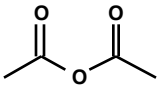
not react uphill



would react downhill



not react uphill



would react downhill

10. Rank the acidity of the following, 1 being most acidic, 3 being least (9 points)

a. $CH_3NH_3^+Cl^-$ (2) benzoic acid (1) water (3)

b. CH_3CO_2H (1) CH_3CH_2OH (2) $CH_3CH_2NH_2$ (3)

c. water (3) p-nitrobenzoic acid (1) p-methylbenzoic acid (2)

11. Rank the basicity of the following, 1 being most basic, 3 being least (9 points)

a. $PhNH_2$ (3) $(CH_3)_3N$ (1) CH_3NH_2 (2)

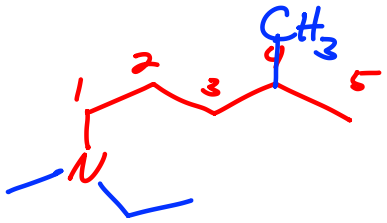
b. Me_2NH (1) CH_3CO_2Na (2) H_2O (3)

c. $NaOH$ (2) CH_3MgBr (1) pyridine (3)

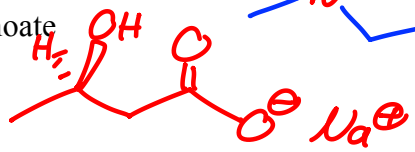
JASPERSE CHEM 360 TEST 4 VERSION 3
Ch 19-21 Amines, Carboxylic Acids, Carboxylic Acid Derivatives

1. Nomenclature. Provide Either the Name or the Structure for the Following Chemicals. (10 points)

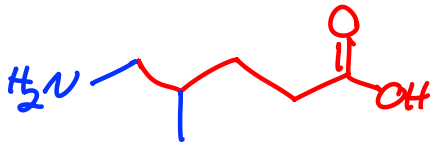
a. N-ethyl-N-methyl-4-methylpentan-1-amine



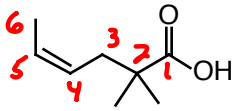
b. sodium (R)-3-hydroxybutanoate



c. 5-amino-4-methylpentanoic acid

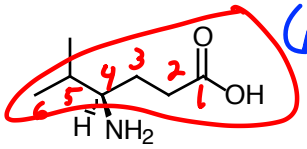


d.



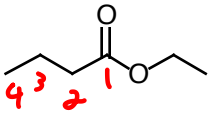
(Z)-2,2-dimethyl hex-4-enoic acid

e.



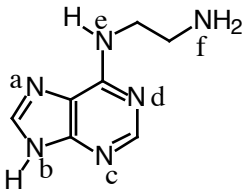
(R)-4-amino-5-methyl hexanoic acid

f.



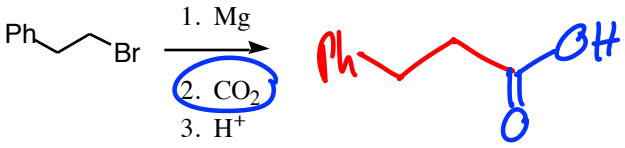
ethyl pentanoate

2. For each nitrogen a-f, identify the hybridization of the nitrogen atom, and identify the hybridization of the nitrogen lone pair. [Adenine is an important player in information transfer (DNA, RNA, genetics, etc.) and energy storage/release (ATP/ADP).]

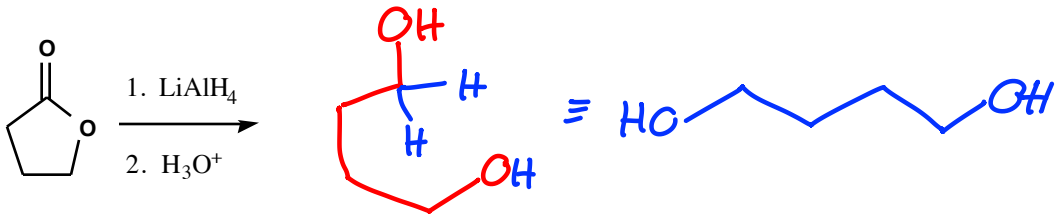


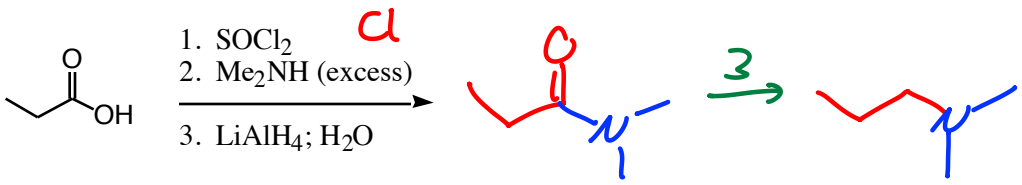
Nitrogen Atom	Hybridization of the Nitrogen Atom	Hybridization of the Nitrogen Lone Pair
a	sp^2	sp^2
b	sp^2	p
c	sp^2	sp^2
d	sp^2	sp^2
e	sp^2	p
f	sp^3	sp^3

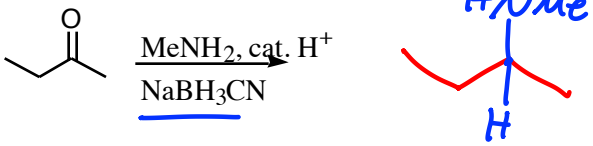
3. Synthesis Reactions. Draw the feature product of the following reactions (need not show any byproducts). (15 points)

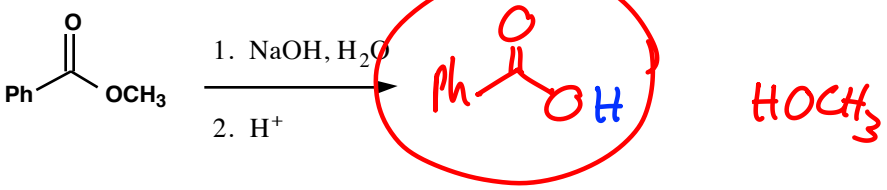
a. 

b. 

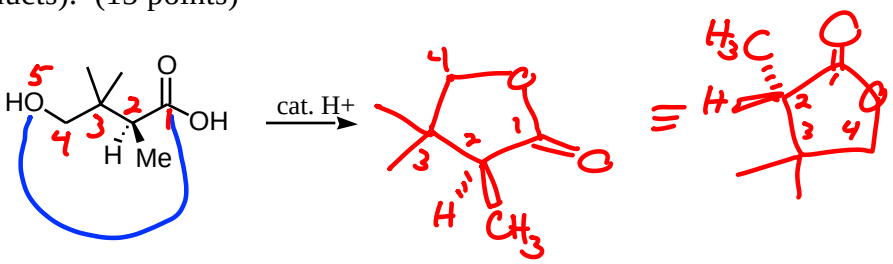
c. 

d. 

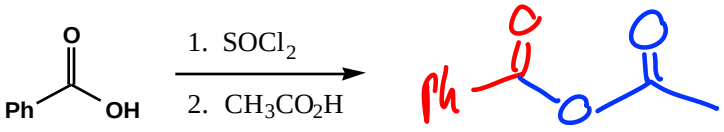
e. 

