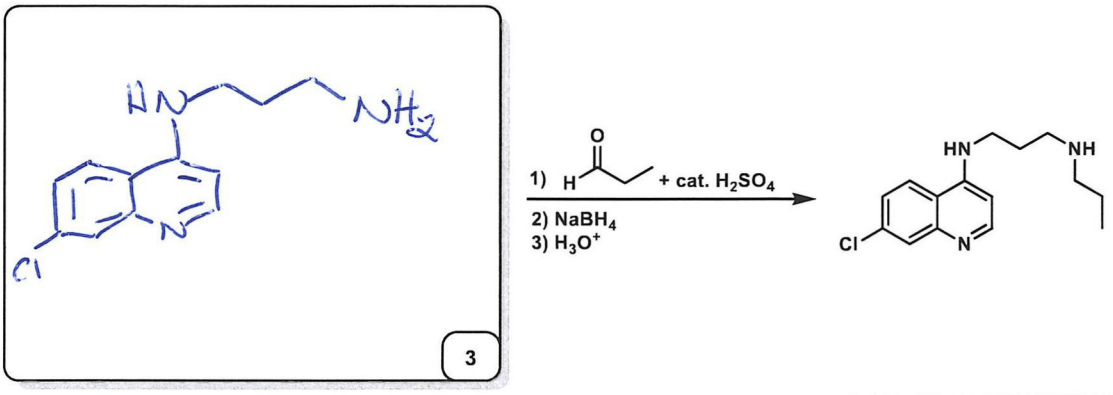
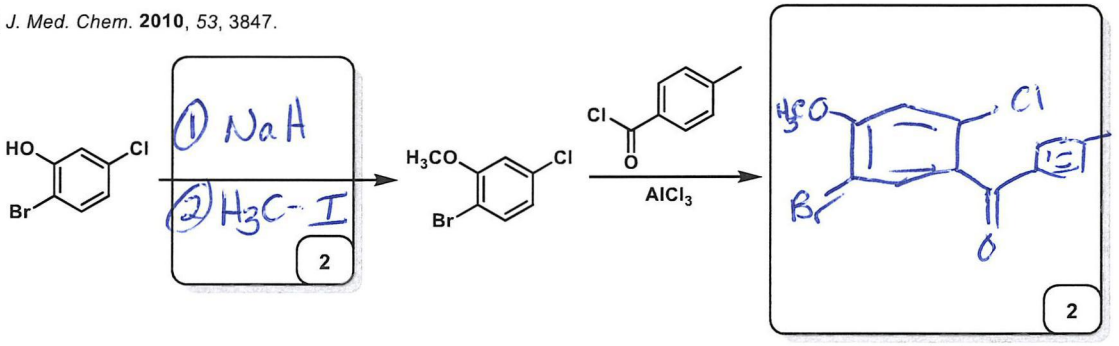
1. **Quick Synthesis.** Fill in the boxes with either the correct reagents or products. Please be sure to indicate stereochemistry (where appropriate) and steps, if needed. For any boxes pointing to a specific atom, please calculate the oxidation number for that atom. (18 pts)

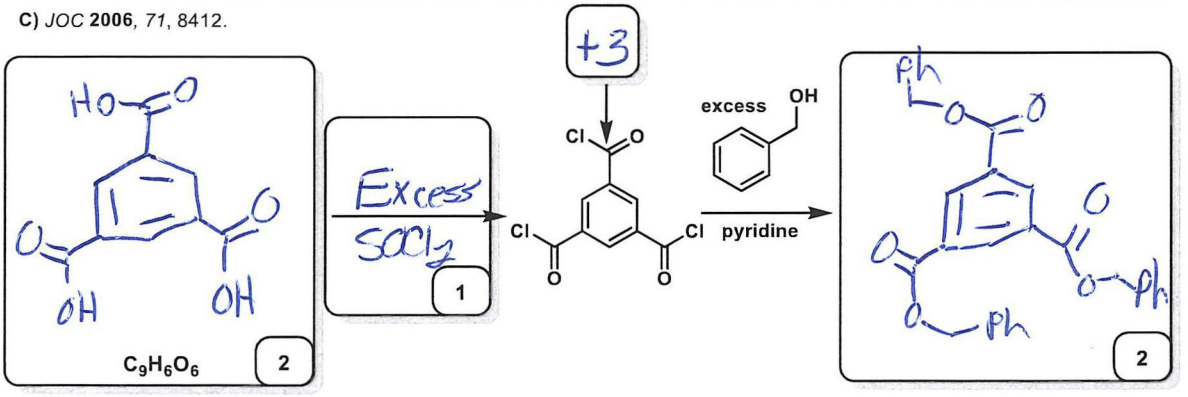
A) *J. Med. Chem.* **2010**, *53*, 8209.



