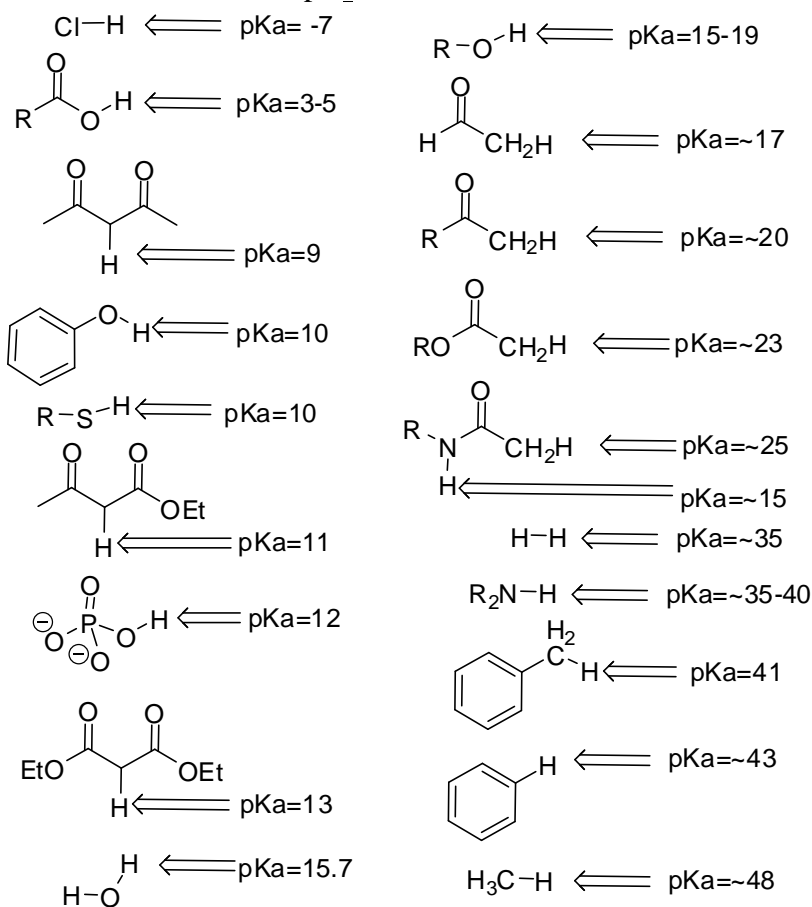


The examination has six questions on five pages. The point values for each question are found with the question. Partial credit will be given where appropriate.

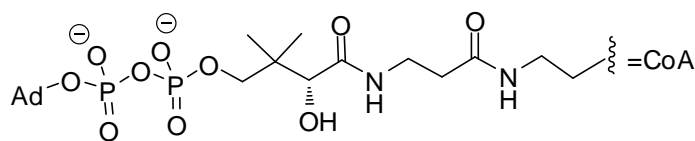
Read each question carefully before answering. Be certain you understand everything the question is requesting. Do the easy questions first. If questions appear confusing or exceedingly complex, then you may need to rethink the question. Keep in mind the intended examination topics.

In organic chemistry, hand-drawn pictures convey specific information. Be sure the drawing you have made conveys the essential information required to answer the question. Make certain that three-dimensional pictures display the correct atom arrangements. Don't forget to include lone pairs of electrons and formal charges when appropriate.

