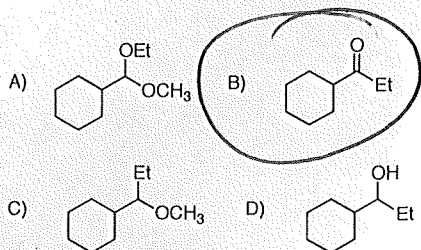
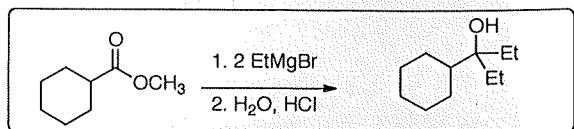


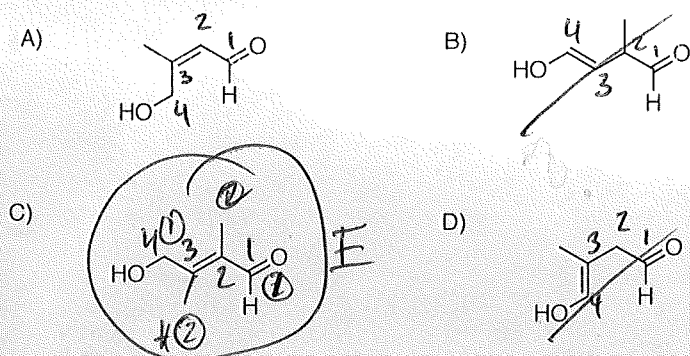
You are not allowed to post this key on the internet!

Problems 1 to 25 (3 pts each): Please use the front of the Scantron form:

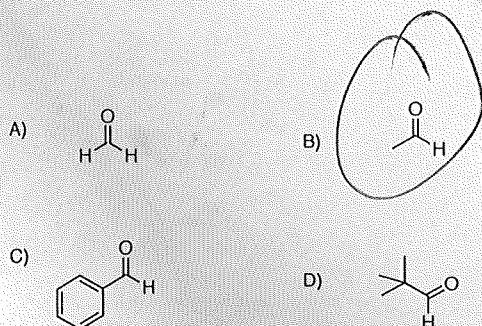
1. Which of the following compounds is a key intermediate for the reaction in the box?



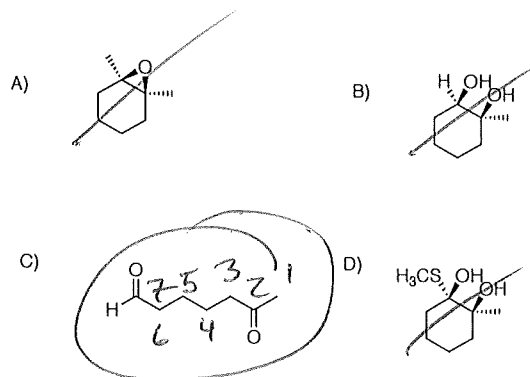
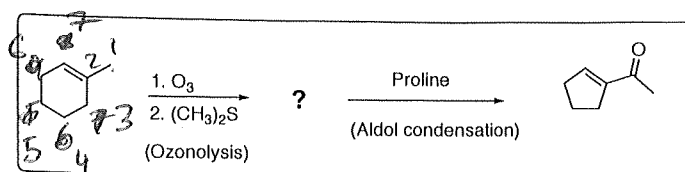
2. Which of the following represents the structure of (*E*)-4-hydroxy-2-methyl-2-butenal?



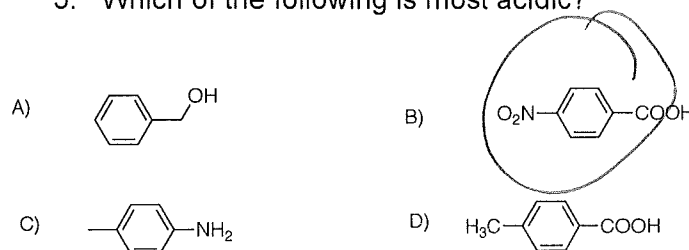
3. Which of the following compounds is able to undergo self-condensation by aldol reaction?