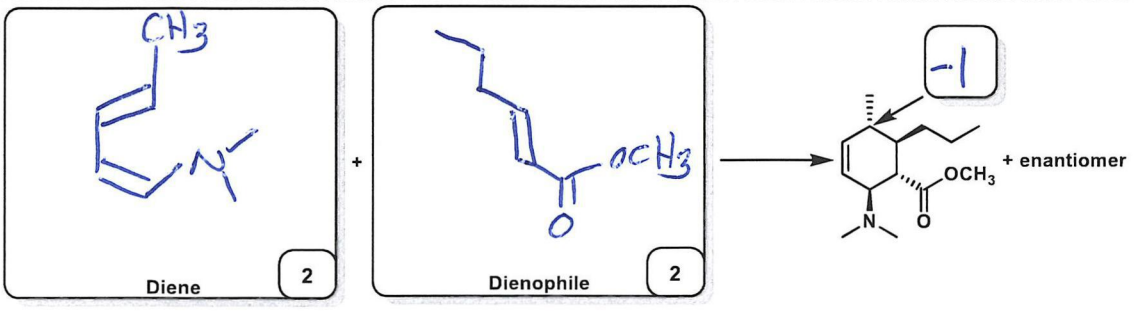
B) *J. Med. Chem.* **2010**, *53*, 3847.



C) *JOC* **2006**, *71*, 8412.

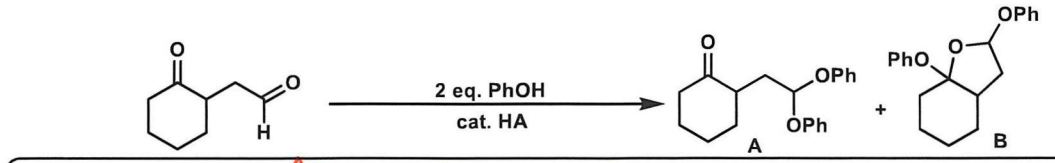


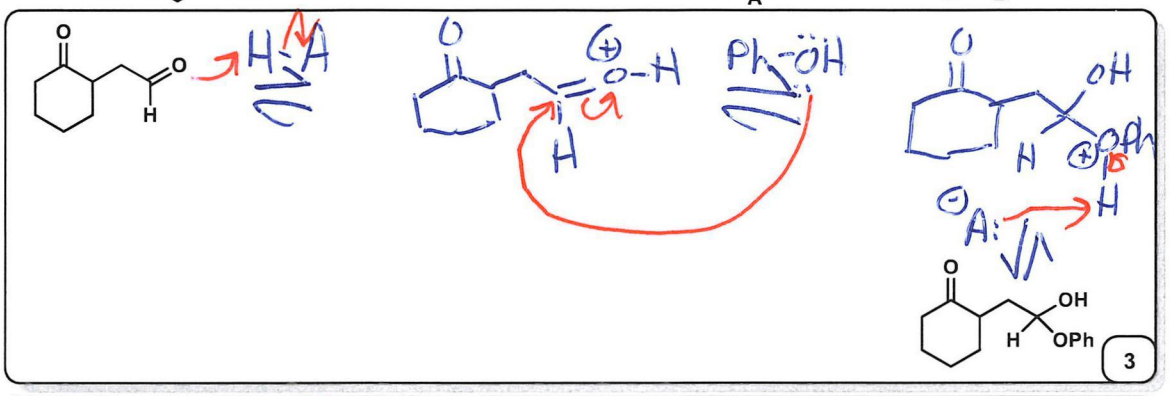
D)