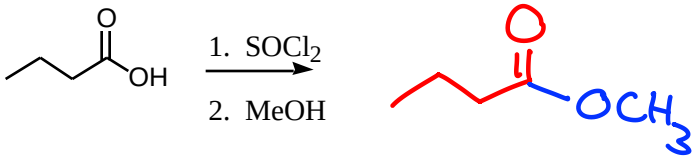
f. 

4. Synthesis Reactions. Draw the feature product of the following reactions (need not show any byproducts). (15 points)

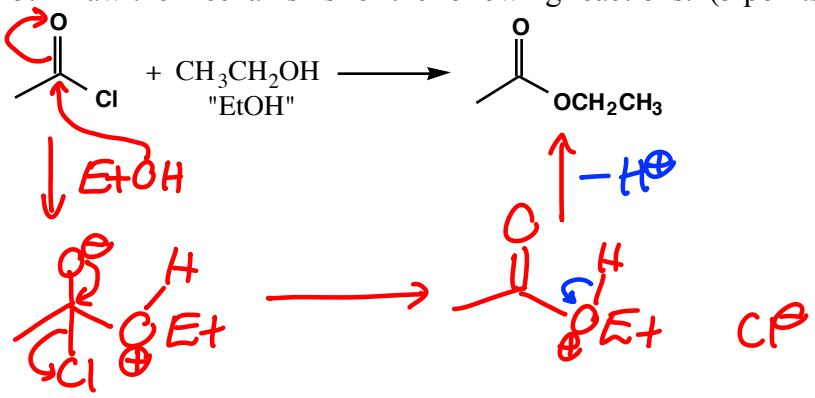
a. 

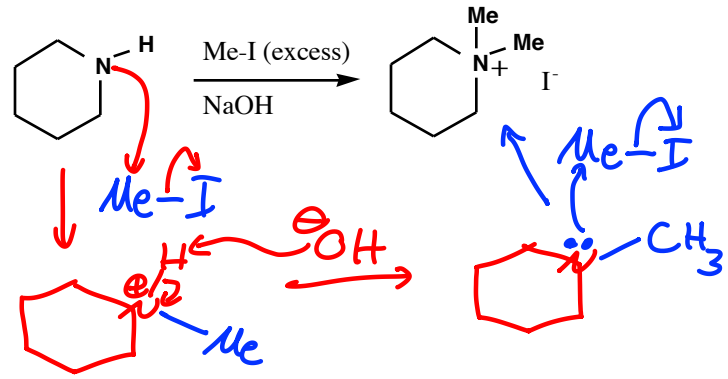
b. 

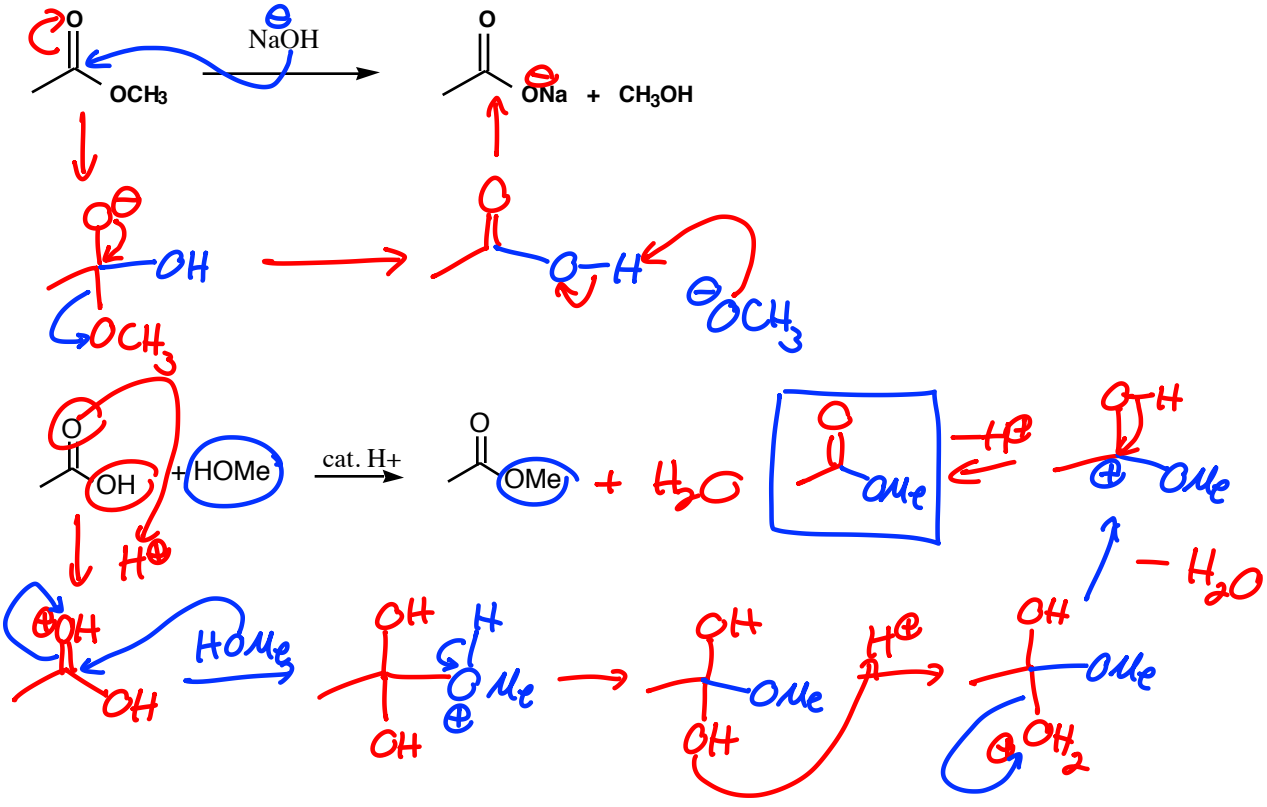
c. 

d. 

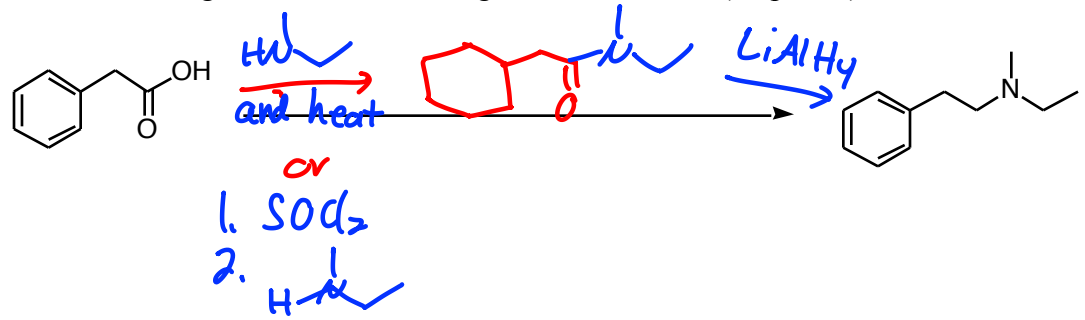
5. Draw the mechanisms for the following reactions. (5 points)