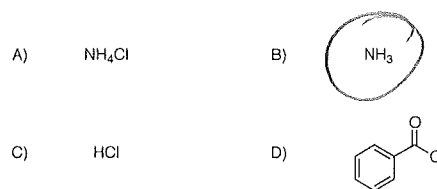
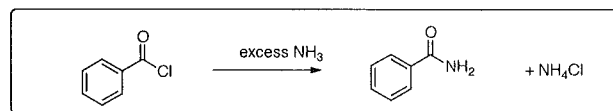
4. What is the intermediate of the following reaction sequence?



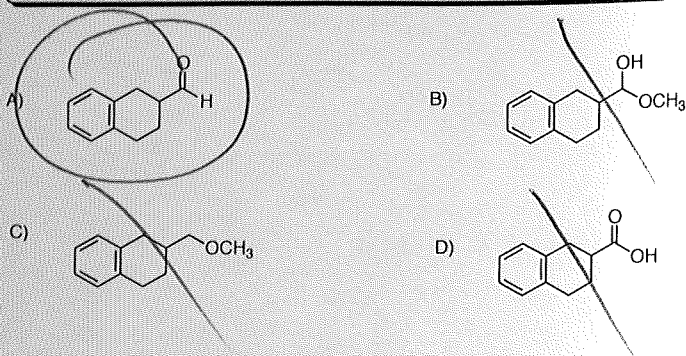
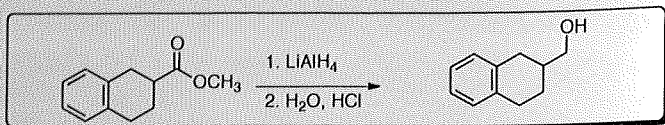
5. Which of the following is most acidic?



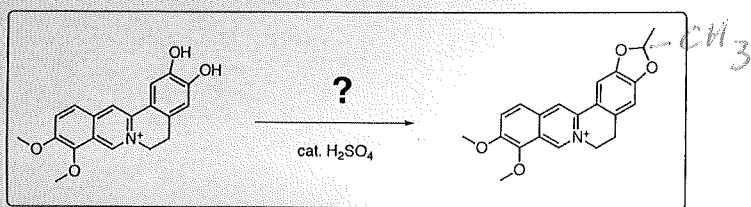
6. In the conversion in the box which of the following acts as a nucleophile?



7. Which of the following is a key intermediate for the reaction in the box?



8. * Consider the transformation in the box. What is the required reactant?



- A) ethyl acetate B) propanal
- C) acetone D) DMF

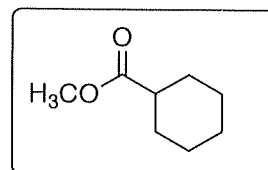
Not graded!

9. Which of the following is LEAST reactive towards nucleophilic acyl substitution?

- A) acetyl chloride B) acetic anhydride
- C) ethyl acetate D) DMF

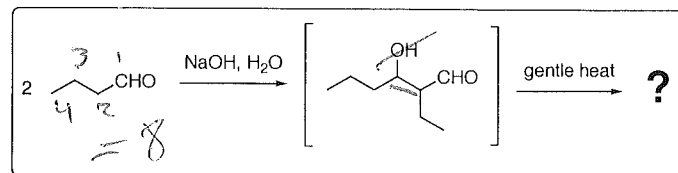
AMIDE

10. Consider the ester shown in the box. Which of the following reagents is expected to reduce this compound?



- A) NH_3 B) H_2SO_4
- C) NaOCH_3 D) LiAlH_4

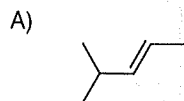
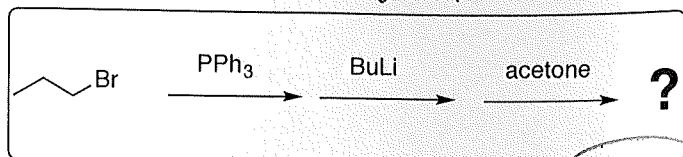
11. What is a major product of the following Aldol condensation?



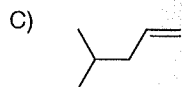
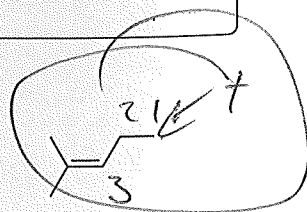
- A) B) C) D)

12. What is a major product of the reaction sequence shown in the box?

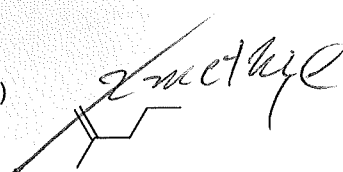
WITTIG!