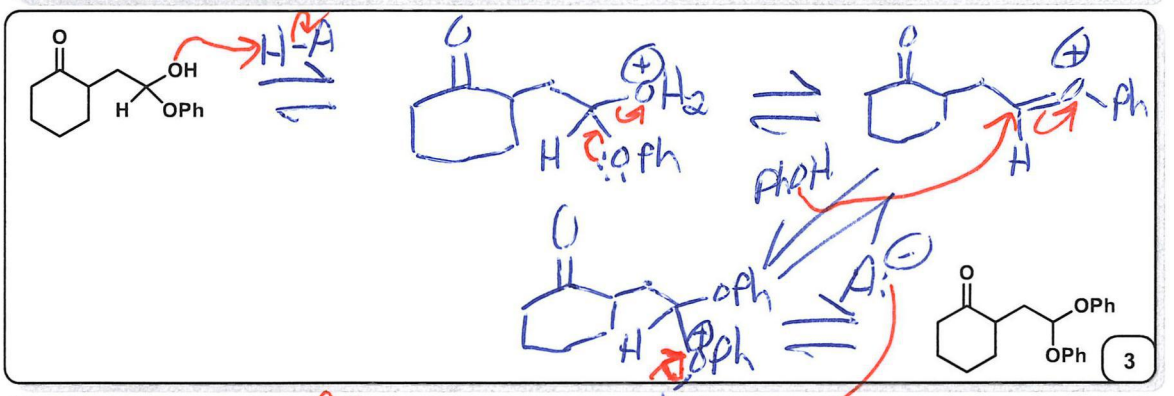


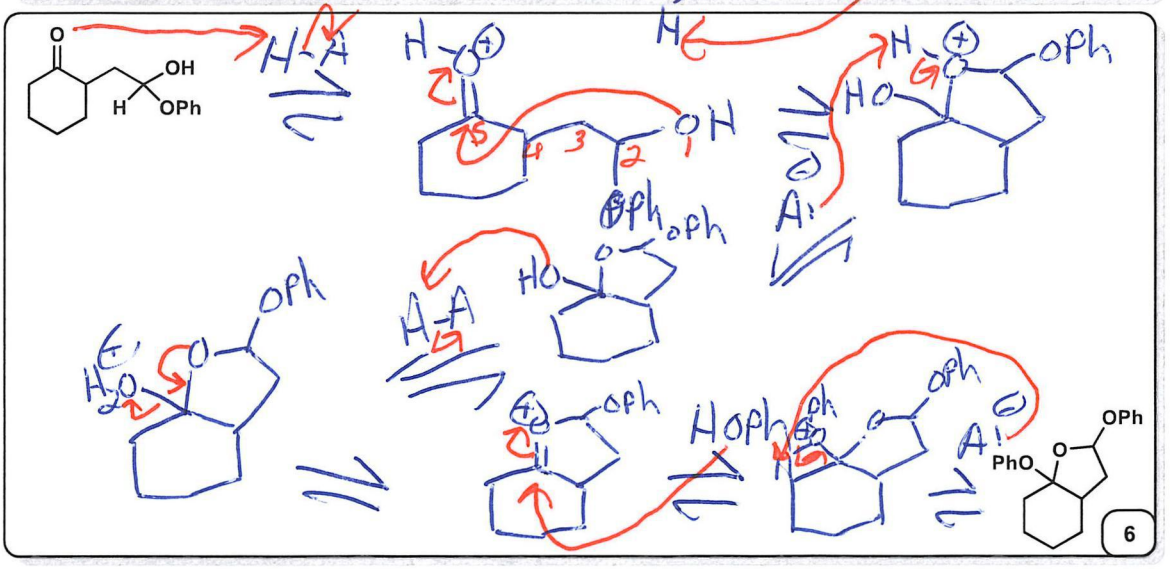
2. **Mechanism.** Below you will find 3 mechanisms. You ***MUST*** do the first mechanism (on this page). Then, do ***ONE*** of the two mechanisms on page 4. *If you do both, I will grade the first one*. (16 pts)

a. Provide a step-wise mechanism that explains the production of both products given. The mechanism has been broken into 3 parts: 1) formation of intermediate; 2) formation of product A; 3) formation of product B.

