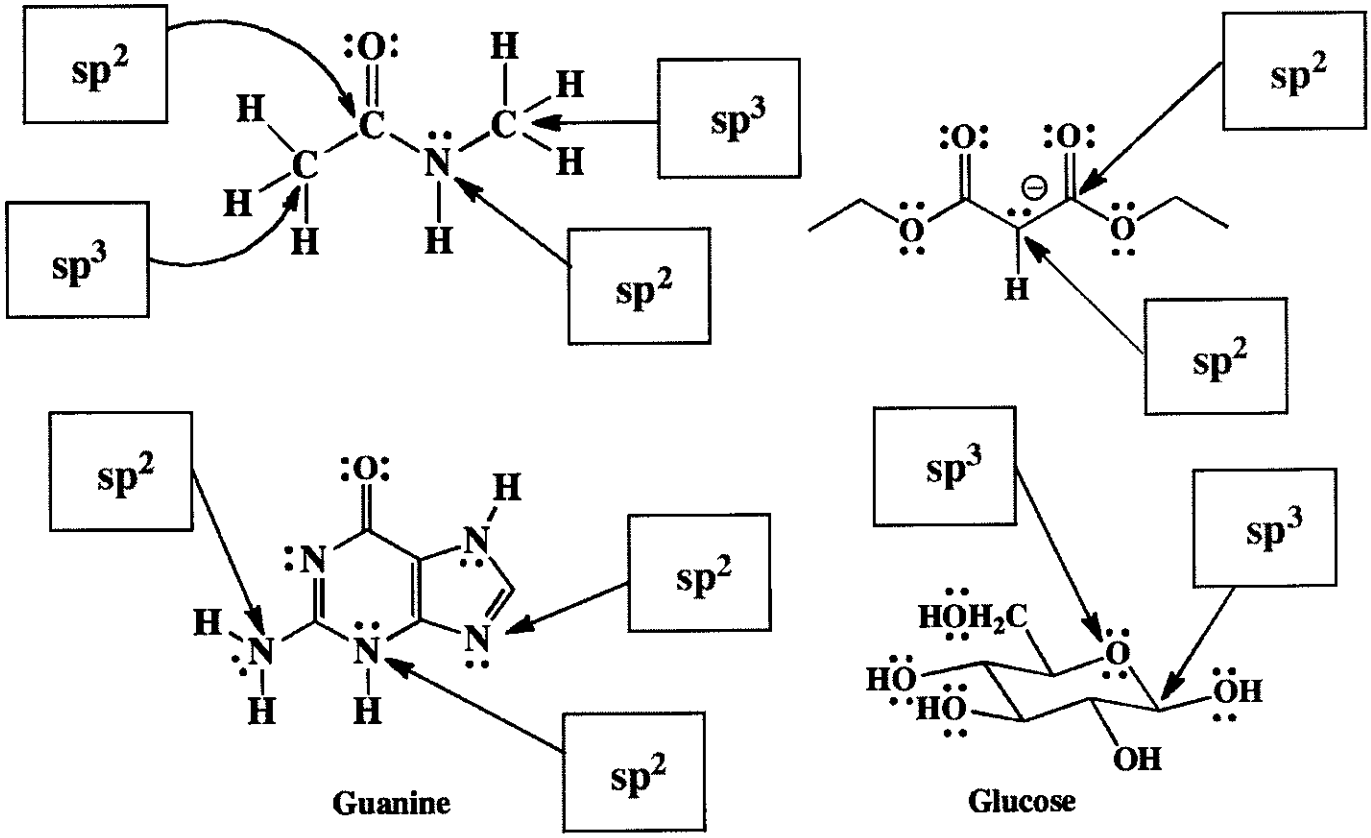
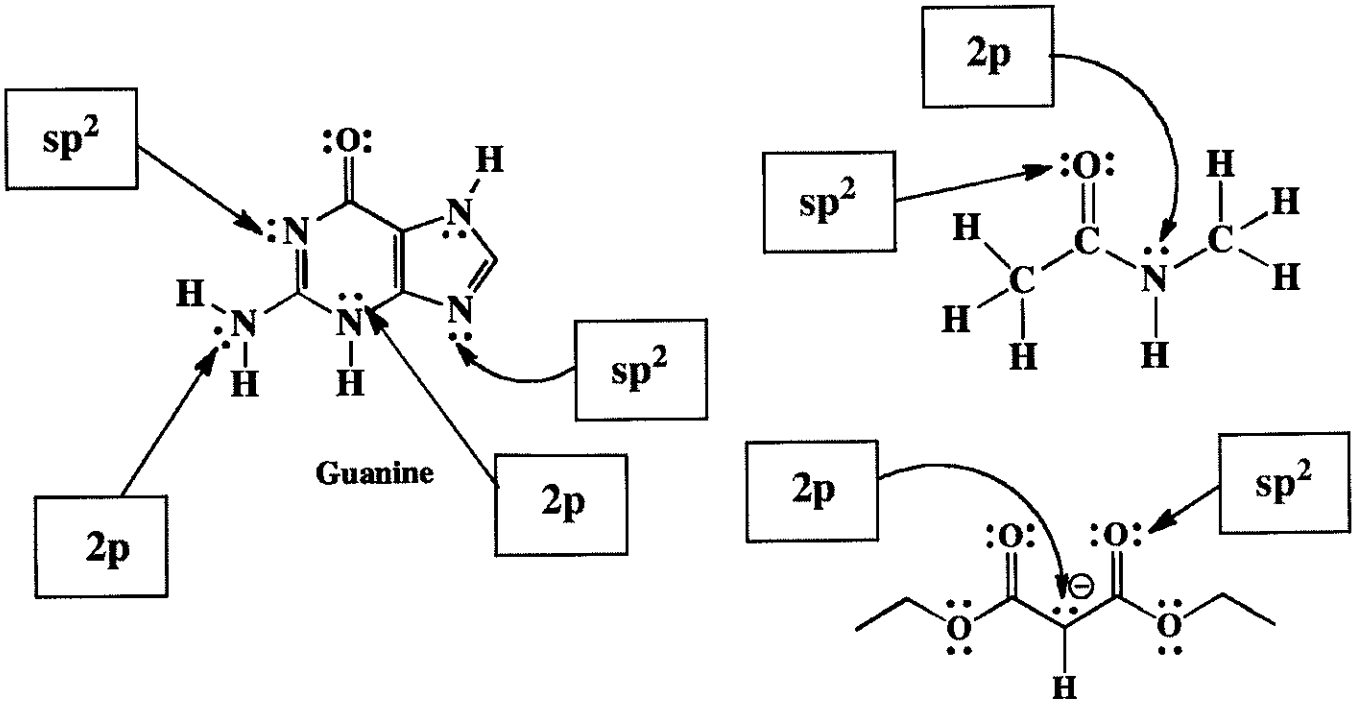
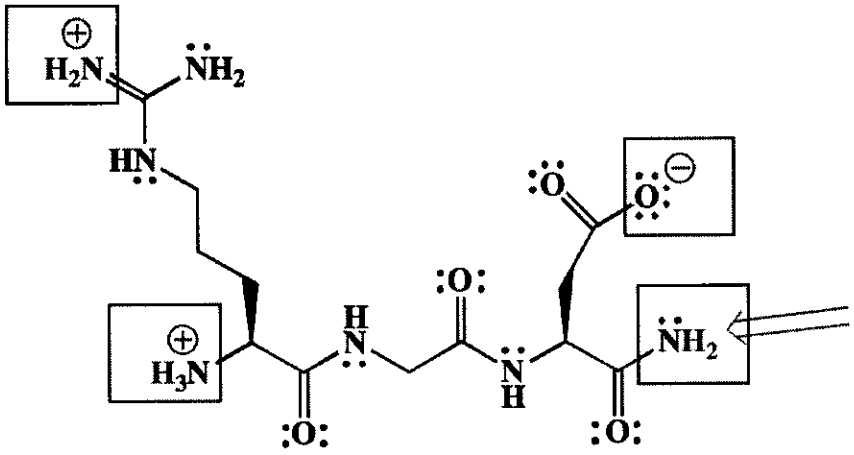
4. (11 pts) In the boxes provided, write the hybridization state of the given atoms.