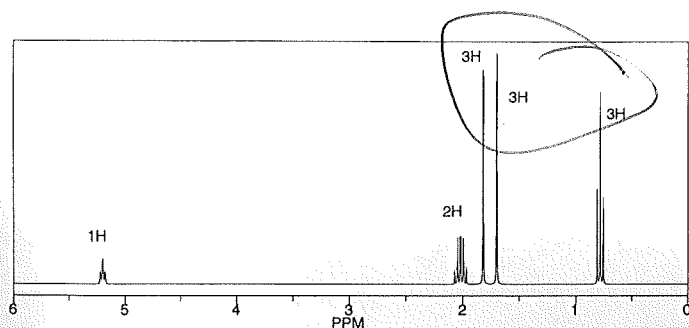
B)



D)



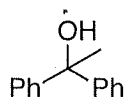
^1H NMR of the major product



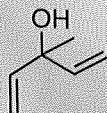
13. Which of the following cannot be prepared by treating ethyl acetate with a Grignard or organolithium reagent?



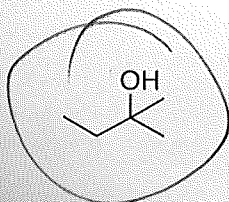
B)



C)

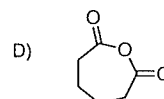
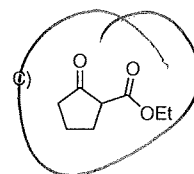
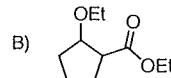
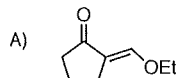
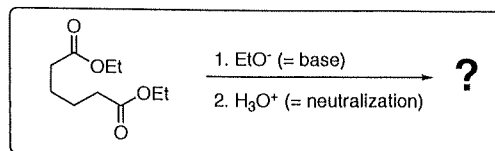


D)

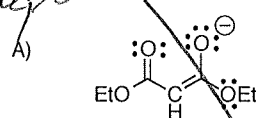


14. The reaction below involves an intramolecular Claisen condensation (also called Dieckmann condensation).

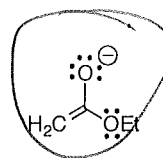
What is the structure of the product?



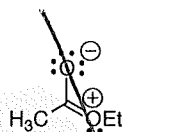
15. Which of the following represents the enolate of ethyl acetate?



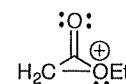
B)



C)

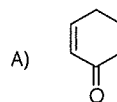
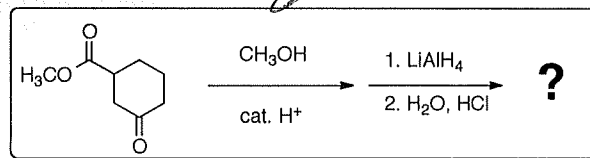


D)

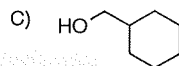
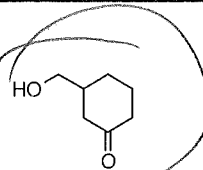


16. What is a major product of the reaction in the box?

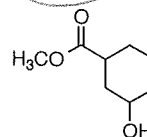
Handwritten: Acetate



B)

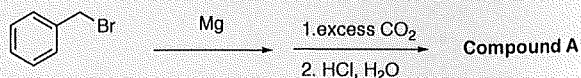


D)

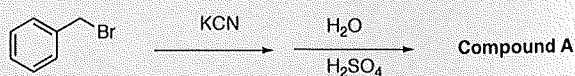


17. Consider compound A. There are several ways of synthesizing this compound, two examples are given below:

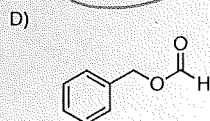
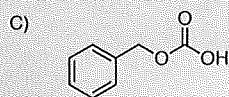
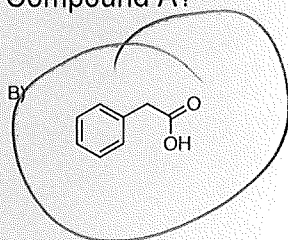
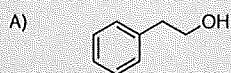
Example 1:



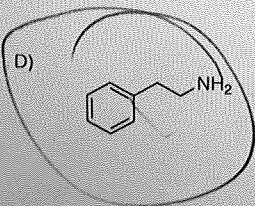
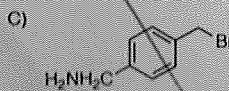
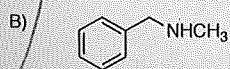
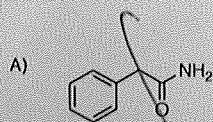
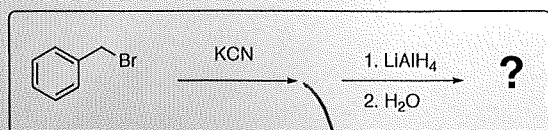
Example 2:



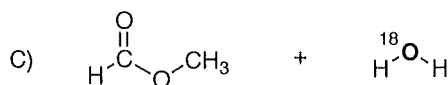
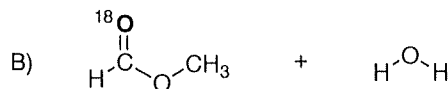
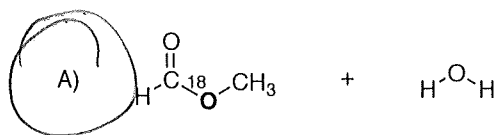
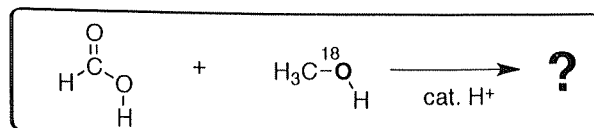
What is the structure of Compound A?



18. The following reaction sequence results in an amine. What is the structure of that amine?

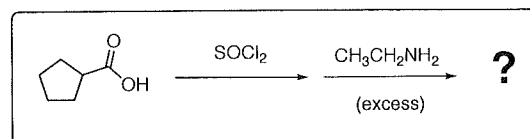


19. What are the products of the reaction of formic acid with ¹⁸O labeled methanol?

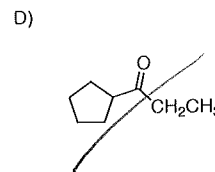
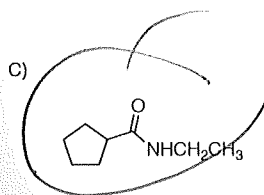
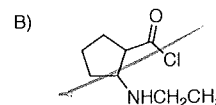
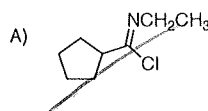


D) ¹⁸O is incorporated both into the ester AND into the water.

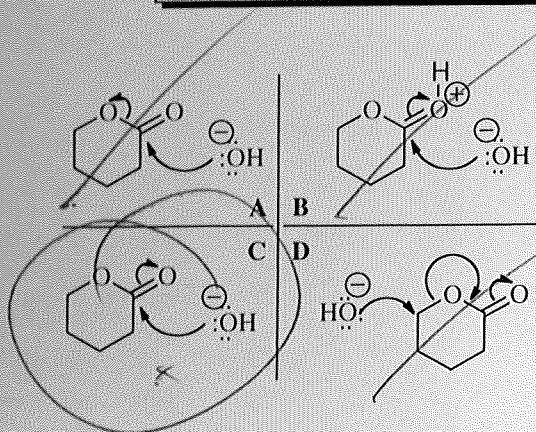
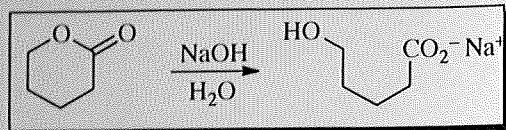
20. What is a major product of the reaction sequence shown in the box?



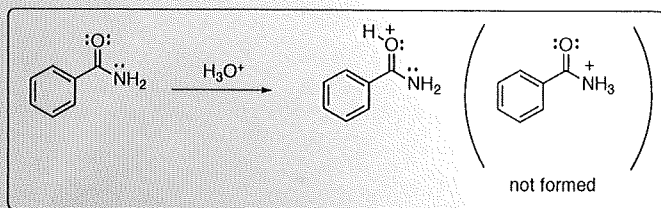
Amide



21. Which of the following correctly describes a key step of the mechanism of the reaction in the box?



22. Consider the protonation of benzamide shown in the box:



What is the primary reason for this observation?