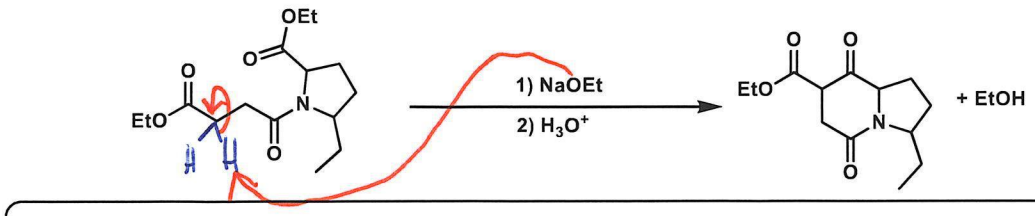


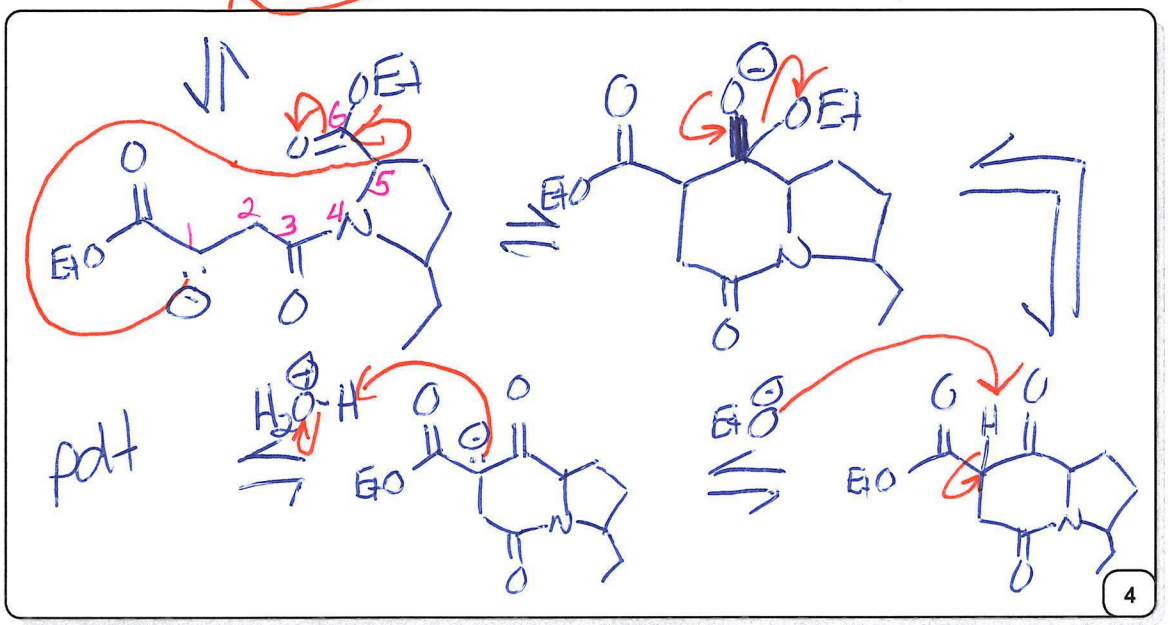


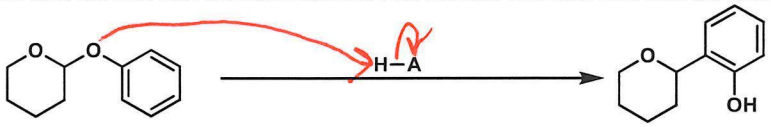


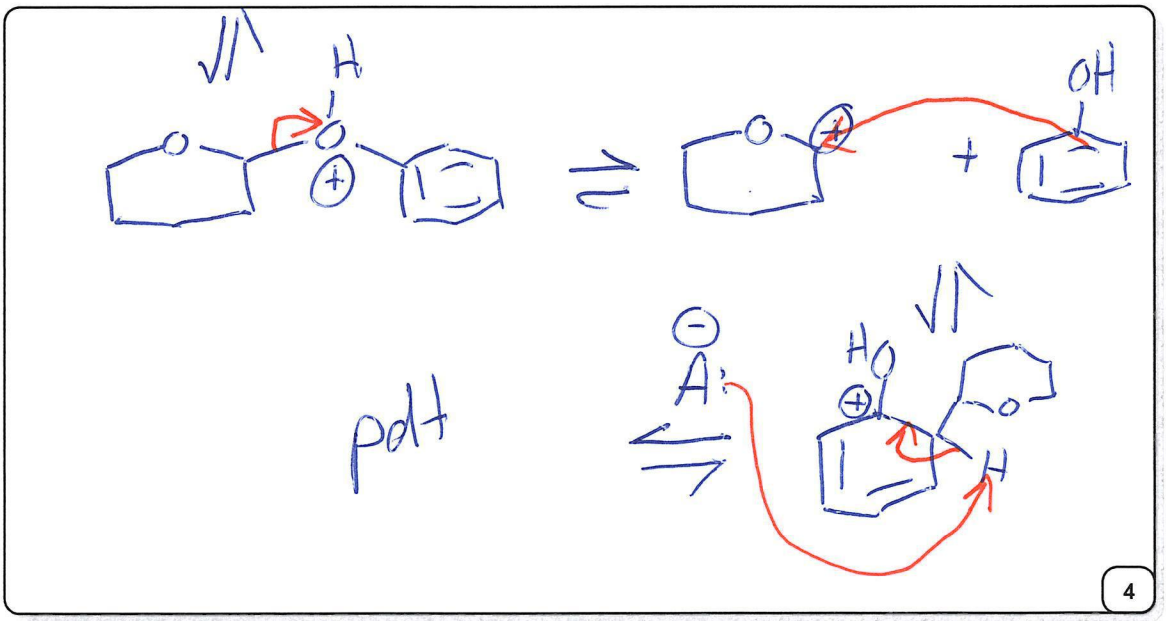


Choose one of the two mechanisms below:



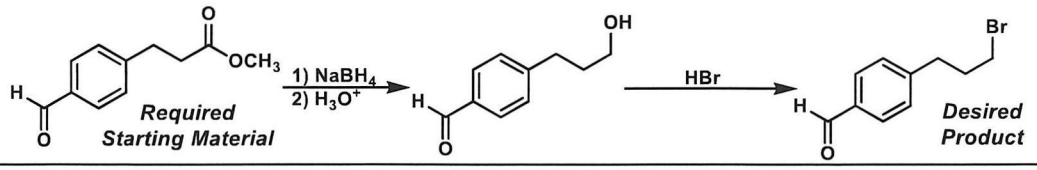






**Hint*: This one involves a variation on electrophilic aromatic substitution....