pK<sub>a</sub> information



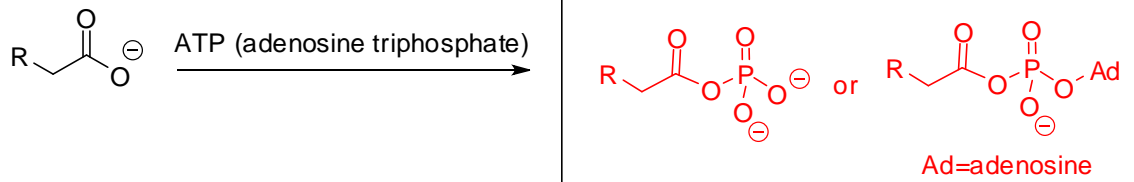
Note: R=alkyl



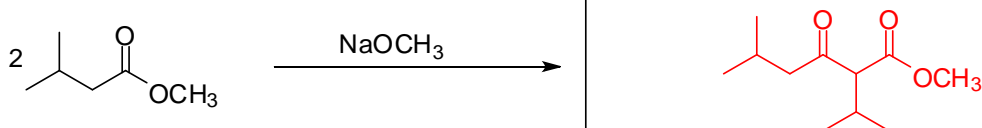
Ad=adenosine 3'-phosphate

1. Provide the necessary information, product or reagents, to complete the following reactions. (15 pts.)

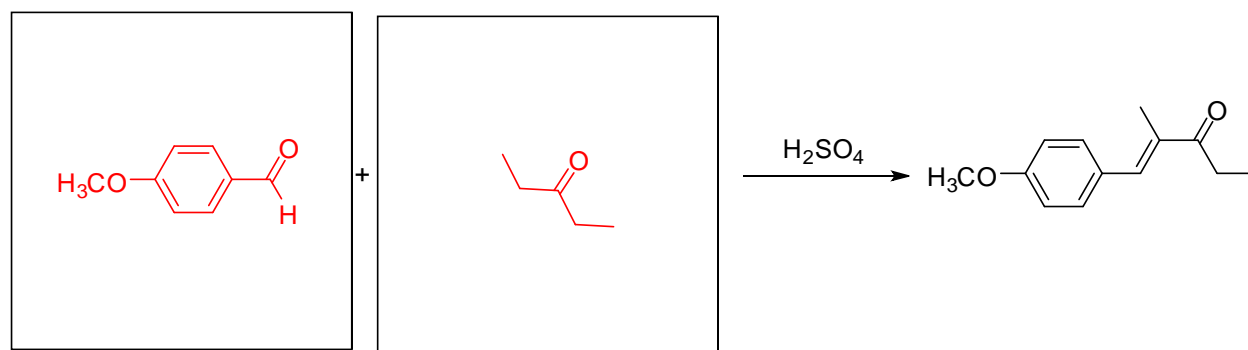
a)



b)

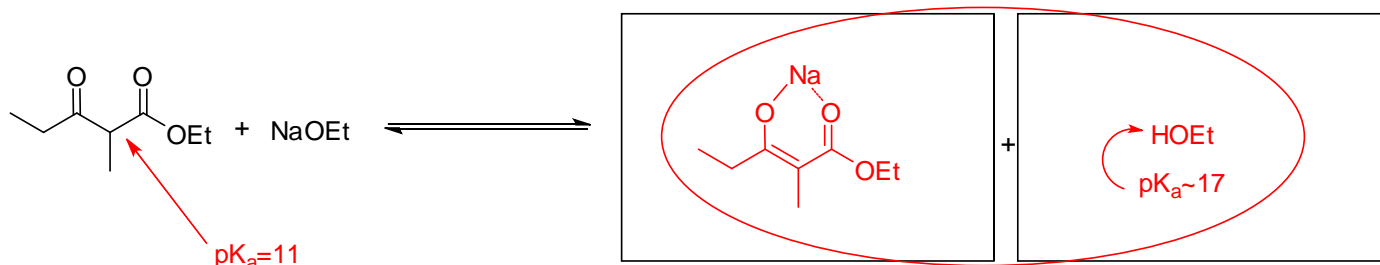


c)

