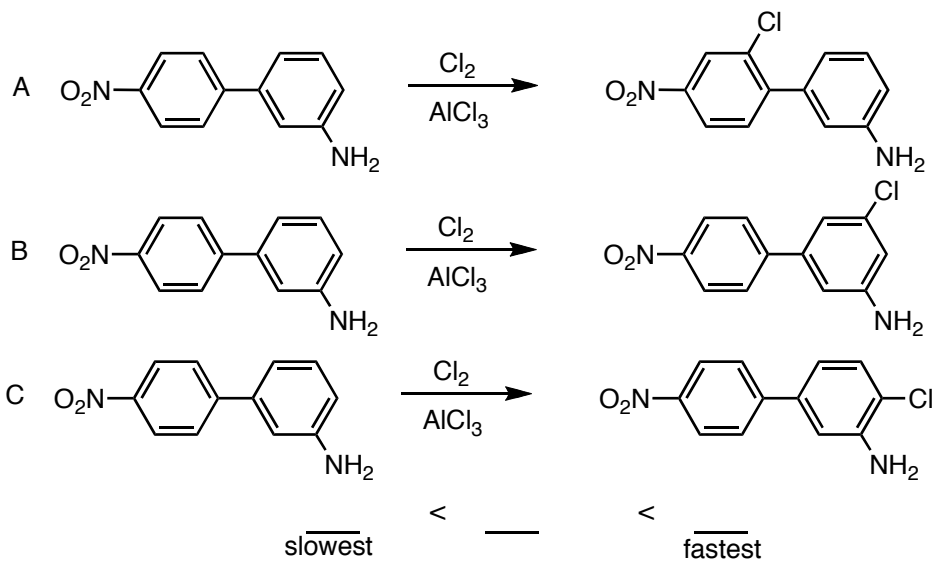


Question 1 (18 pts). Rank the following reactions in order of increasing rate. Give a BRIEF explanation that includes discussions of Lewis acidity/basicity, nucleophilicity/ electrophilicity, substitution, addition, elimination or rearrangement as appropriate.



Extra credit question (5 pts). β -carotene is synthesized using which reaction?

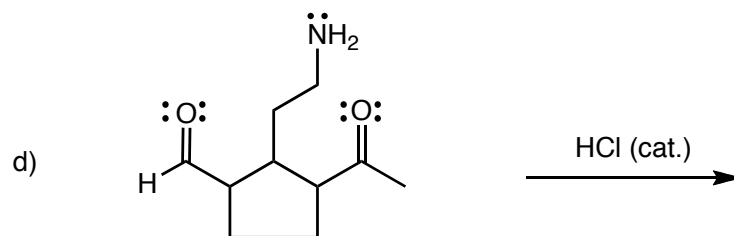
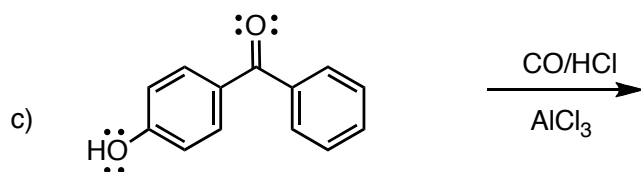
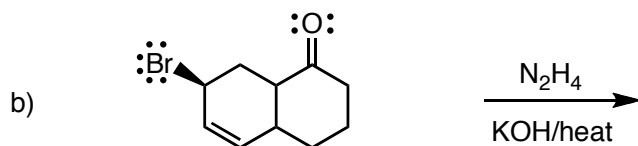
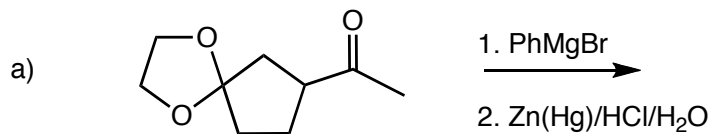
Clemmenson

Grignard

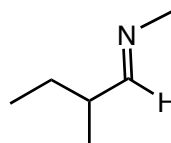
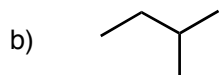
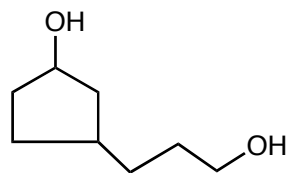
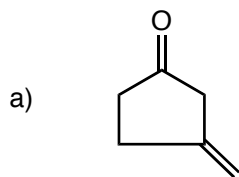
Wittig