*

3. **Flawed Synthesis.** Below you will find two syntheses that will not lead to the ***Desired Product***. Describe the flaw(s), then provide a route that will lead to the ***Desired Product***. Both problems are required. (10 pt)



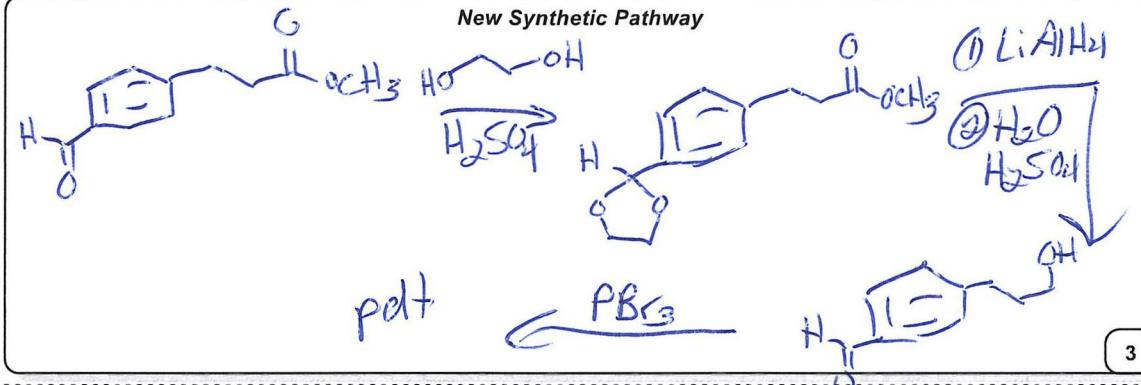
Synthetic Flaw(s)