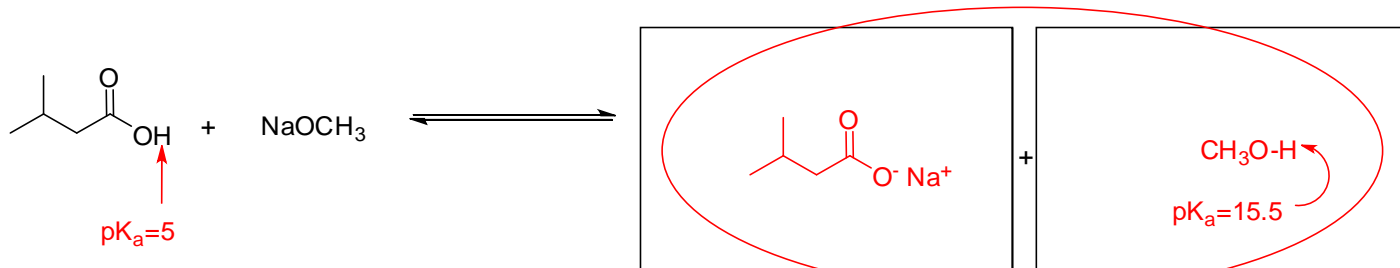


2. Complete the following acid-base equilibria by providing the conjugate base and acid products. Draw the most stable resonance form of all products and be sure to include formal charges and counter ions. Identify the  $\text{pK}_a$  of the most acidic proton in the acid on each side of the equilibrium and circle the side of the equilibrium that will be favored. (5 pts. each)

a)

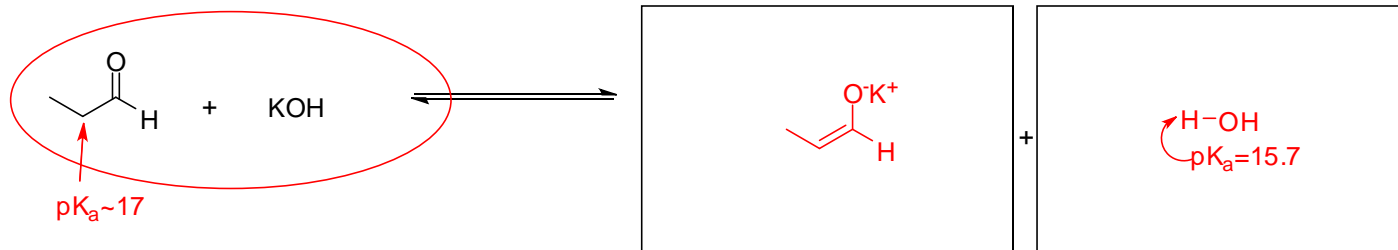


b)



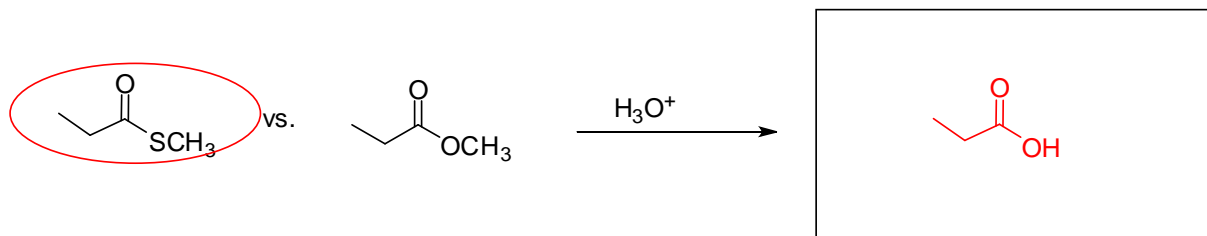
/25 pts.

c)

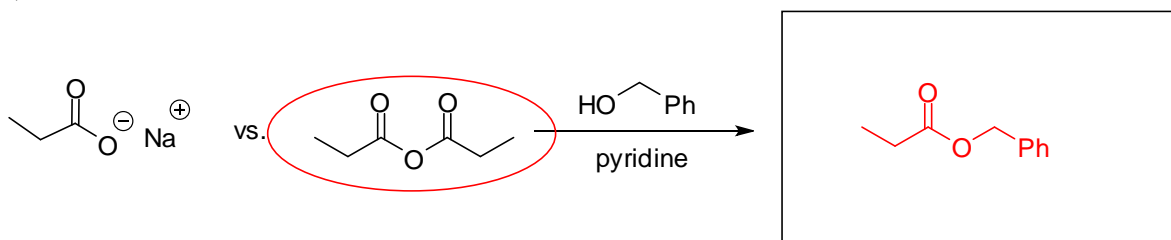


3. Circle the starting material that is more reactive with the reagents shown (2 pts. each) and provide the product of this reaction in the box to the right. (3 pts. each)