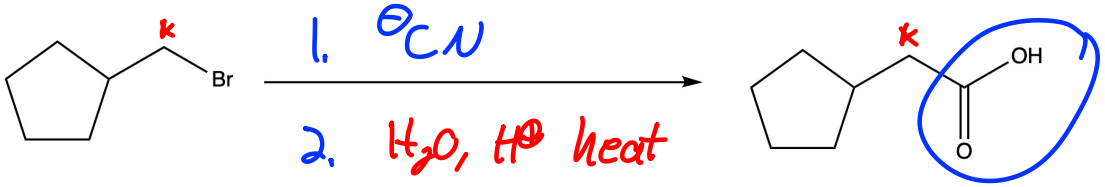


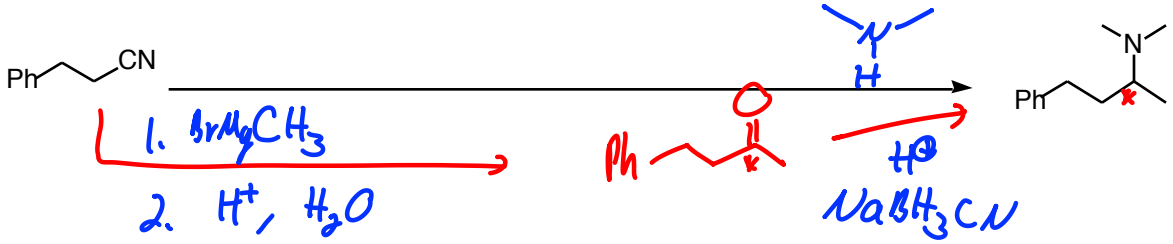


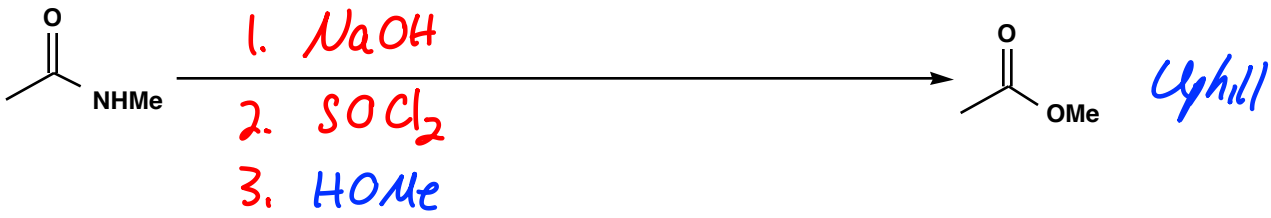


6. Provide Reagents for the following Transformations (15 points)







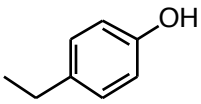


7. Which, when dissolved in diethyl ether, will: (5 points each)

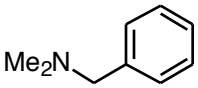
a) Extract into NaOH/H_2O? A, D — NaOH ionizes RCO2H and phenols

b) Extract into HCl/H_2O? B — HCl ionizes amines

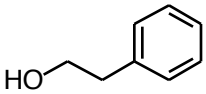
c) Extract into water? None — Neutral water does not ionize them



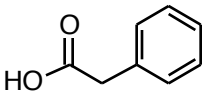
A



B



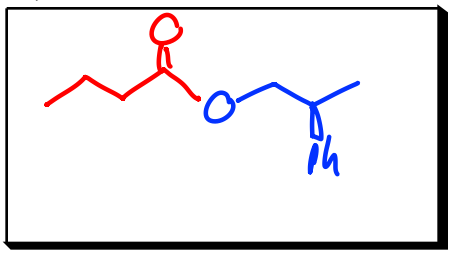
C

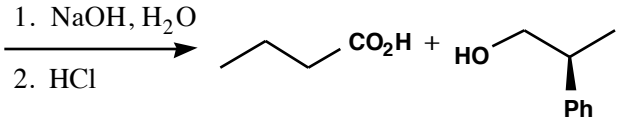


D

8. Hydrolysis Reactions. Draw the starting materials for the following hydrolysis reactions. (6 points)

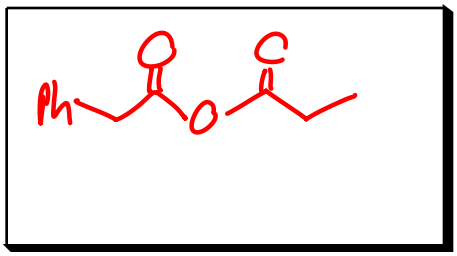
a.

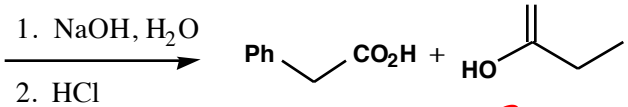




alcohol & ester at start

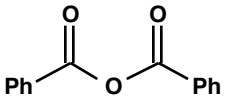
b.



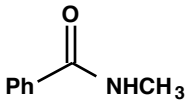


acid & anhydride

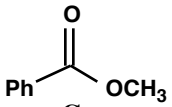
9. Rank the following according to their reactivity toward NaOH/H_2O hydrolysis.



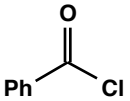
A A



B N

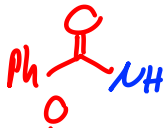


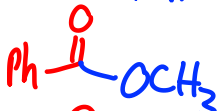
C E

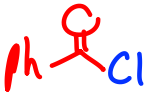


D Cl

Given the structures **A-D** above, which of the following reactions will proceed spontaneously? (2 points)

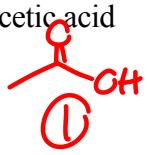
(A) **A** + H_2NCH_3 → **B** — N —  — Yes — Downhill

A + $HOCH_3$ → **C** — E —  — Yes — Downhill

A + HCl → **D** — Cl —  — No — Uphill

10. Rank the acidity of the following, 1 being most acidic, 3 being least (3 points each)

a. acetic acid vs. water vs. $NH_4^+Cl^-$



1 3 2

b. CH_3OH vs. CH_3NH_2 vs. F_2CHOH

2 3 1

w

$F_2CHO^\ominus$

stabilizes oxyanion

c. p-methoxybenzoic acid vs. benzoic acid vs. acetone

donor

2 1 3

disadvantageous for conjugate anion

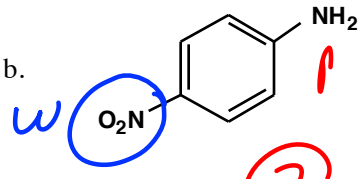
11. Rank the basicity of the following, 1 being most basic, 3 being least (3 points each)

a. CH_3OH vs. $PhNH_2$ vs. CH_3NH_2

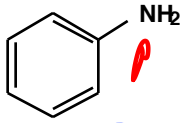
3 2 1

sp^3

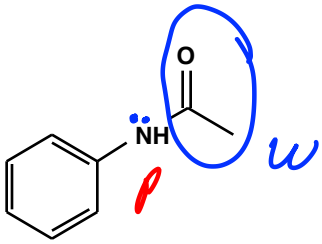
b.



vs.