(1) $NaBH_4$ will not reduce ester; but will reduce aldehyde

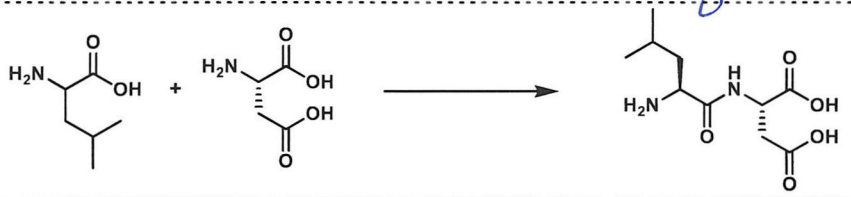
(2) HBr would lead to rearrangements

2

New Synthetic Pathway



3



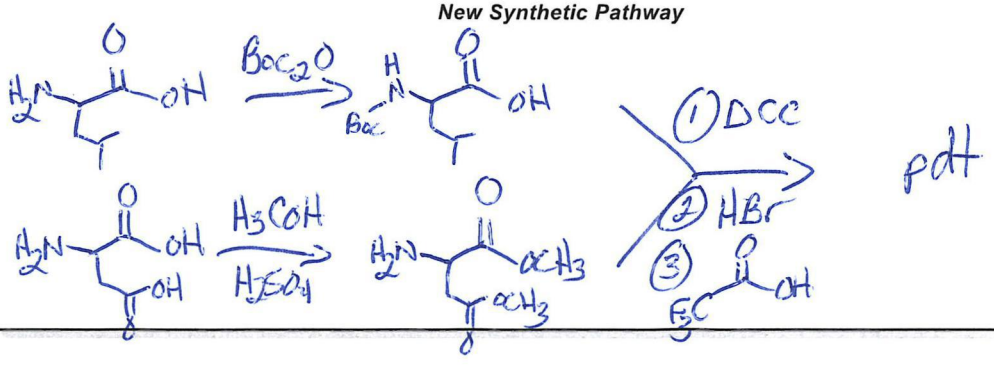
Synthetic Flaw(s)