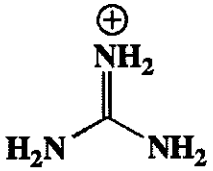


5. (8 pts) In the boxes provided write the type of atomic orbital that contains the indicated lone pair of electrons.



5. (10 pts) The following tripeptide, referred to as RGD, binds to certain receptors in the integrin family involved with cell adhesion. **In each box, add the correct number of protons as well as lone pairs of electrons and draw any formal charges on the boxed atoms TO INDICATE THE APPROPRIATE PROTONATION STATES AT pH 7.0. Refer to pK_a values in the table at the beginning of the exam as well as the value for guanidinium listed below to the right:**

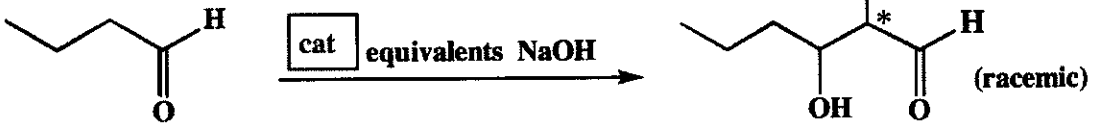


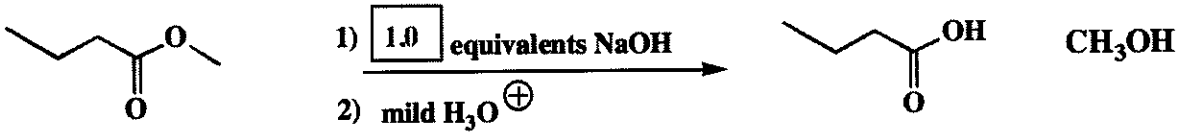


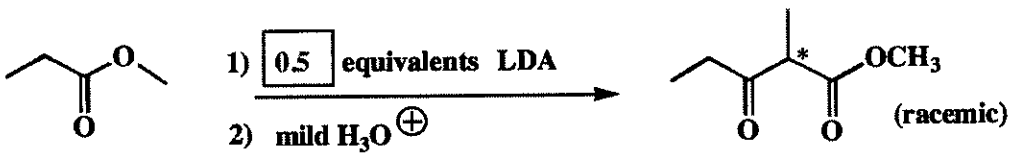
Recognize this as an amide that cannot be protonated near neutral pH because of the delocalized nature of the lone pair.

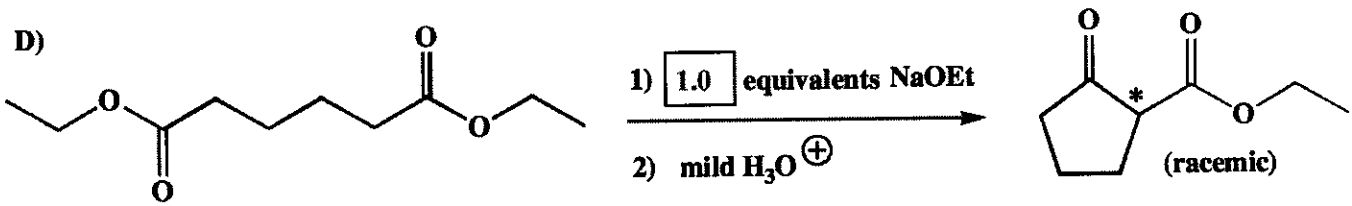
What is the overall charge on the RGD peptide at pH 7.0? +1

6. (2 pts each) In each of the boxes over an arrow, **write the minimum number of equivalents** of the specified reagent required to carry out the reaction shown **to completion**. If only a catalytic amount is needed, write "CAT". Note: **You must assume the carbonyl compound starting material is initially present in an amount of 1.0 equivalent.**

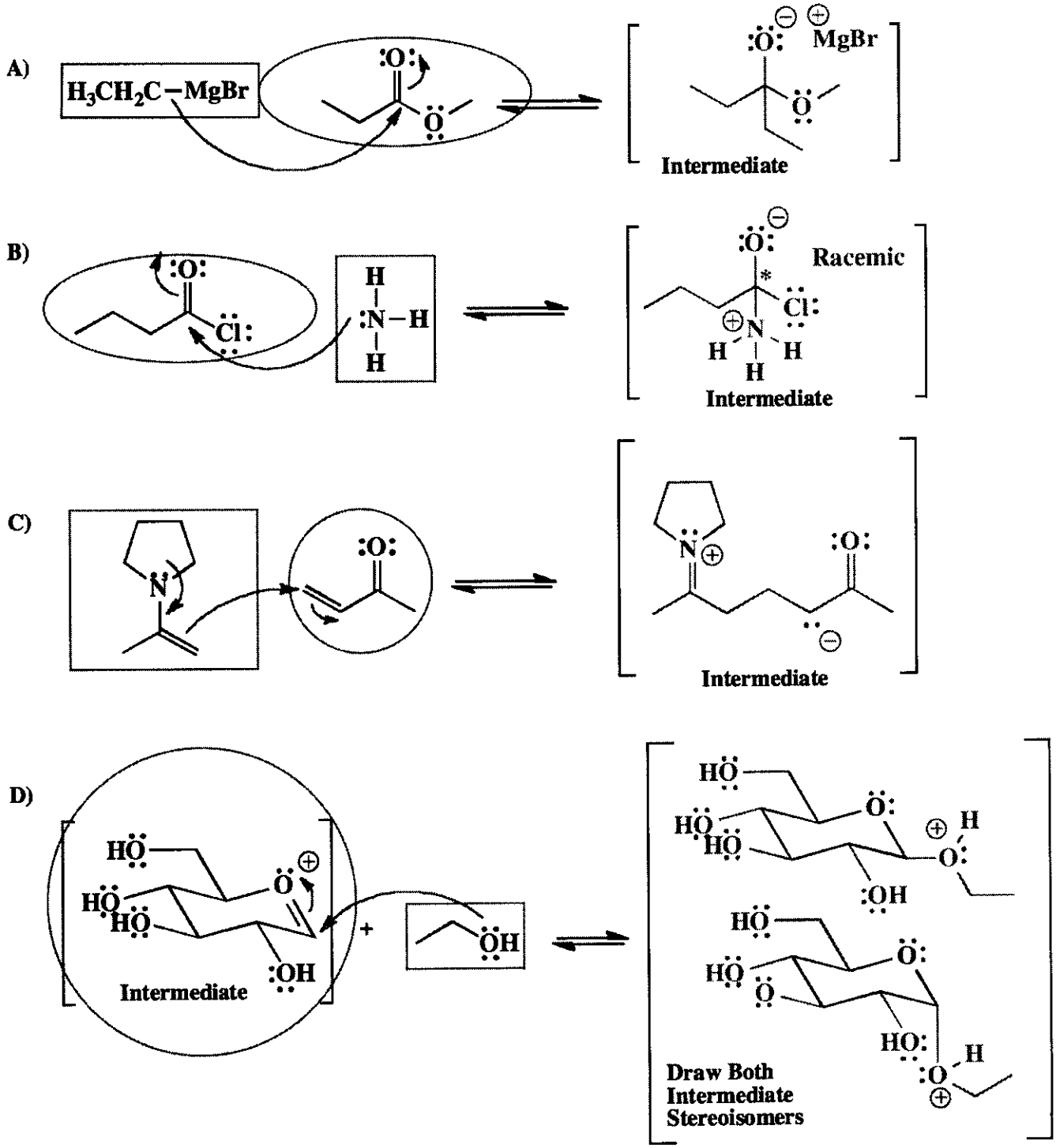
A) 

