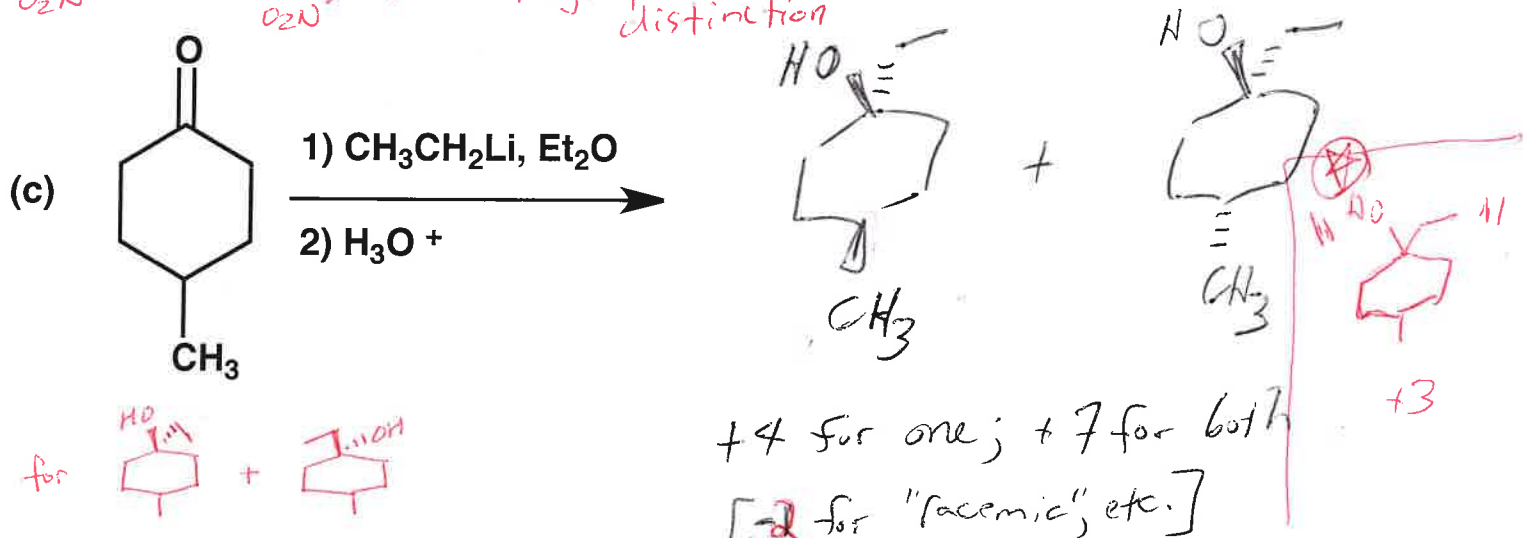
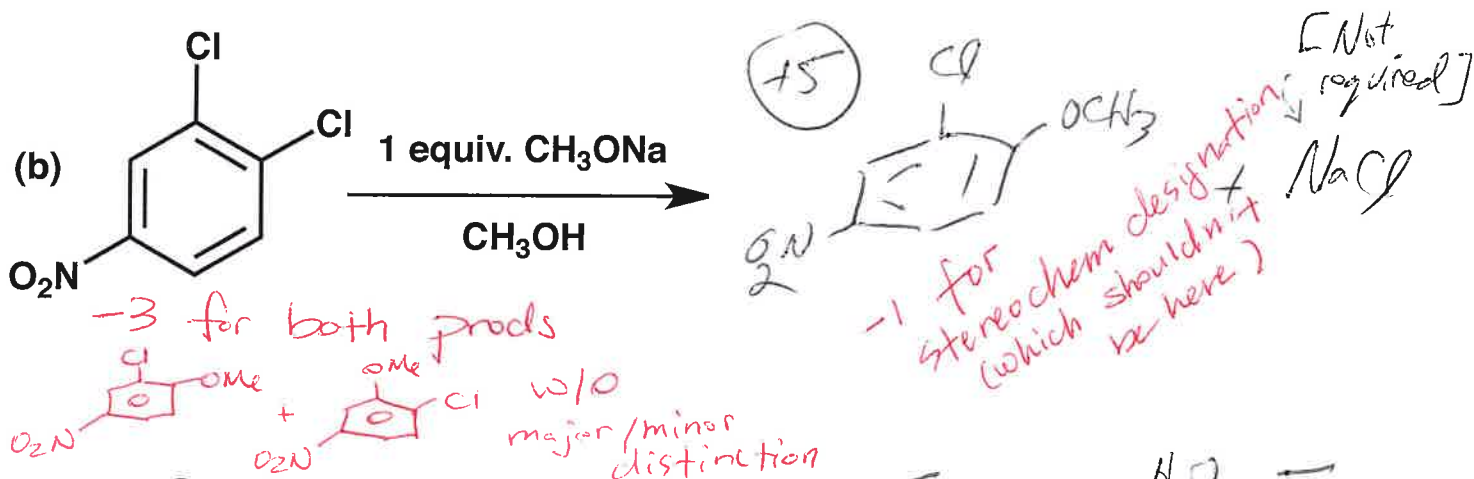
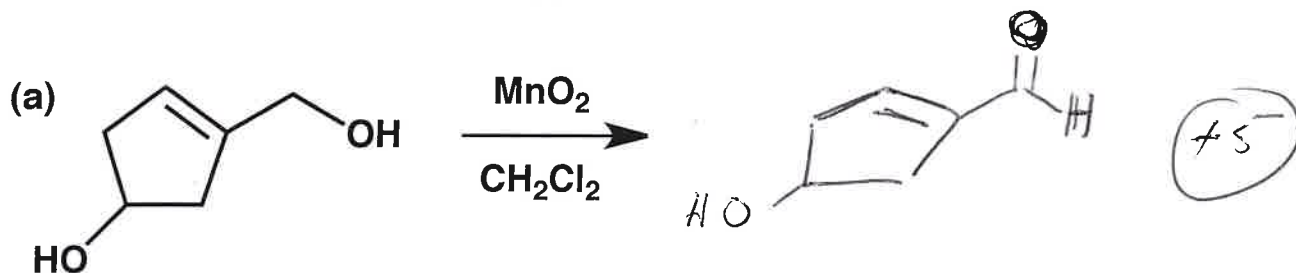