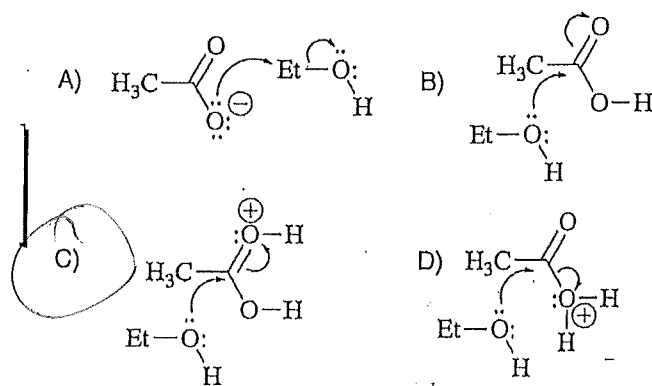
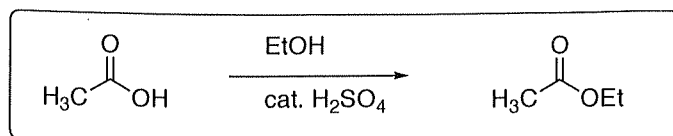
A) Relative electronegativity of nitrogen versus oxygen.

B) Oxygen is a better nucleophile than nitrogen.

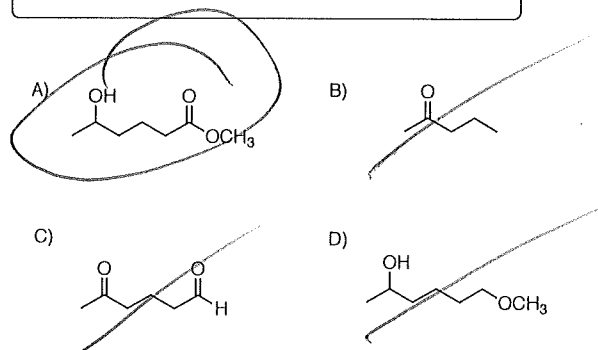
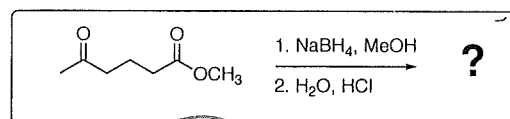
C) Stabilization of the positive charge via resonance.

D) Steric effects, there is more room for the proton to attach to oxygen.

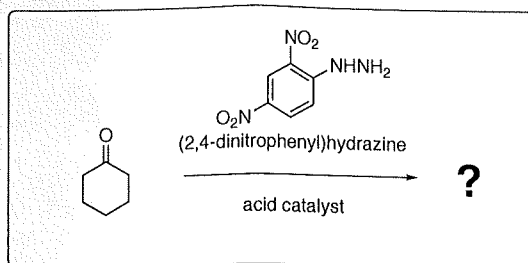
23. Which of the following represent a key step for the reaction in the box?



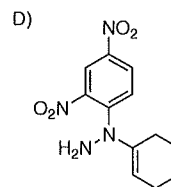
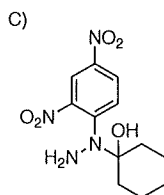
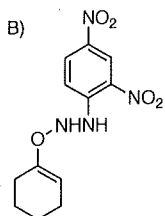
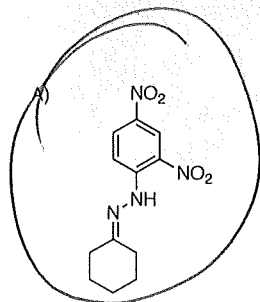
24. What is a major product of the reaction in the box? - IR of the major product: 3422 (br), 1739 cm⁻¹



25. The reaction of 2,4-dinitrophenylhydrazine with aldehydes or ketones has been traditionally used to characterize such carbonyl compounds. What is the product of 2,4-dinitrophenylhydrazine with cyclohexanone?