B) 

C) 

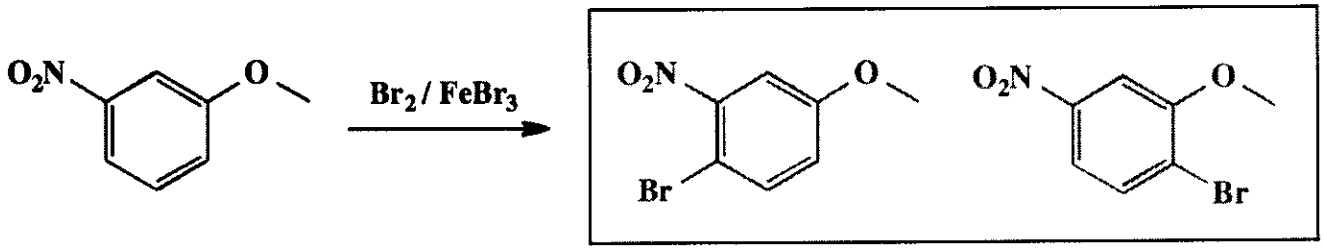
D) 

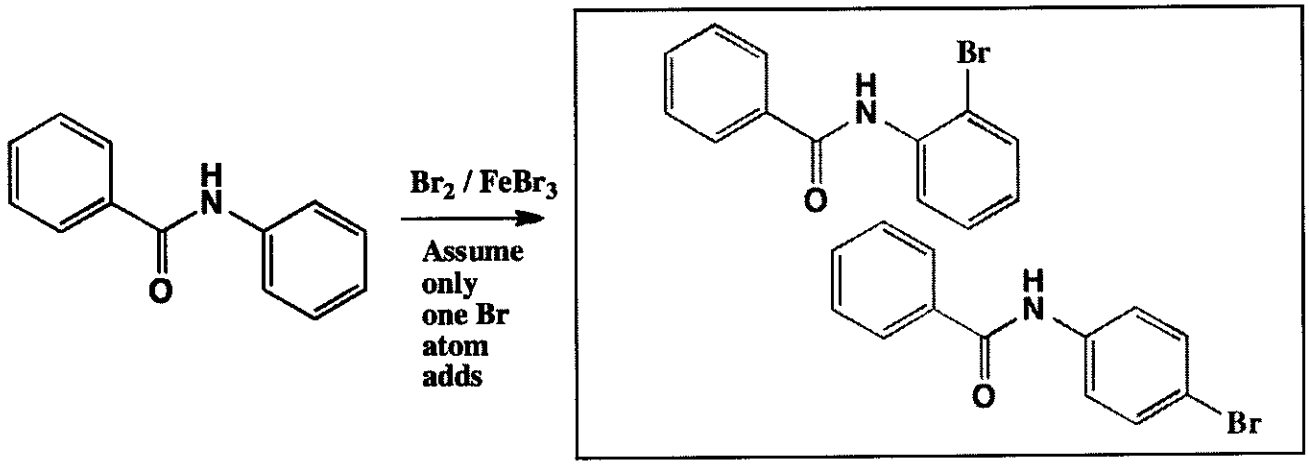
11. (26 points) Many of the reactions we have learned this semester involve steps with nucleophiles reacting with electrophiles. For the following examples of steps in mechanisms we have seen this semester, **1) Draw the intermediate that will be formed when the two molecules react. 2) Draw all formal charges and lone pairs on the intermediates. 3) Draw arrows on the starting materials to indicate the flow of electrons that leads to the intermediate. 4) Label all chiral centers with an asterisk (*) and write "racemic" where appropriate. 5) Finally, draw a box around the nucleophile and a circle around the electrophile in each case. There is no need to draw products or any further steps of the mechanisms.** You might want to read these directions again so you know what we want.