General Instructions:

- (i) Use scratch paper at back of exam to work out answers; final answers must be recorded at the proper place on the exam itself for credit. Models are allowed.
- (ii) Print your name on each page.
- (iii) Please keep your paper covered and your eyes on your own work. No electronic devices may be used. Misconduct will lead to failure in the course.

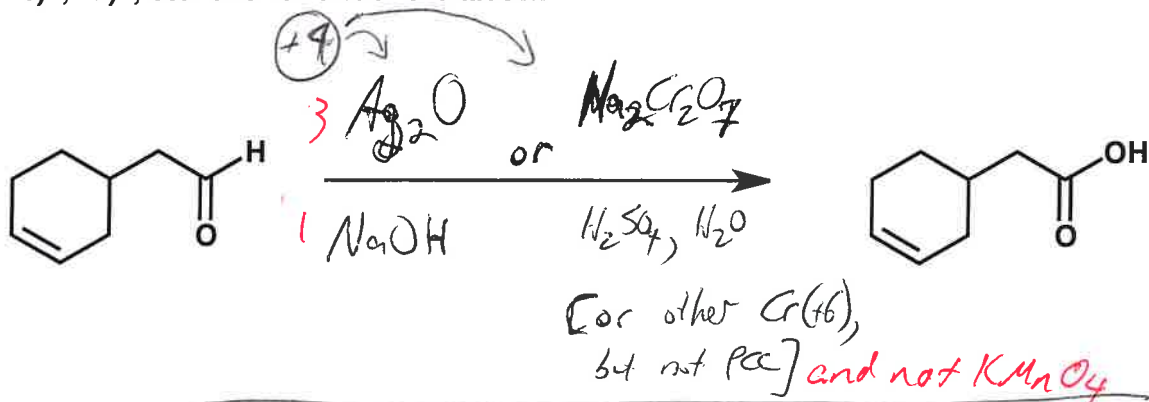
1. (17 points) Show the product(s) expected from the reactions indicated below.



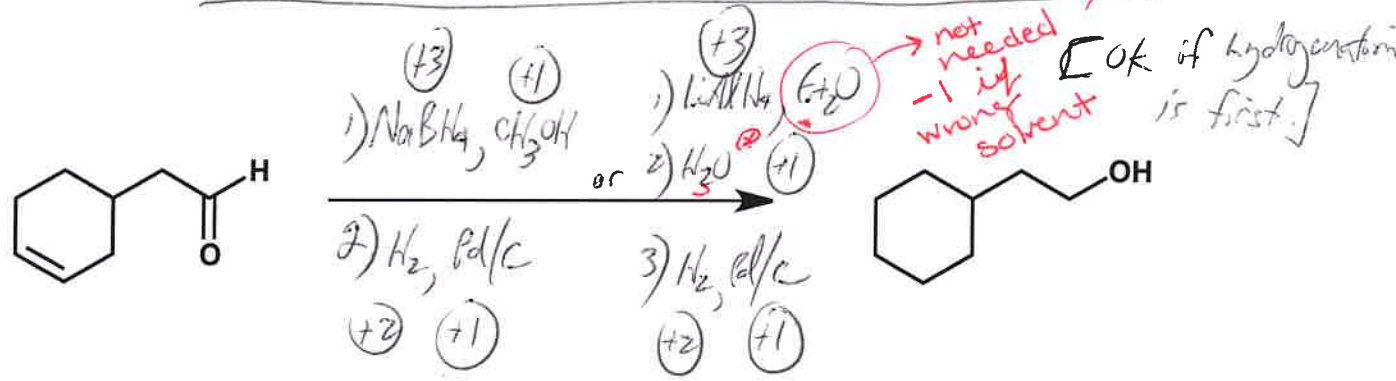
Name \_\_\_\_\_

2. (23 points) Show the reagents and other organic molecules required to convert the starting material to the indicated product. Be sure to differentiate clearly between distinct steps, by using "1)", "2)", etc. over or under the arrow.