(1) Need Protecting groups

(2) Need DCC

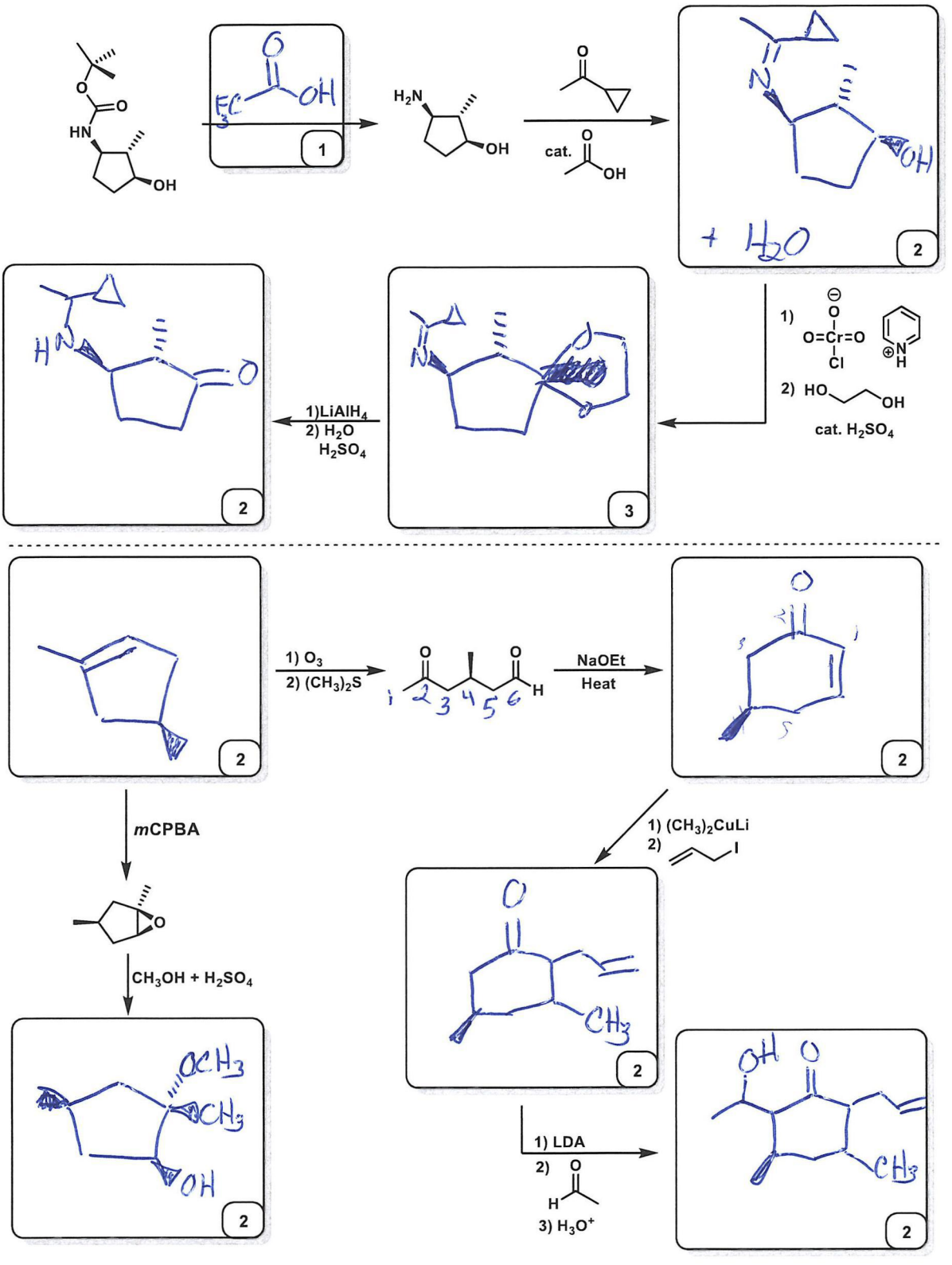
2

New Synthetic Pathway



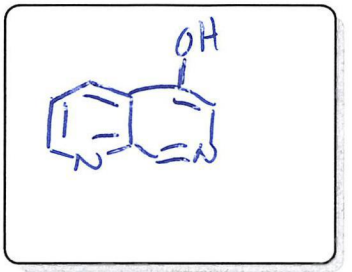
3

5. **Guided Synthesis.** Fill in the missing reagents / intermediates / products to complete the following synthetic schemes. (18 pts)



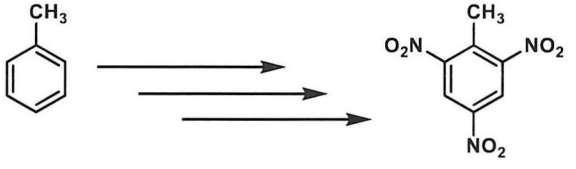
6. **Short Answer.** First, fill in the products / structures required to complete the reaction or transformation indicated (if needed). Then provide a ***SHORT*** written response for the question posed with each reaction. You may use structures to aid your explanation, if necessary. (10 pts)

a. We learned in class that ketones and aldehydes can tautomerize to enols; however, most prefer to be in the ketone / aldehyde form over the enol form. The compound below is an exception. Provide the enol form of the ketone below and then provide a brief rationale for why this compound exists primarily as the enol.



Enol form is aromatic
↳ more stable

b. Trinitrotoluene (TNT) can be made through 3 nitration reactions starting from toluene. The first nitration occurs at room temperature, the second at 80 °C and the third nitration requires refluxing conditions (>120 °C). Provide a ***BRIEF*** explanation for this observed difference in reactivity.



Toluene ***TNT***

Each nitro group adds a strongly deactivating group to the ring, slowing the subsequent rxns down.

7. **Less-Guided Synthesis.** In the left box, fill in the final product from the list of reagents provided. In the right box, provide the reagents to complete the transformation. (10 pts)