Aldol

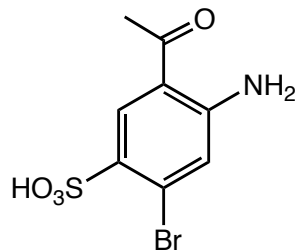
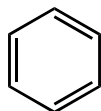
Question 2 (32 pts.) Provide the missing major organic products, you can IGNORE stereochemistry EXCEPT WHERE EXPLICITLY INCLUDED IN THE STARTING STRUCTURE, and you do **NOT** need to state what kinds of reactions these are or whether a solution of the product would be optically active.



Question 3 (40 pts.) In each case, synthesize the (target) molecules on the right from the starting molecules the left. this can not be done in one reaction. Give reagents and conditions and the intermediate molecules at each step. Do not show any mechanisms or transient intermediates.



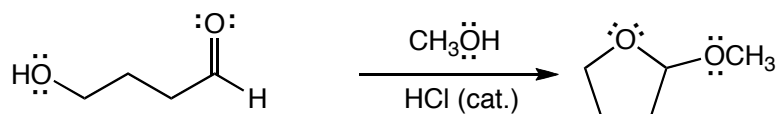
Question 4 (20 pts.) Synthesize the (target) molecule on the right from the starting molecule the left. this can not be done in one reaction. Give reagents and conditions and the intermediate molecules at each step. Do not show any mechanisms or transient intermediates.



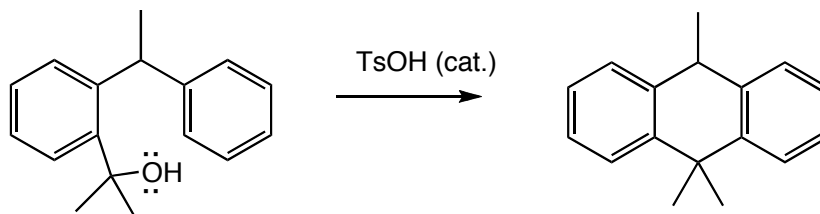
Question 5 (40 pts.) Give a complete arrow-pushing mechanisms for the following reactions.

Indicate the lewis acid/base for each INTERmolecular step (LB or LA) and whether they are also Brønsted bases/acids (LB/BB or LA/BA)

a) DRAW ALL RELEVANT RESONANCE CONTRIBUTORS OF THE INTERMEDIATES



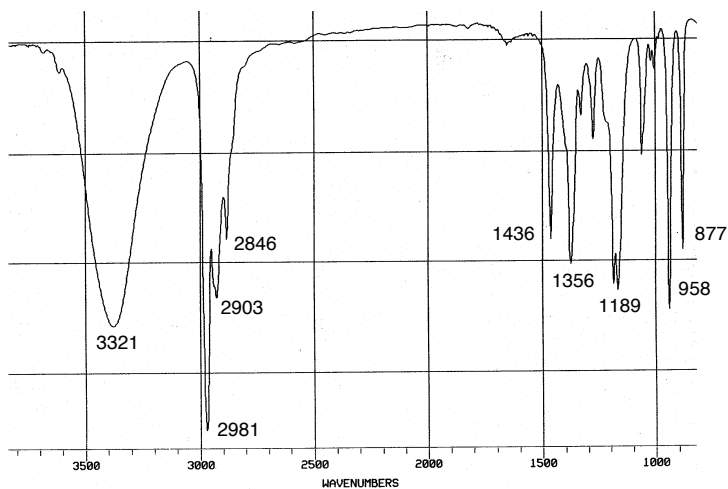
b) DO NOT draw resonance contributors for the intermediates



Question 6 (25pts) Provided are spectra for a compound with molecular formula $C_6H_{14}O$

a) Give the degrees of unsaturation _____

b) On the infrared spectrum, indicate which peaks correspond to which functional groups

c) draw the structure and clearly indicate which hydrogens correspond to which signals **in the proton nmr spectrum (only)**