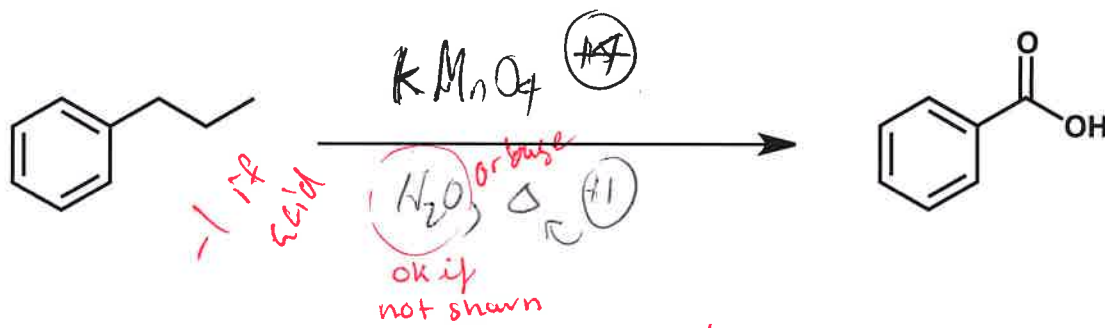
7 (a)



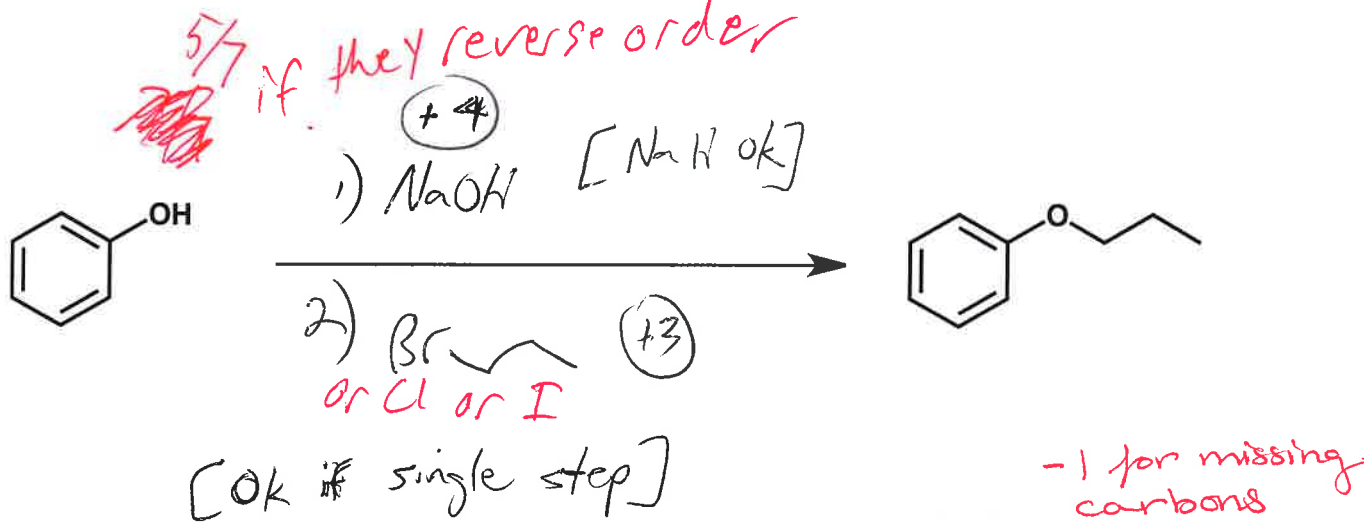
7 (b)



5 (c)



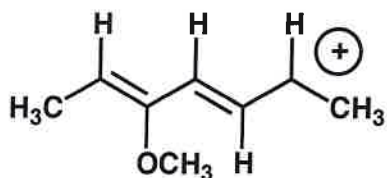
7 (d)



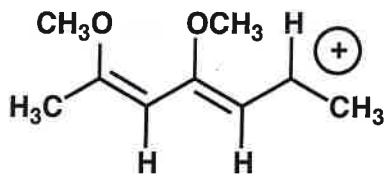
Name \_\_\_\_\_

3. (10 points)

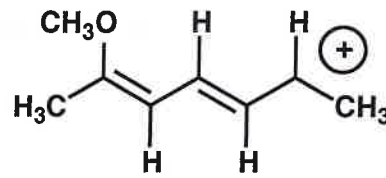
(a) Rank the three carbocations below in terms of DECREASING stability, i.e., from MOST stable on the left to LEAST stable on the right.



I

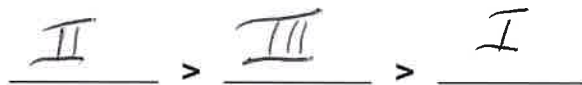


II



III

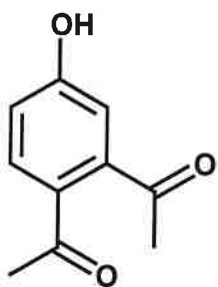
Decreasing stability:



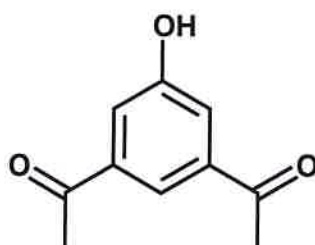
(+5)

[No partial credit]

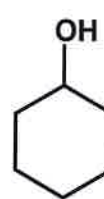
(b) Rank the three <sup>molecules</sup> phenols below in terms of DECREASING  $pK_a$  i.e., from HIGHEST  $pK_a$  on the left to LOWEST  $pK_a$  on the right.