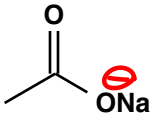
vs.



w

2 1 3

c.



2

$(CH_3CH_2)_3N$

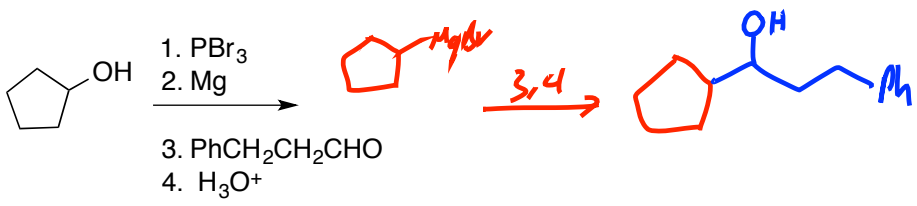
1 sp^3

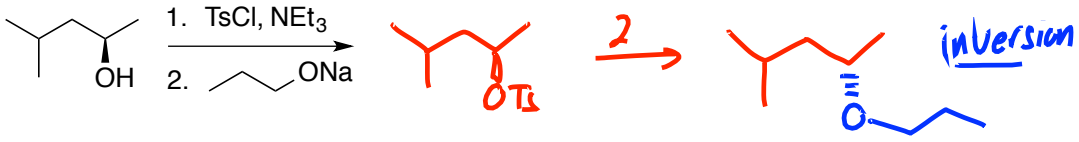
H_2O

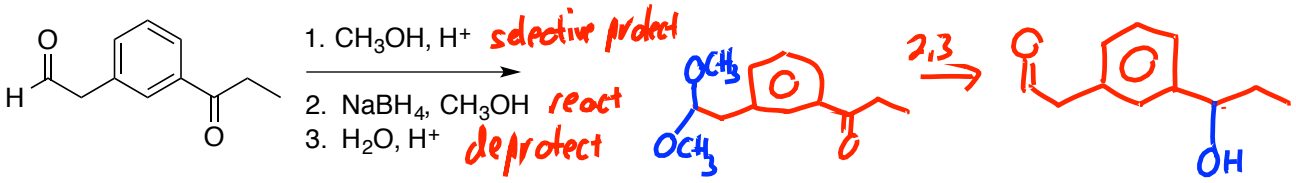
3

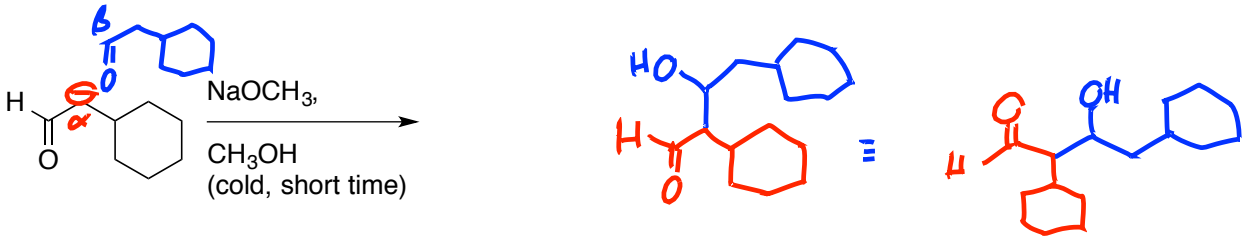
Organic Chemistry II - Jasperse FINAL EXAM PRACTICE VERSION 1

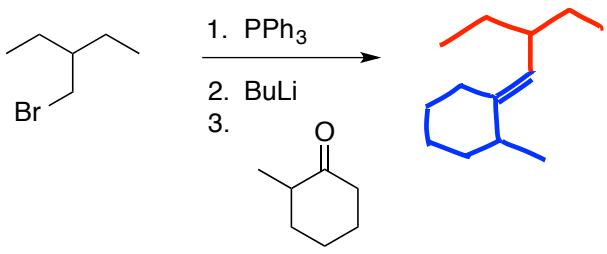
1. Give the major product for the following reactions. (3 points each)

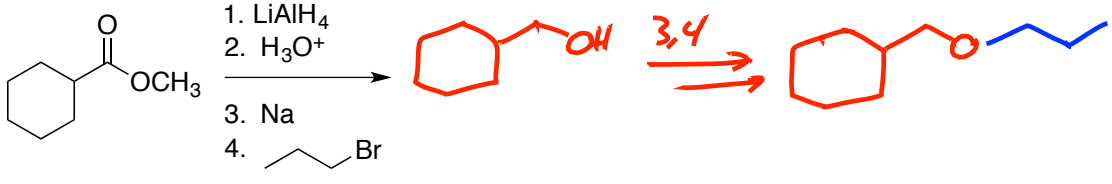
a. 

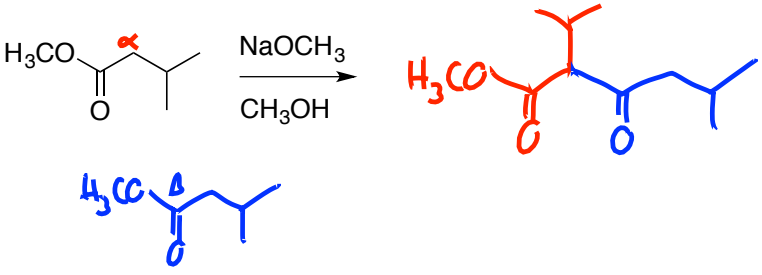
b. 

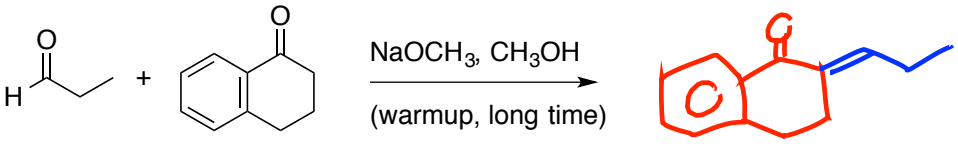
c. 

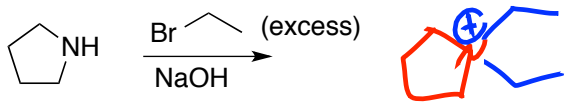
d. 

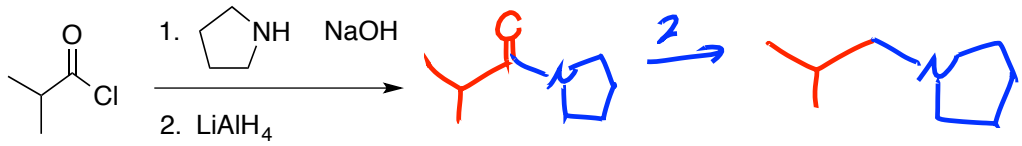
e. 