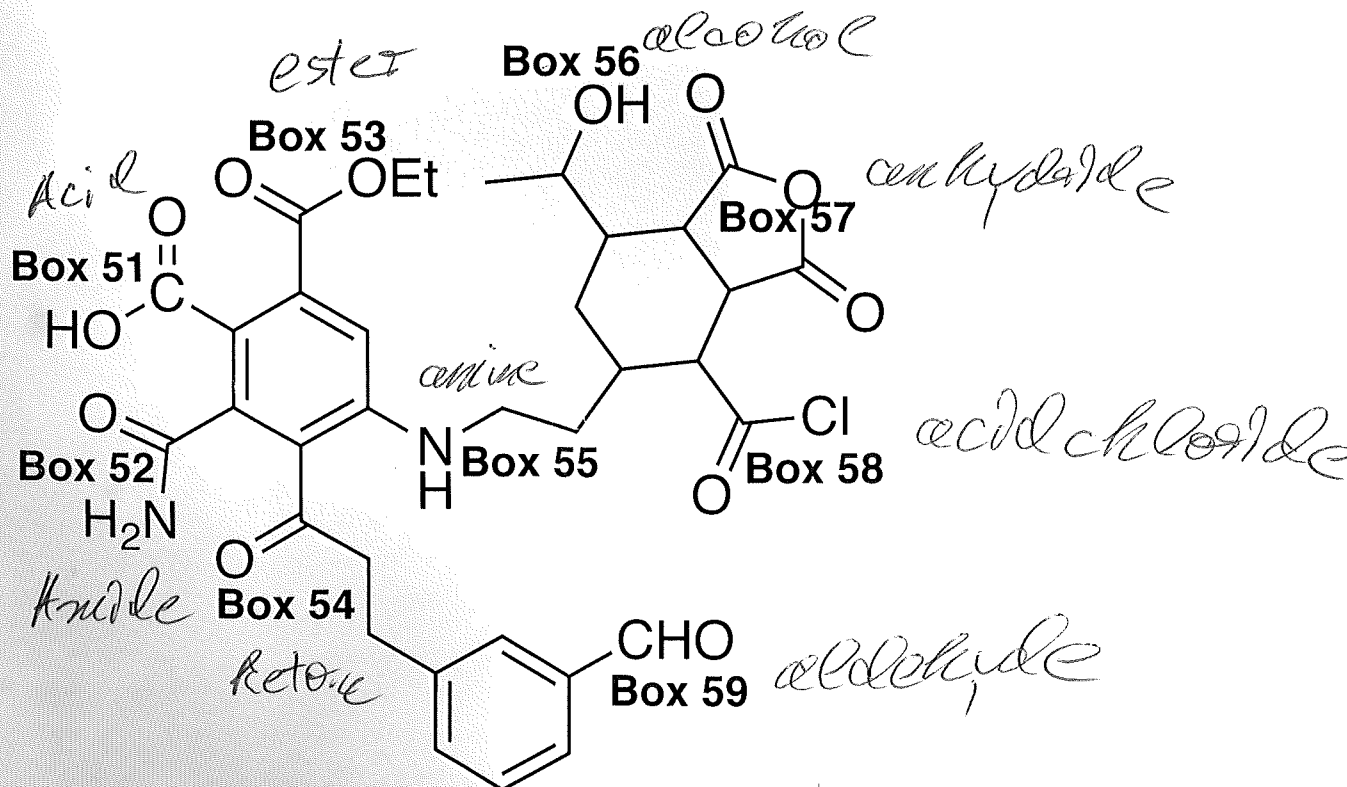


Hydrazone



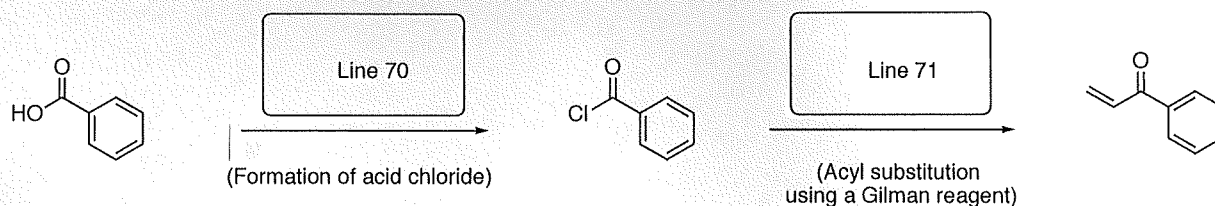
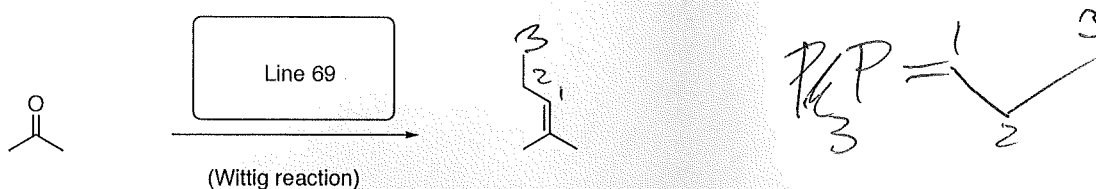
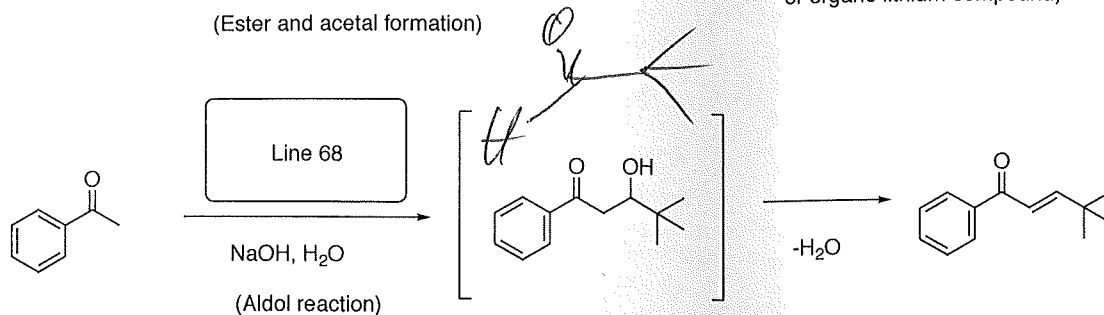
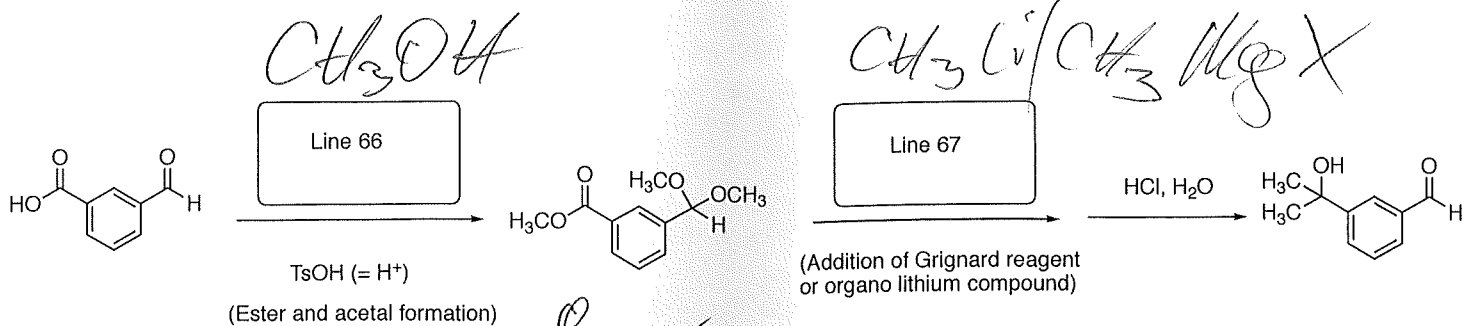
Problems 26 and 27: Please use the back of the Scantron form.

26. (18 pts) Identify the functional groups in the molecule below: Choose from the following: aldehyde, ketone, oxime, imine, hydrazone, acetal, alcohol, nitrile, acid, ester, amide, amine, anhydride, acid chloride. Please use boxes 51 to 59 on the back of the Scantron form.



DO NOT FORGET TO ANSWER PROBLEM 26!!!!

27. (6 pts) Please provide the required reactants or reagents. Please write your answers into lines 66 to 71.



END OF EXAM

SOCl_2

$(\text{H}_2\text{C}=\text{CH})_2\text{CaLi}$