IV



V



VI

Decreasing  $pK_a$ :



(+5)

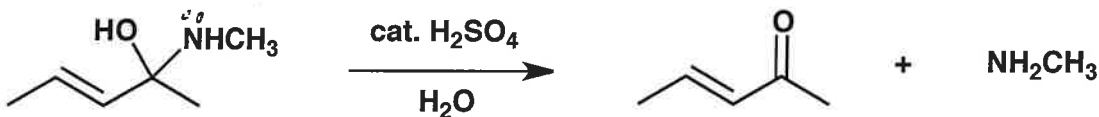
+2 for this only

4. (19 points) Provide a mechanism (curved arrows) for each reaction shown below. Draw all important resonance structures for intermediates.

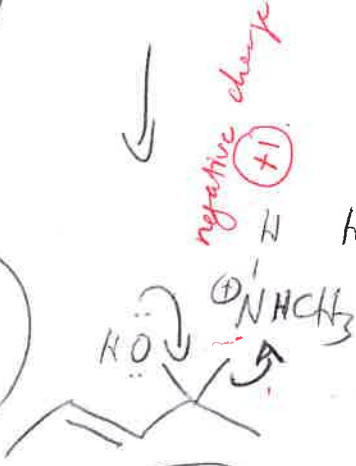


*Must show bond being broken*

+2 for arrows

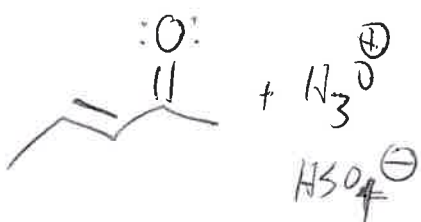


+2 for arrow(s)

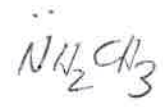
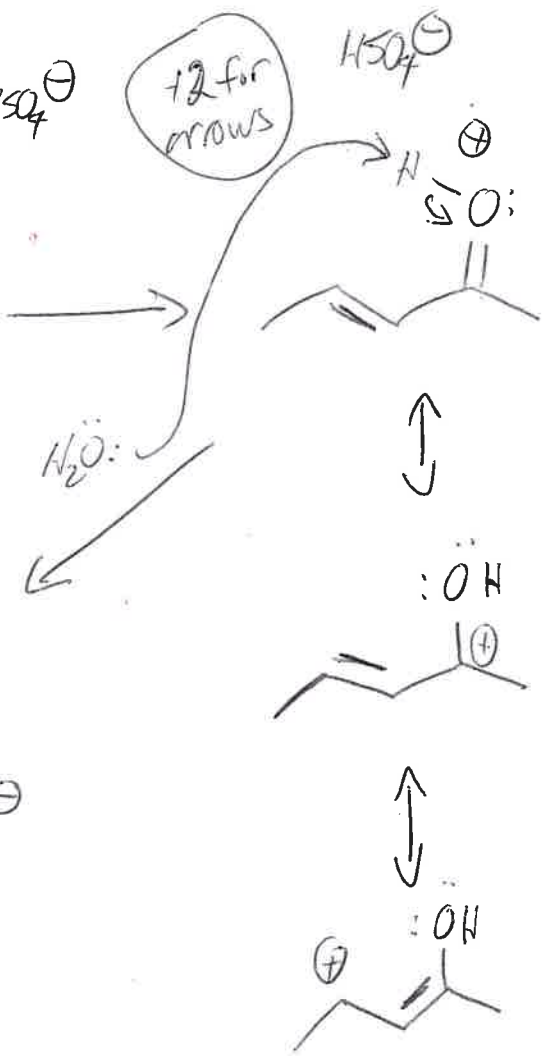


+2 for intermediate

+1 for forgetting charge



+2 for arrows



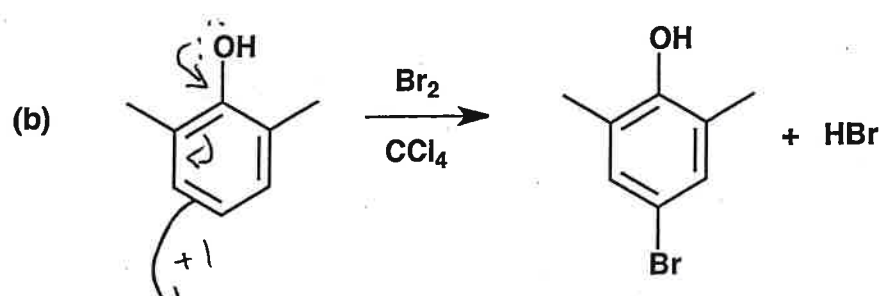
+1 for each res. structure

+11 total

[Arrows for any res. structure can be correct.]

4. (cont.)