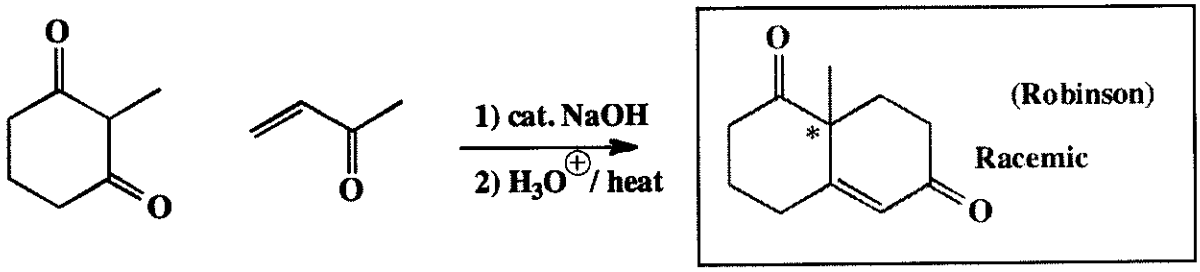


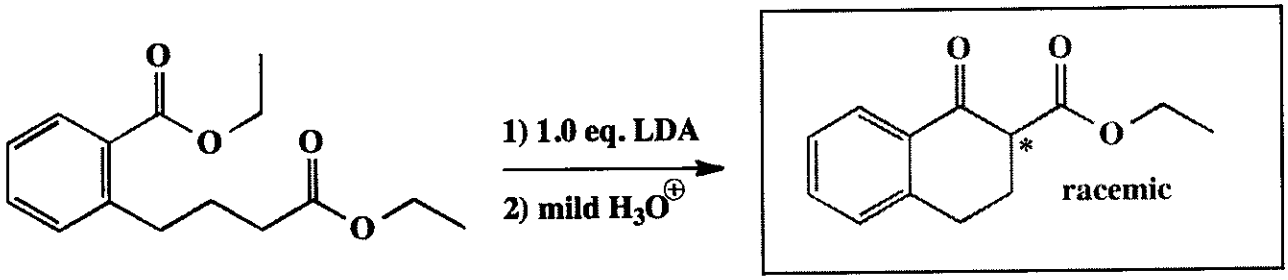
Did you remember to draw boxes and circles?

16. (18 pts.) You might find these are harder so take your time. Write the predominant product or products that will occur for each transformation. **If a new chrial center is created and a racemic mixture is formed, mark the chiral center with an asterisk "*" and write "racemic" under the structure. If ortho/para products are made, you must draw both. Note, for this problem, aldols can dehydrate if heated in dilute acid.**