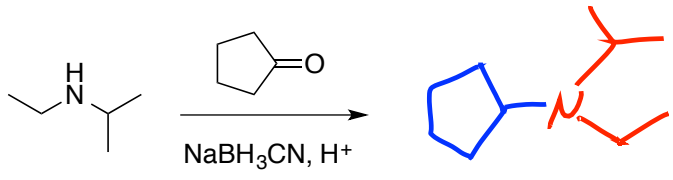
f. 

g. 

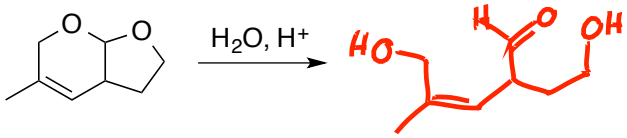
h. 
O
H
+
O
NaOCH3, CH3OH
(warmup, long time)

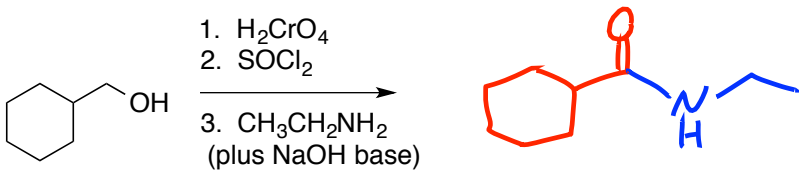
i. 
NH
Br
(excess)
NaOH

j. 
O
Cl
1. NH NaOH
2. LiAlH4
2

k. 
H
N
O
NaBH3CN, H+

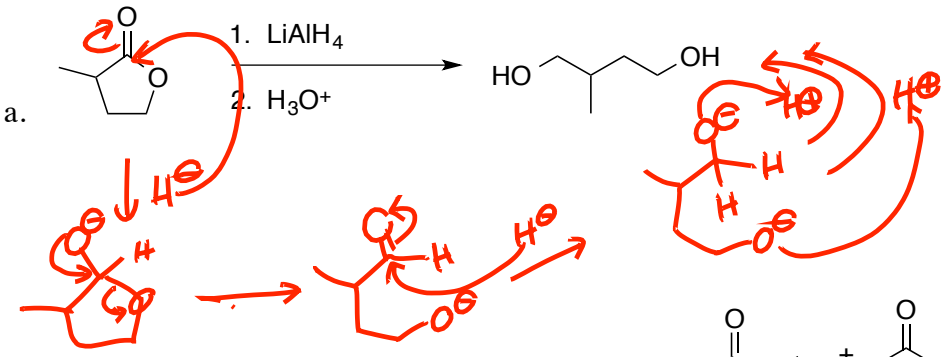
l. 
HO
1. PBr3
2. NaCN
3. H2O, H+, heat
3

m. 
O
O
H2O, H+
HO
OH

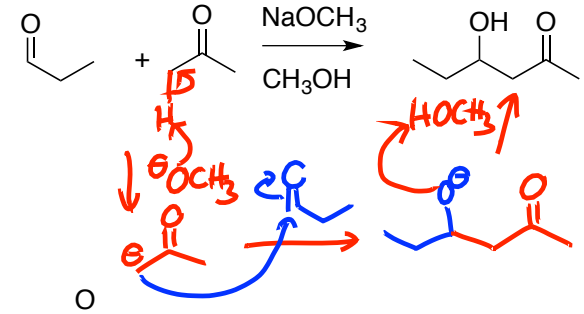
n. 
OH
1. H2CrO4
2. SOCl2
3. CH3CH2NH2
(plus NaOH base)

2. Provide the **mechanisms** for the following reactons (3 points each)

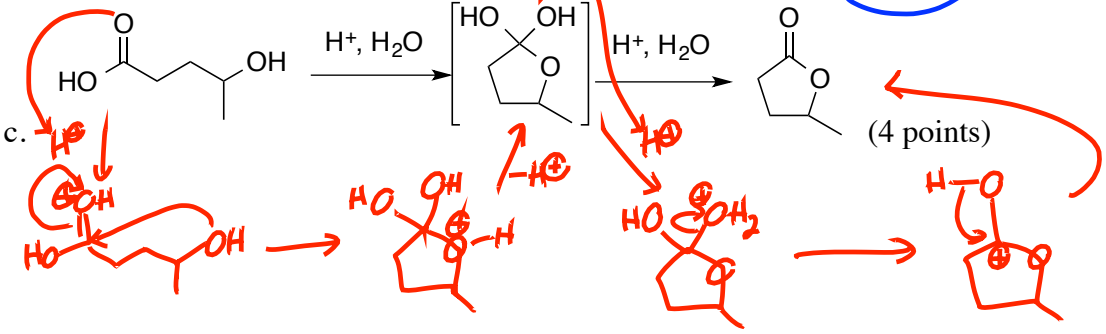
a.



b.

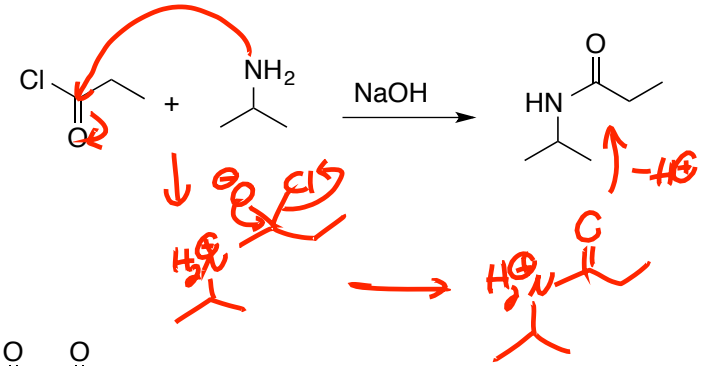


c.

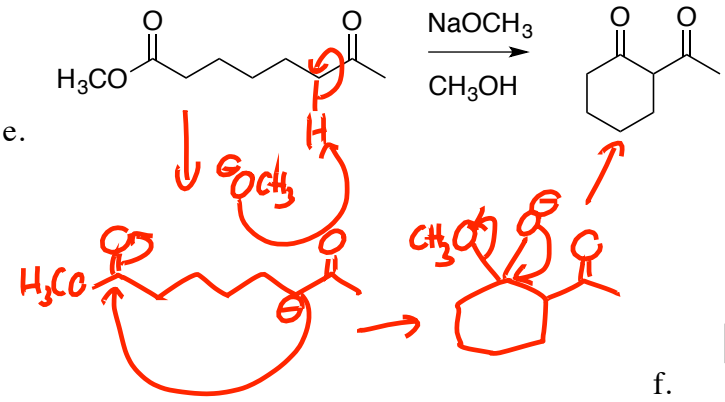


(4 points)

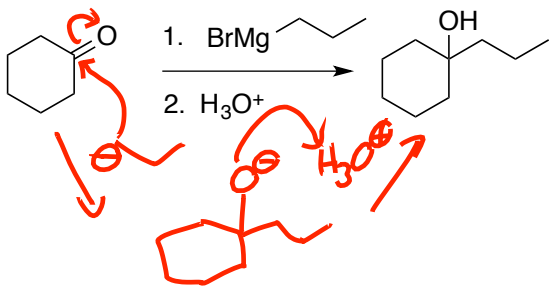
d.