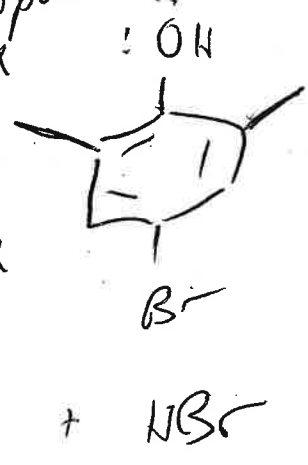
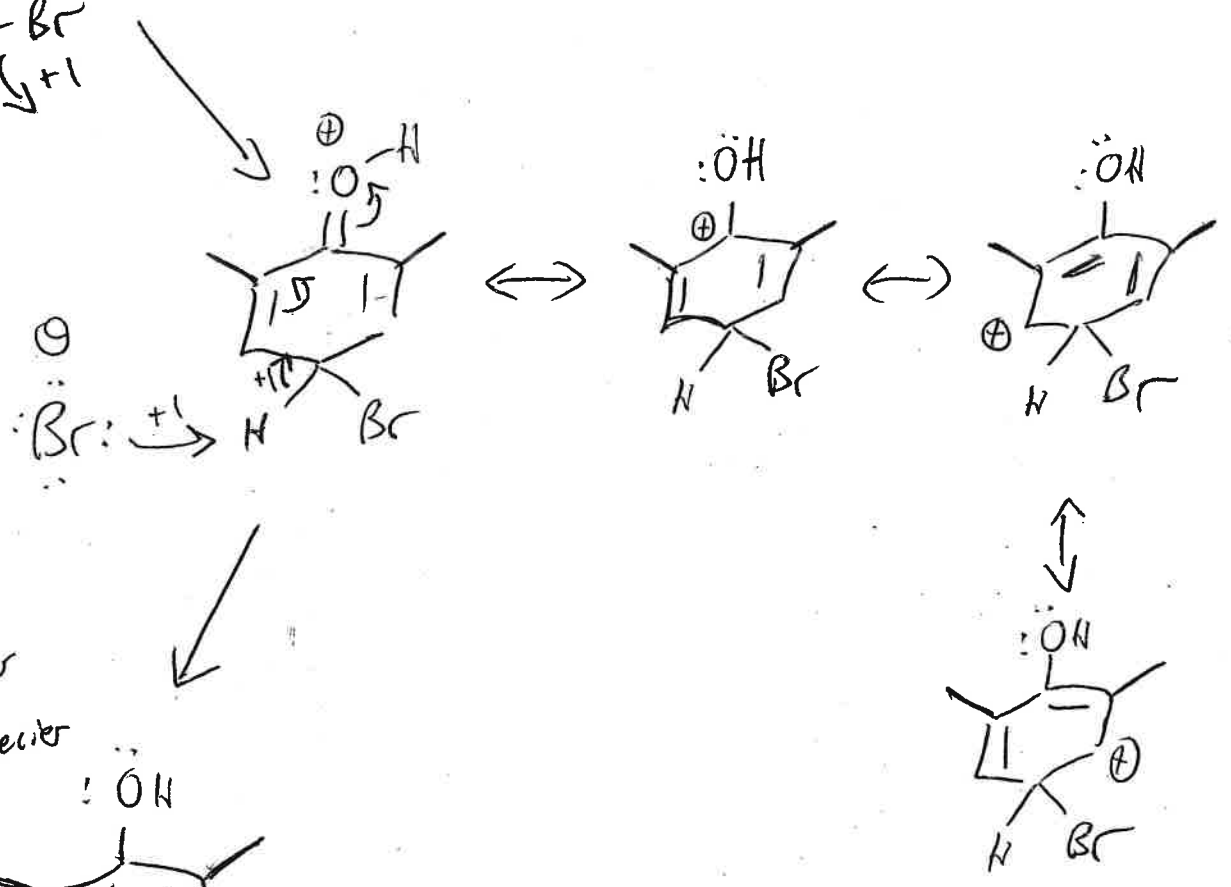
8 pts total



deprotonated  
Max of 4 pts  
if use

Br-[CCl<sub>4</sub>] as  
brominating species  
6 pts max

If both  
2 pts max



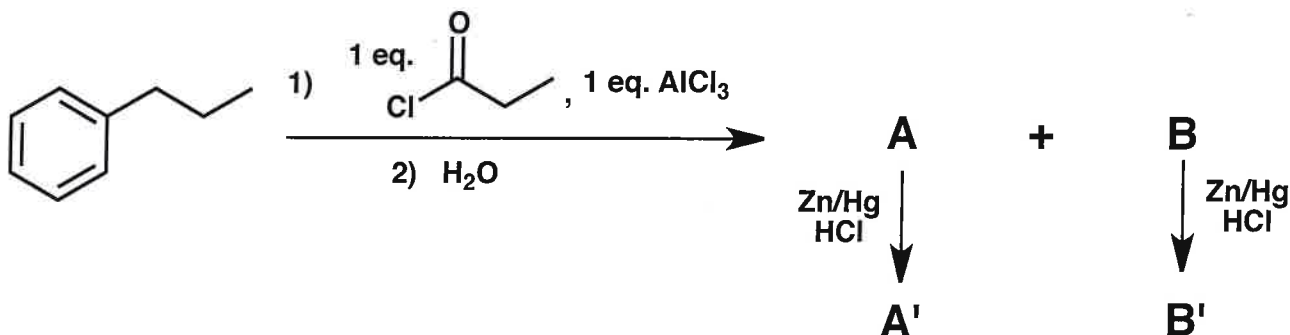
+2 for each set of curved arrows (different possibilities for full credit). [4 total]

+1 for each correct res. struct. of the intermediate.