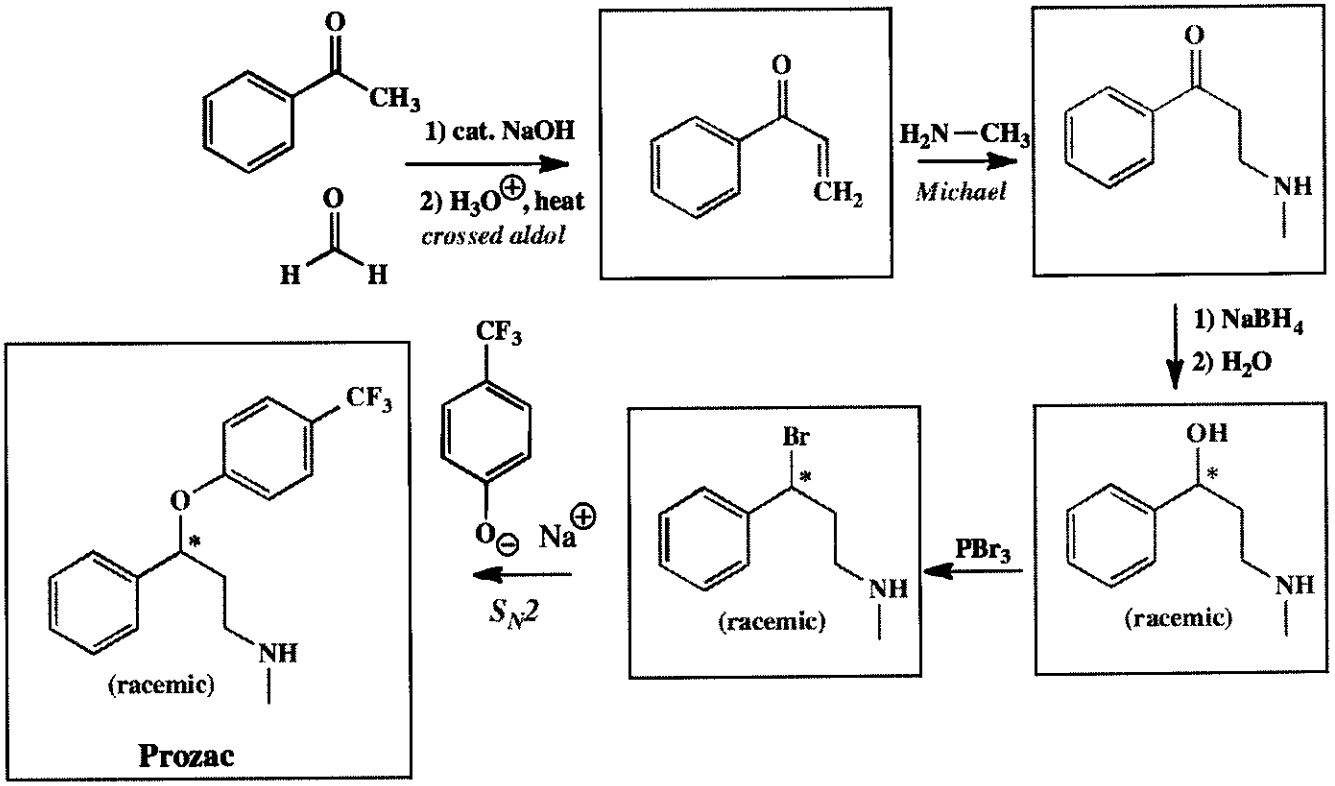






It is time to apply your synthetic knowledge to a real world synthesis problem!

18. (21 pts.) Here is the synthesis of the important pharmaceutical Prozac. You are familiar with all of the chemistry, it just might take you a while to recognize the reactions. **Fill in the boxes with the appropriate structures, and remember to use an asterisk "*" and write "racemic" to indicate any new chiral centers created along the way. Hint: not listed in order, this set of transformations includes a Michael reaction, an S_N2 reaction, a reduction reaction, conversion of a OH group to a halide and an aldol reaction WITH dehydration.**