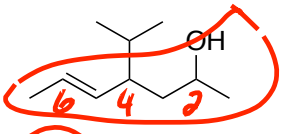
e.



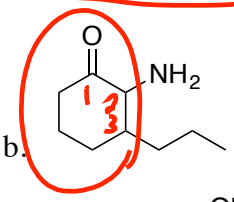
f.



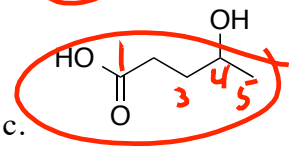
3. Give **Names or structures** for the following: (6 points)

a. 

E-4-isopropylhept-5-en-2-ol

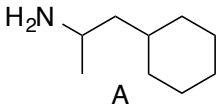
b. 

2-amino-3-propylcyclohexanone

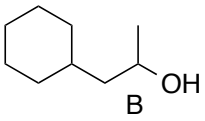
c. 

4-hydroxypentanoic acid

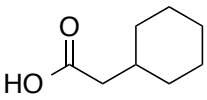
4. **Separatory Funnel/Extraction**: Suppose the following three chemicals are initially dissolved in ether in a separatory funnel. (2 points each; there will not necessarily be something extracted in each aqueous wash, so "none" might be the correct answer.).



A



B



C

a. Identify which (if any) would **extract out into the aqueous layer** if treated with **basic water (NaOH/H_2O)**.

C

b. Identify which (if any) would **extract out into the aqueous layer** if treated with **acid water (HCl/H_2O)**.

A

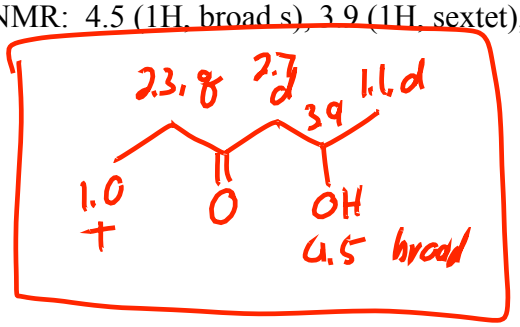
c. Identify which (if any) would **extract out into the aqueous layer** if treated with **neutral distilled water (H_2O)**.

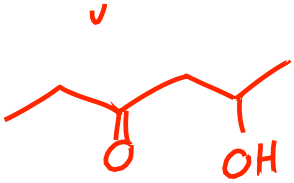
none

5. Mystery Problems: Suggest a structure for an unknown A whose formula is $C_6H_{12}O_2$ and gives the following chemical test results. (4 points)

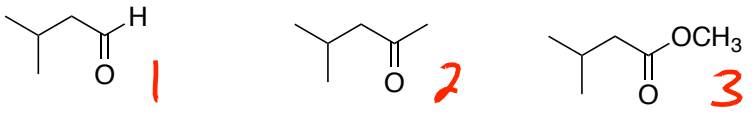
• Formula	$C_6H_{12}O_2$	1 EU
• Hydrogenation Test	H_2/Pt	no alkene — No reaction
• Chromic Acid Test	H_2CrO_4	2° alc — Reacts, turns green/brown, precipitate forms.
• Lucas Test	$HCl/ZnCl_2$	2° alc — Reacts, makes 2nd layer.
• 2,4-DNP Test	2,4-dinitrophenylhydrazine	Reacts, yellow precipitate — ketone
• Tollens Test	$Ag(NH_3)_2^+OH^-$	No reaction
• Iodoform Test	excess I_2, NaOH, H_2	No reaction

- H-NMR: 4.5 (1H, broad s), 3.9 (1H, sextet), 2.7 (2H, d), 2.3 (2H, q), 1.1 (3H, d), 1.0 (3H, t)

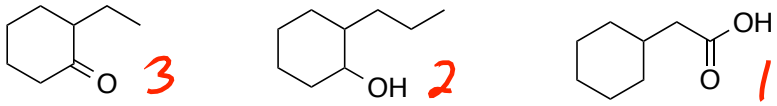




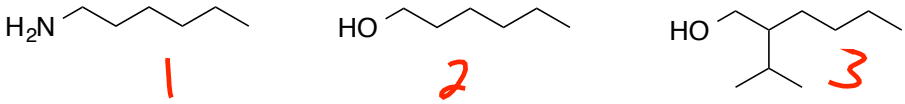
6. Rank the following, with 1 being highest, or most. (2 points each)

a. 

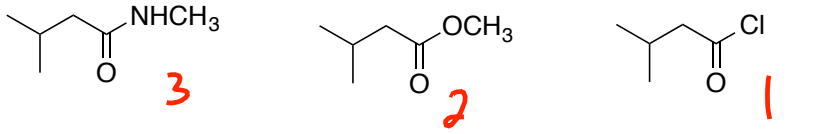
Reactivity towards nucleophilic attack (for example, by PhMgBr)

b. 

Boiling Point

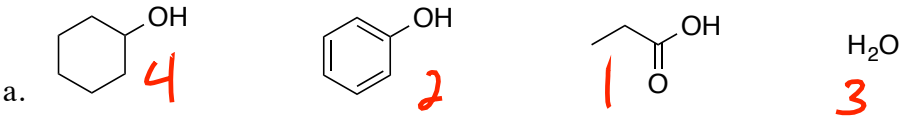
c. 

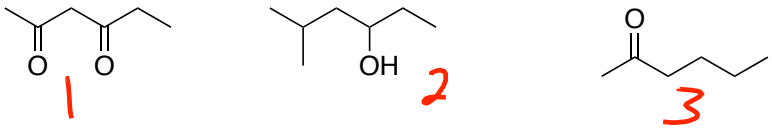
Water Solubility

d. 

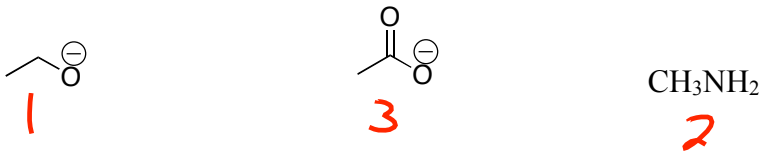
Reactivity towards nucleophilic attack

7. Rank the acidity of the following, from 1 (most) to 4 (least): (4 pts)

a. 

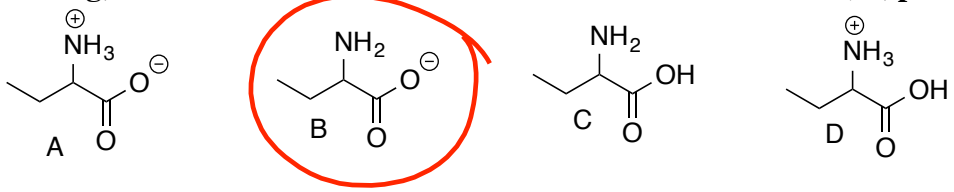
b. 

8. Rank the basicity of the following, 1 being most basic, 3 being least

a. 