[4 total]

Name \_\_\_\_\_

5. (16 points) The first reaction indicated below gives rise to two products, A and B. When these products are separated from one another and individually subjected to the second reaction, product A' or B' is generated. Based on the  $^{13}\text{C}$  NMR data given below, provide structures for A, B, A' and B' in the indicated boxes.



$^{13}\text{C}$  NMR data:

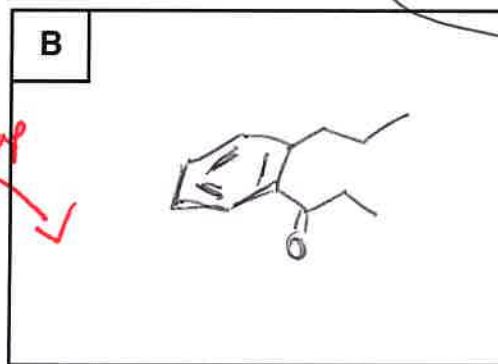
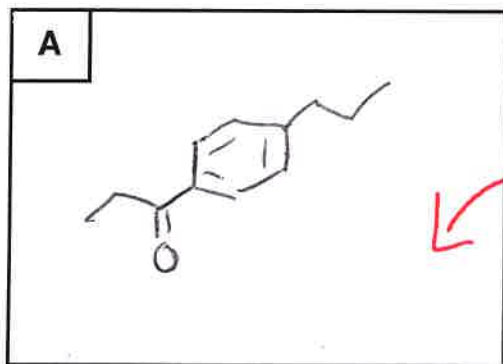
Compound A -- 5 resonances < 50 ppm, 4 resonances 120-140 ppm, 1 resonance ~200 ppm.

Compound B -- 5 resonances < 50 ppm, 6 resonances 120-140 ppm, 1 resonance ~200 ppm.

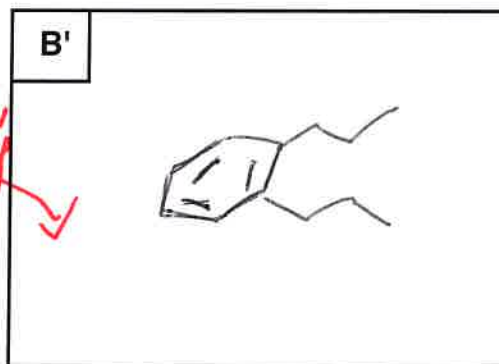
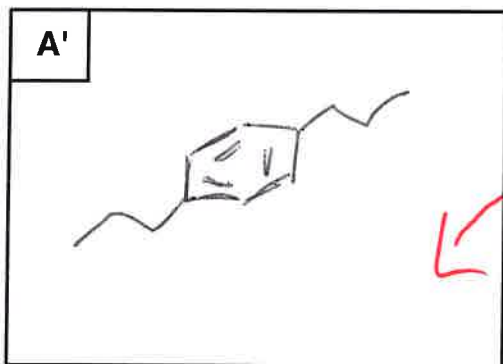
Compound A' -- 3 resonances < 50 ppm, 2 resonances 120-140 ppm.

Compound B' -- 3 resonances < 50 ppm, 3 resonances 120-140 ppm.

+4 each  
correct structure



*1/4 for flip flip*

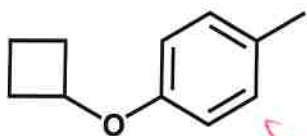


*1/4 for flip flip*

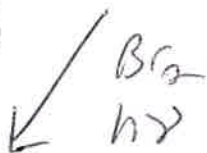
Name \_\_\_\_\_

6. (15 points) Propose an efficient synthetic route from the indicated starting material to the target. You may use any other starting materials and reagents. Show the expected product after each step in your synthetic route. (Do not provide mechanistic information.)

Starting material =

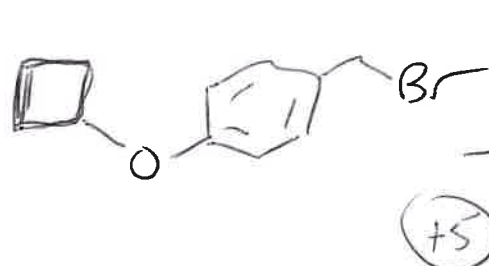
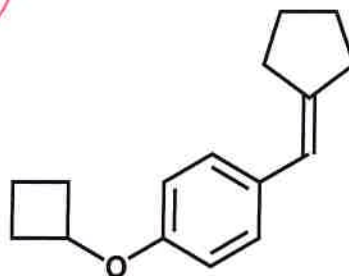


(+5)

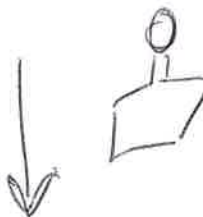
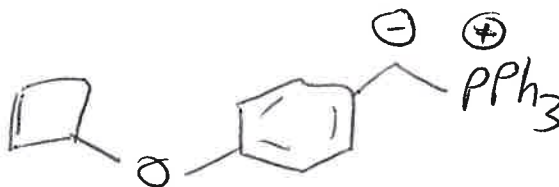
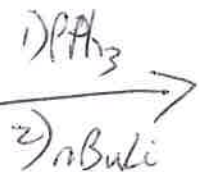