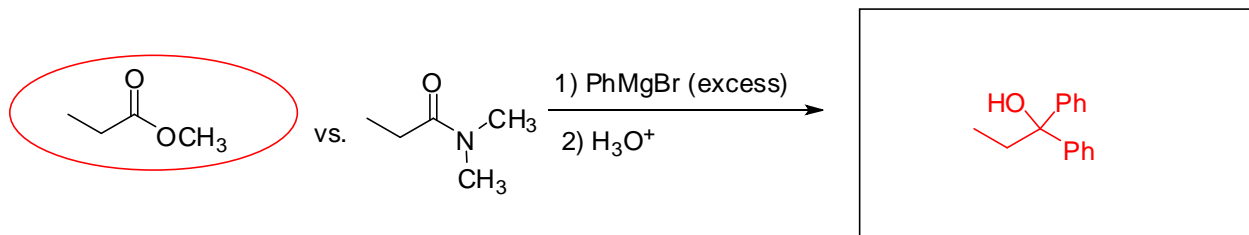
a)



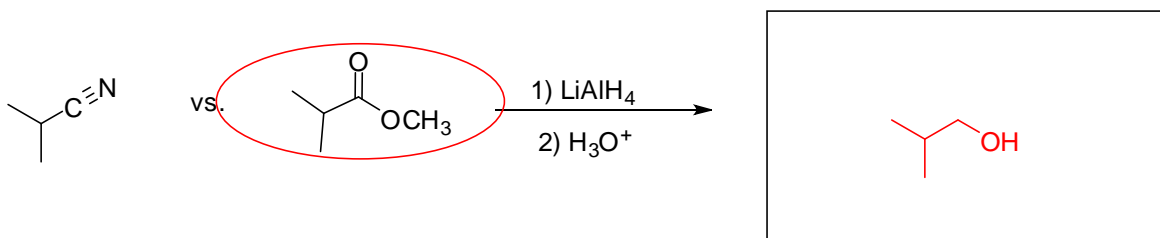
b)



c)

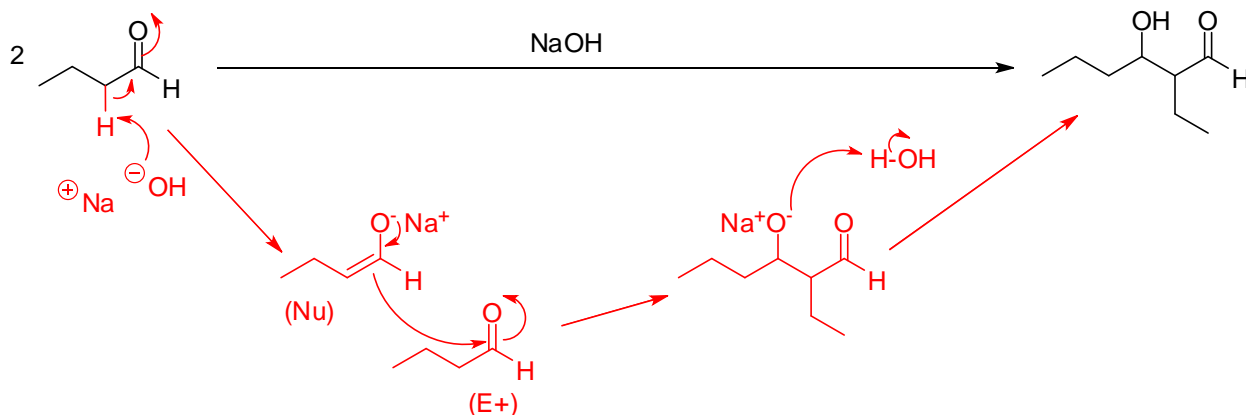


d)