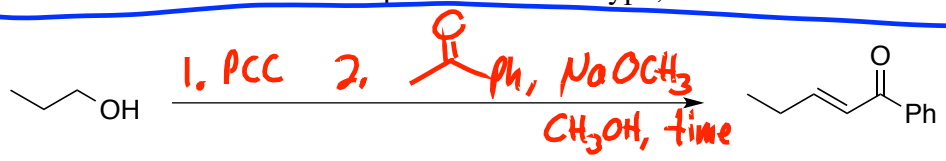
b. CH_3NHNa (1) $CH_3C(O)NH_2$ (3) $(CH_3)_3N$ (2)

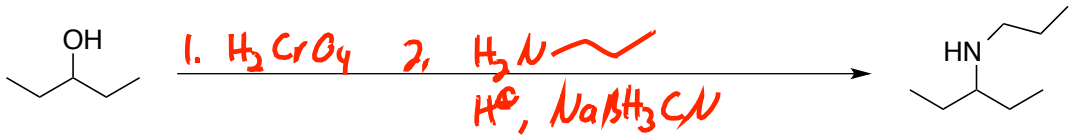
9. Of the following, which one form would exist under basic conditions? (ex, pH = 10)

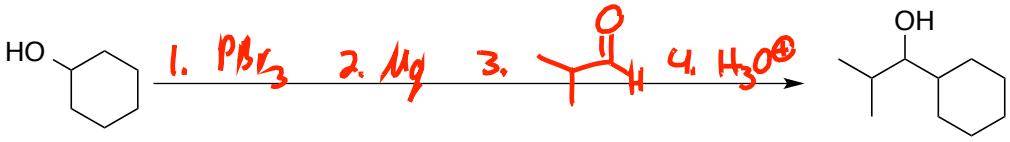


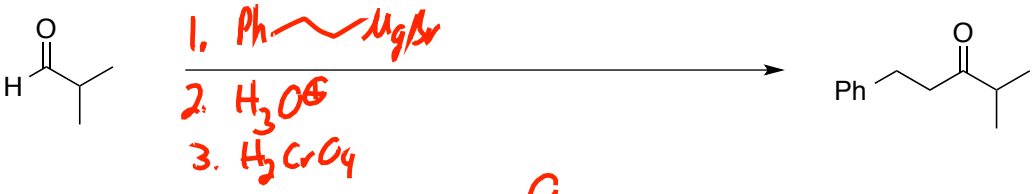
10. Provide the reagents necessary to accomplish the following transformations (4 points each). You may use anything you wish, as big as you like.

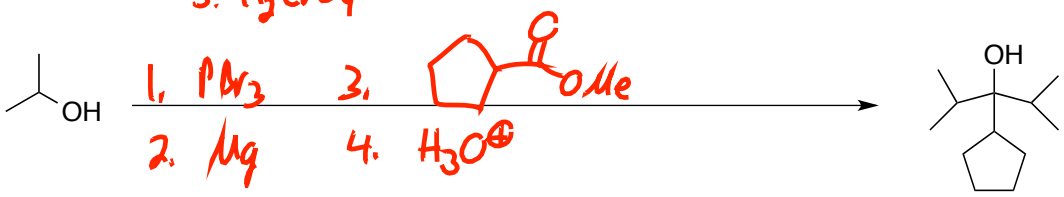
- Note 1: Real test will have 6 problems of this type, but I included more for practice

a. 

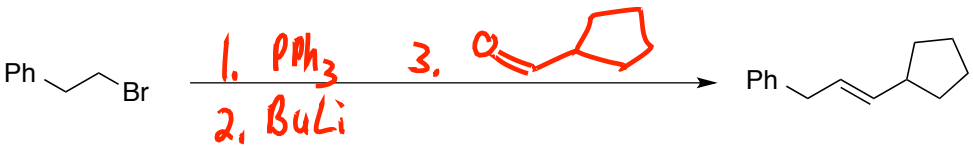
b. 

c. 

d. 

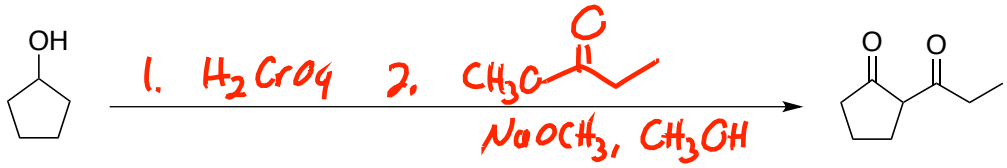
e. 

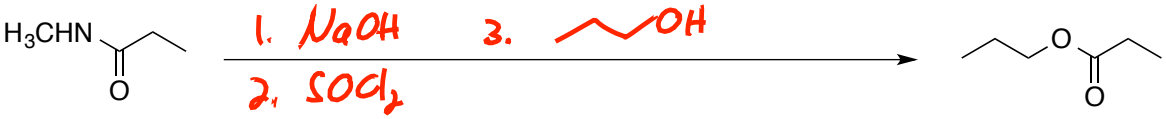
f. 

g. 

Note: no other structural isomer

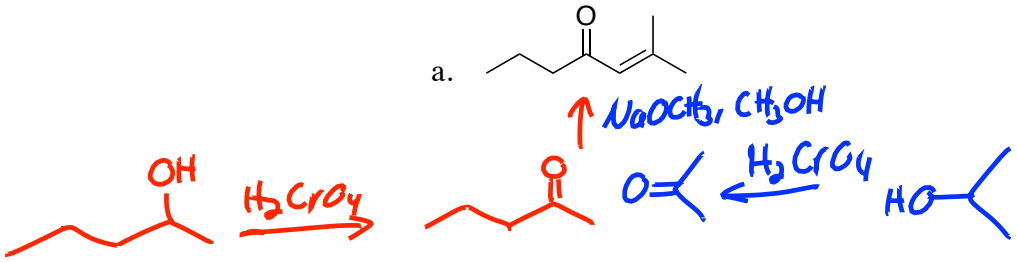
h. 

i. 

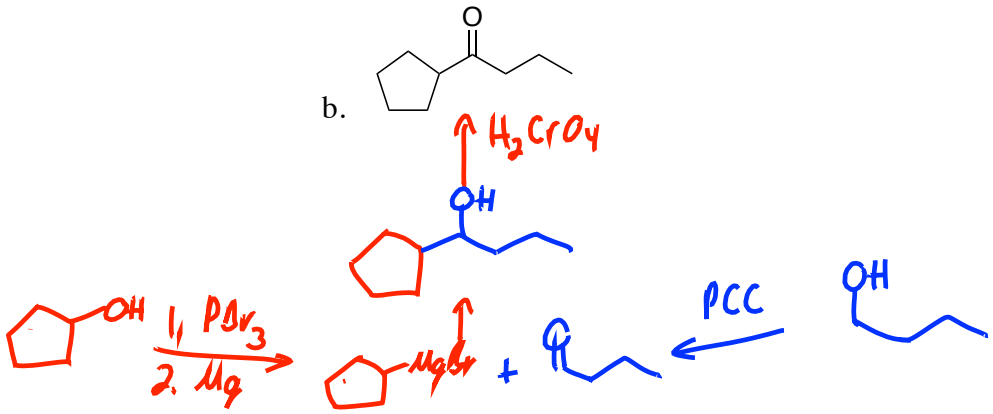
j. 