+3 if initiator not shown

Target =



(+5)



(+5)

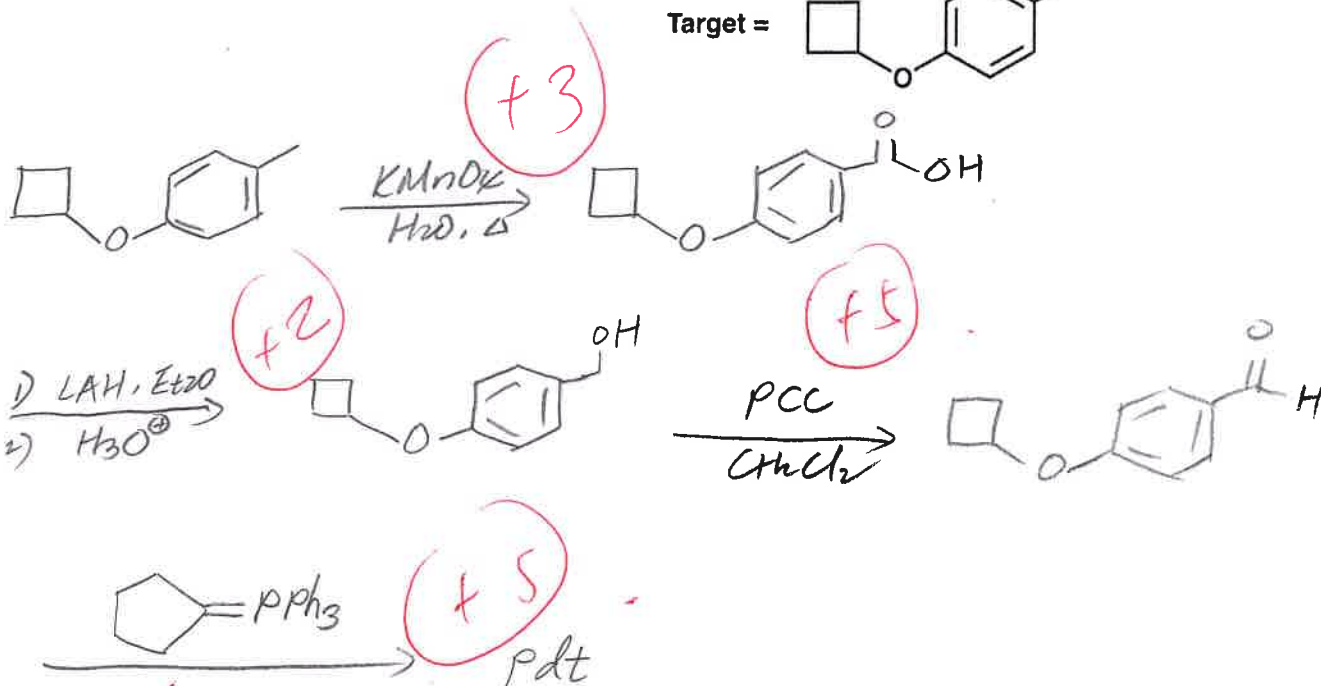
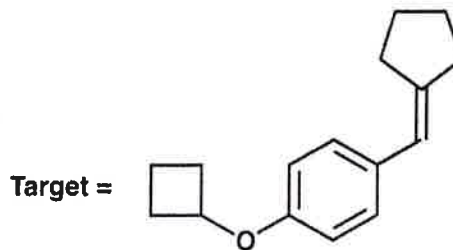
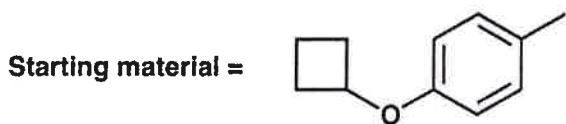


Alternatives...