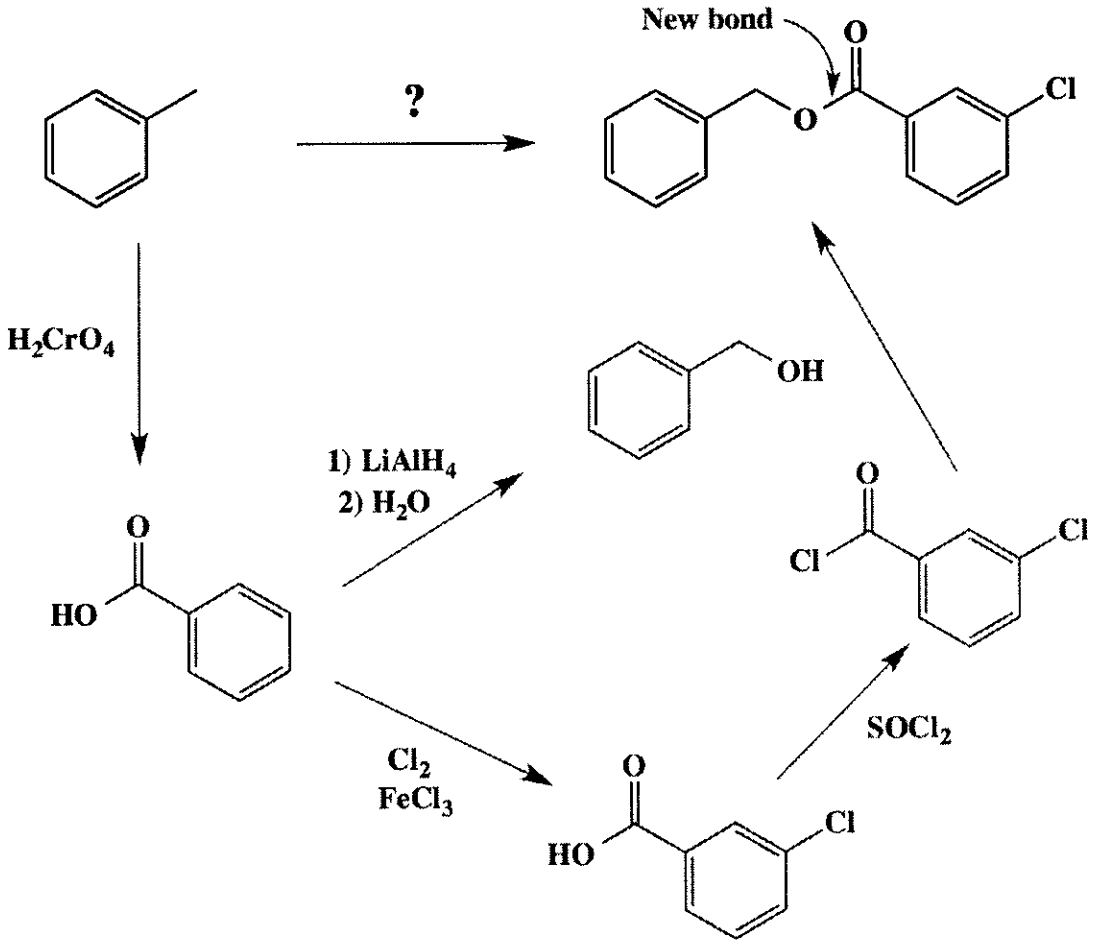


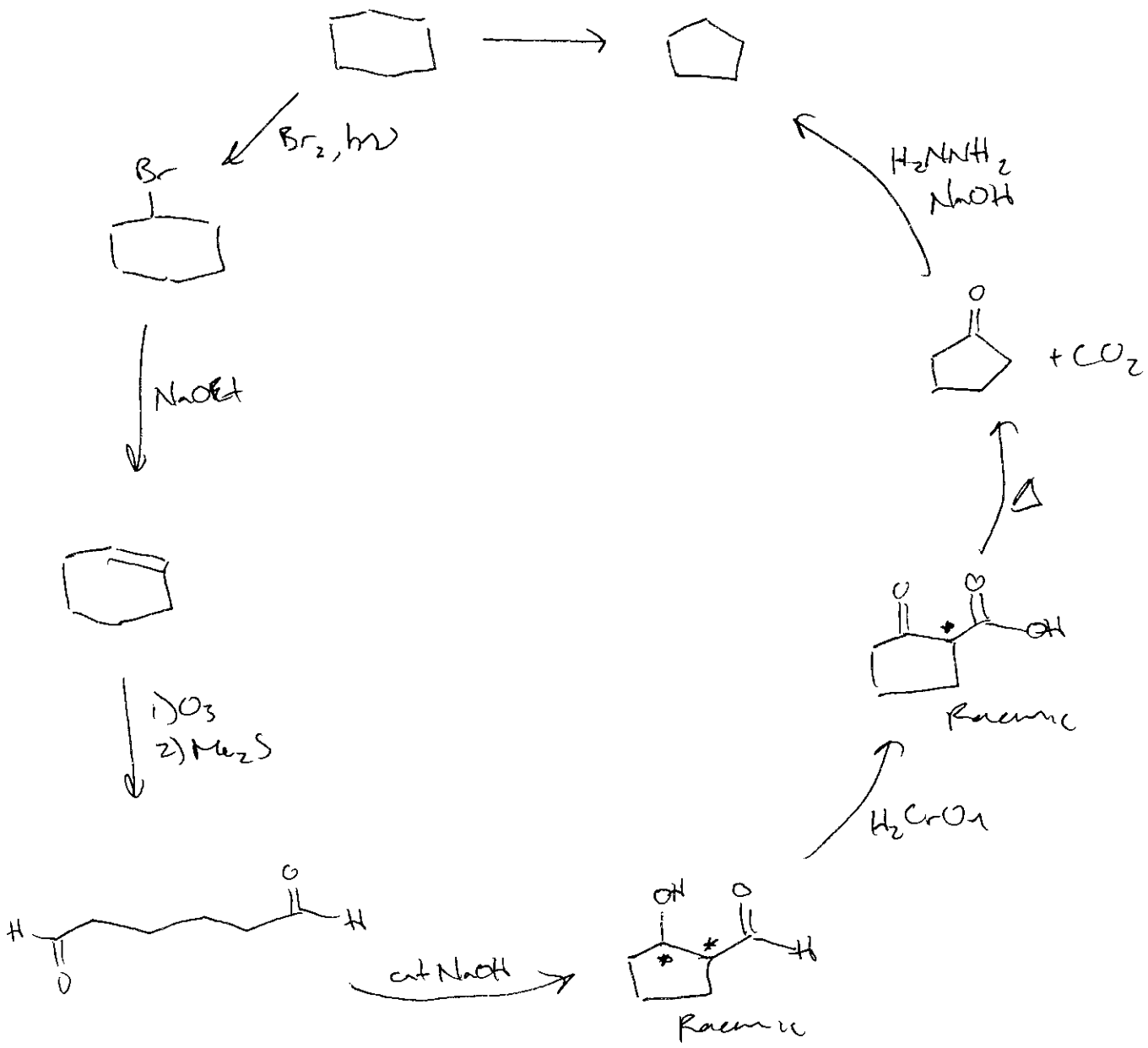
22. Using any reagents turn the starting material into the indicated product. All carbon atoms in the product must come from the starting material. Draw all molecules synthesized along the way. When in doubt, draw the molecule! Label all chiral centers with an asterisk (*) and make sure to right "Racemic" where appropriate.