11. Retrosynthesis: Design syntheses of the following. (4 points each). Allowed starting materials include **alcohols with ≤5 carbons**; and any inorganic reagents (PCC, H_2CrO_4, PBr_3, PPh_3, BuLi, Mg, etc.)

a.

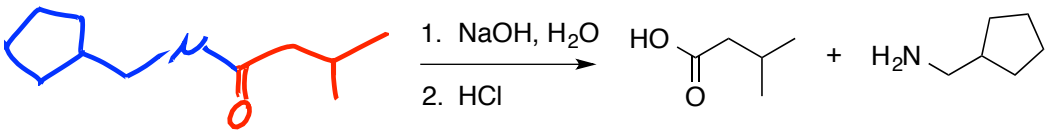


b.

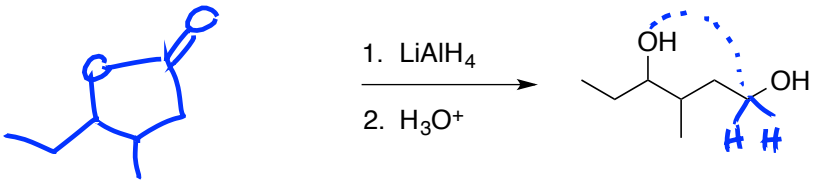


12. Put in the starting materials for the following. (Note: May be only one chemical in several of these cases). (2 points each)

a.

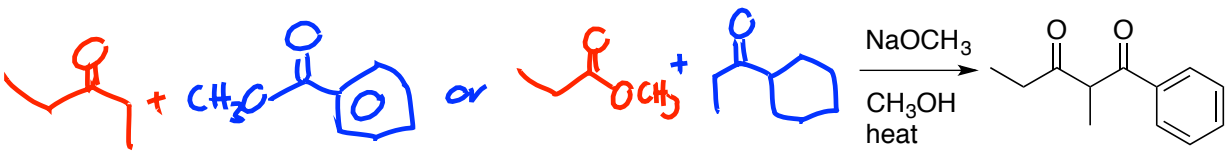


b.



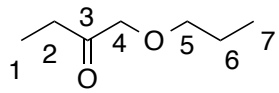
Note: Starting Material includes a ring, and has the formula $C_7H_{12}O_2$

c.



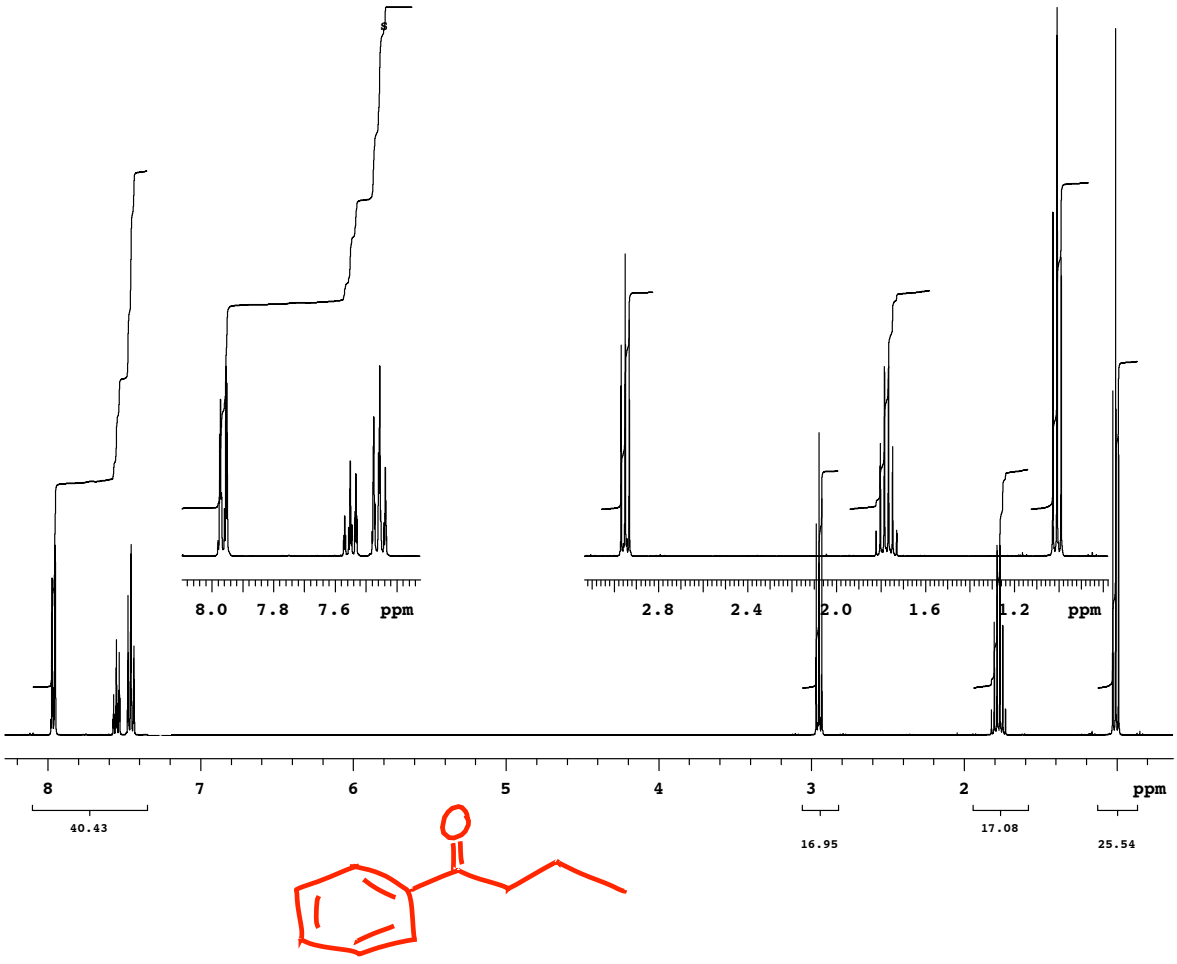
d.

13. Predict the 1H NMR spectrum. Include the source (CH_3-1, etc); approximate chemical shifts (1's, 2's, etc.); integration (1H, 2H, etc.); and splitting (either list the number of lines, or else use letters: "s" for singlet; "d" for doublet etc.). If signals are symmetry equivalent, do not list them twice. (5 pts)



Source	Chem Shift	Integration	Splitting
CH_3-1	1's	3H	3 t
CH_2-2	2's	2H	4 q
CH_2-4	4's	2 H	1 s
CH_2-5	3's	2H	3 t
CH_2-6	1's	2H	6 sextet
CH_3-7	1's	3H	3 t

14. Solve the structure (7pts): $C_{10}H_{12}O$ IR=1680



11. Solve structure (7 pts): $C_6H_{12}O_2$ IR: 1745 ^{13}C: 170(s), 70(t), 28(d), 21(q), 19(q)