*if NBS used or H<sub>2</sub>O or otherwise*

Name \_\_\_\_\_

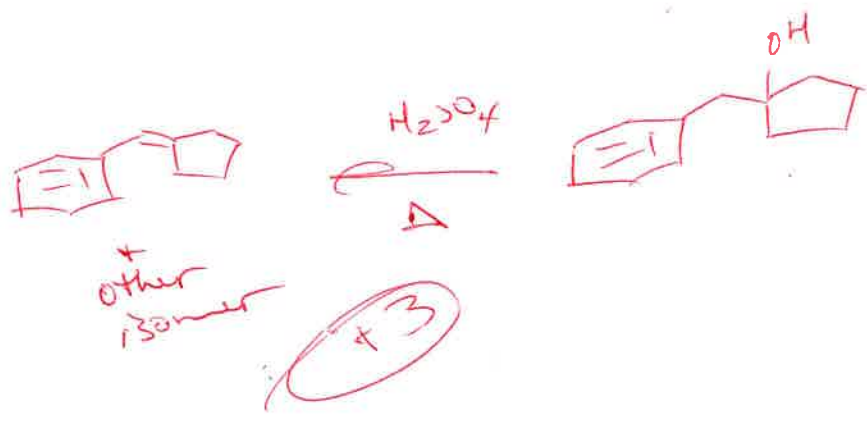
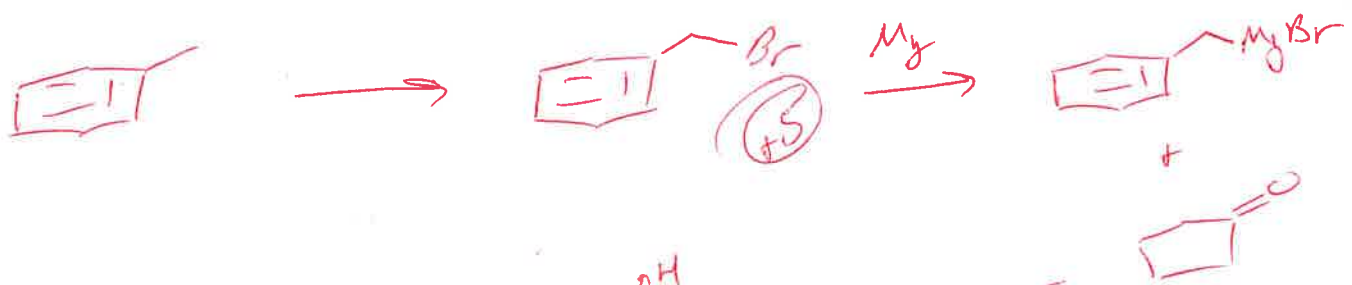
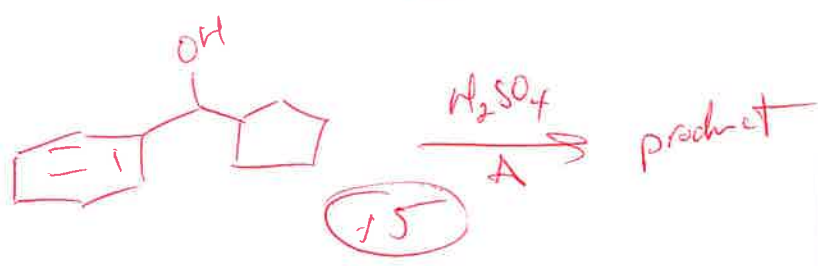
6. (15 points) Propose an efficient synthetic route from the indicated starting material to the target. You may use any other starting materials and reagents.



loses 2 pts if Wittig reagent is wrong.

No pts for format<sup>n</sup> of Wittig reagent; directly using them is fine.

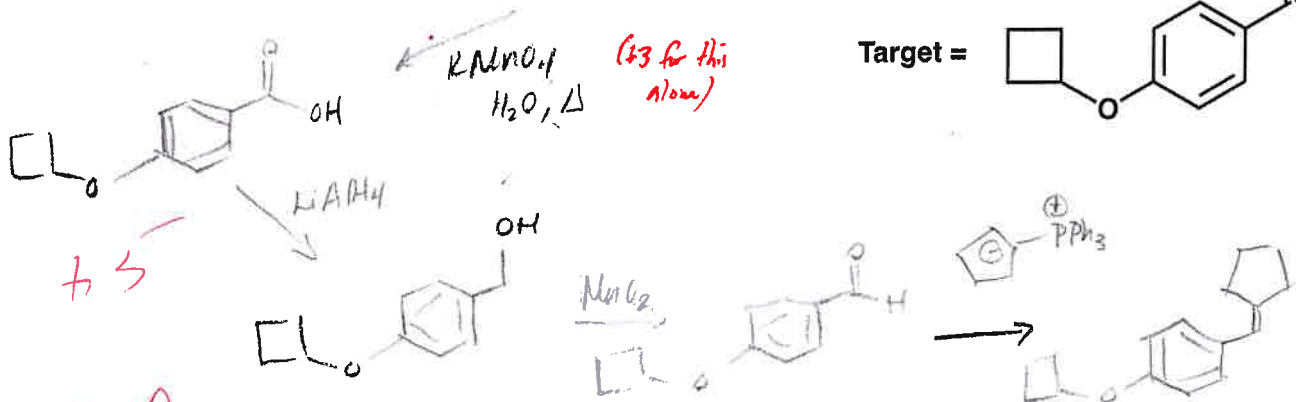
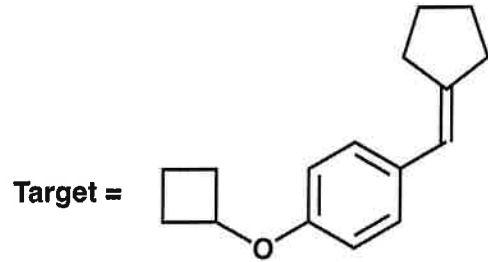
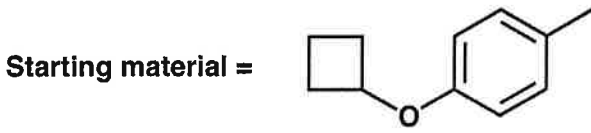




13/15

Name \_\_\_\_\_

6. (15 points) Propose an efficient synthetic route from the indicated starting material to the target. You may use any other starting materials and reagents.



-2 for incorrect oxidant or reductant

+5

+5