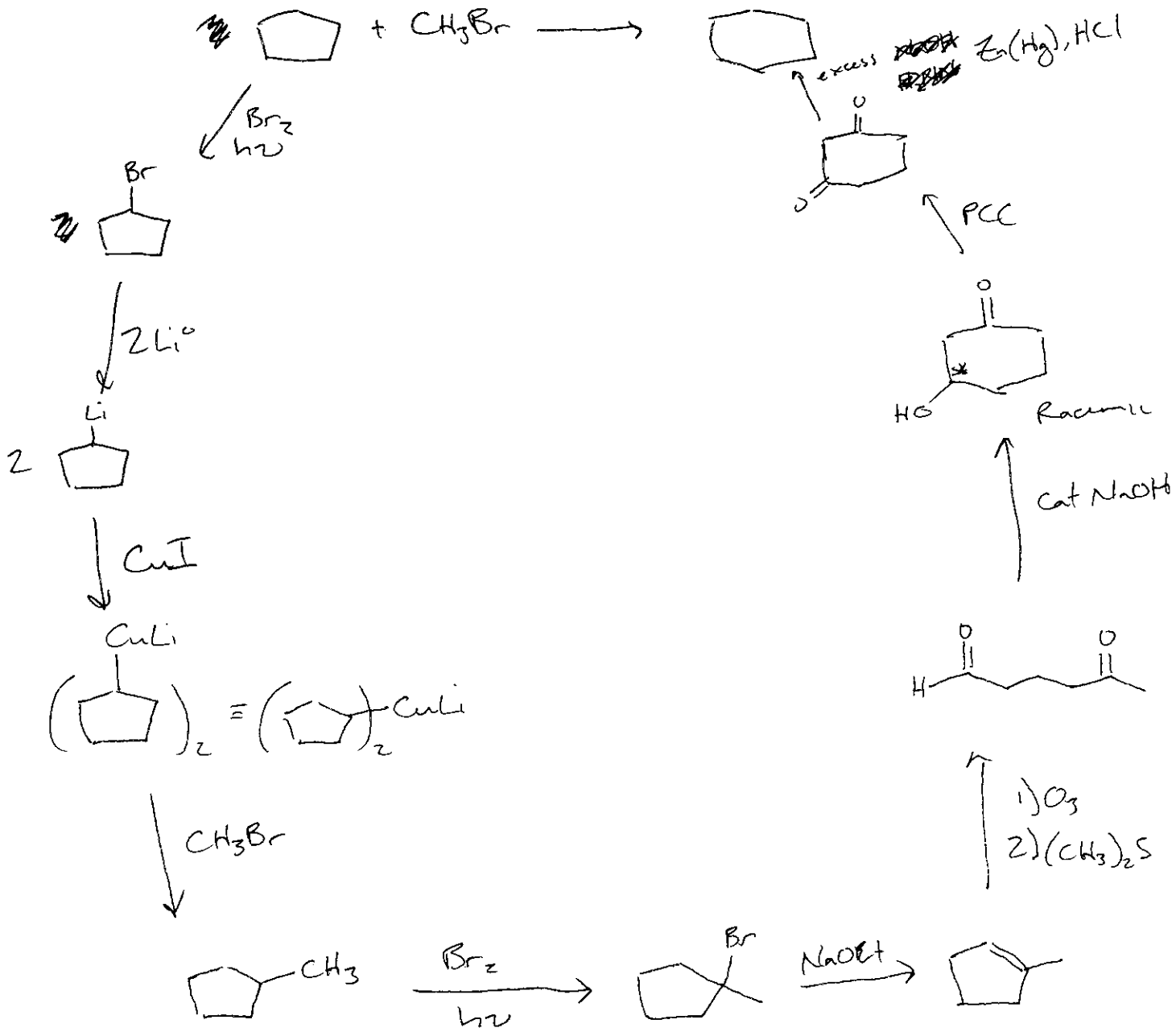
Remember, all of the carbons of the product must come from the given starting material.

(13 pts)

D)




Br2, hν
Br
NaOEt
1) O3
2) Me2S
cat NaOH
H2CrO4
Racemic
Δ
+ CO2
H2NNH2
NaOH
Racemic


+ CH3Br
Br2
hν
excess
Zn(Hg), HCl
PCC
2 Li°
CuI
CuLi
CH3Br
Racemic
cat NaOH
1) O3
2) (CH3)2S
Br2
hν
NaOEt