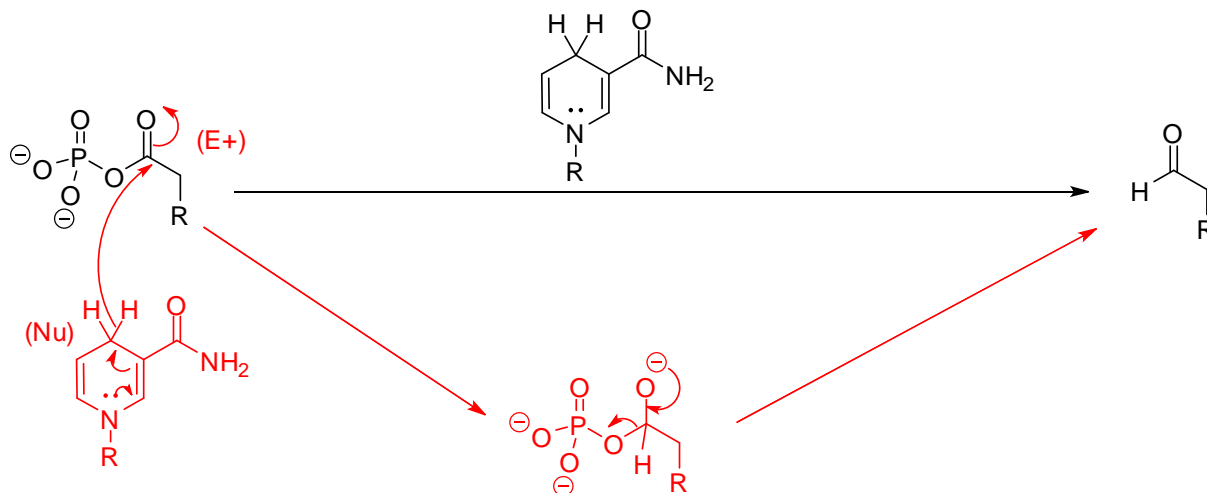


4. Draw the mechanism of the three reactions shown below. You do NOT need to include resonance structures, but you should draw the most stable resonance form of all structures. You should include all formal charges and curved electron flow arrows. You may use general acids, H-A, and general bases, B:, as necessary. Also, follow the directions for identifying the nucleophile (Nu) and electrophile (E+) in each reaction. (8 pts. each)

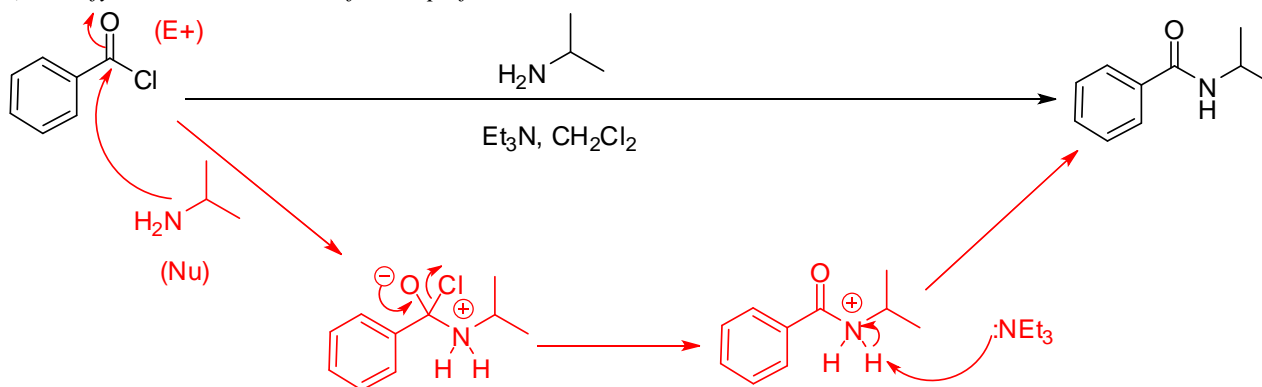
a) Identify the Nu and E+ in the key C-C bond forming step of the reaction.



b) Identify the Nu and E+ in the first step of the reaction.

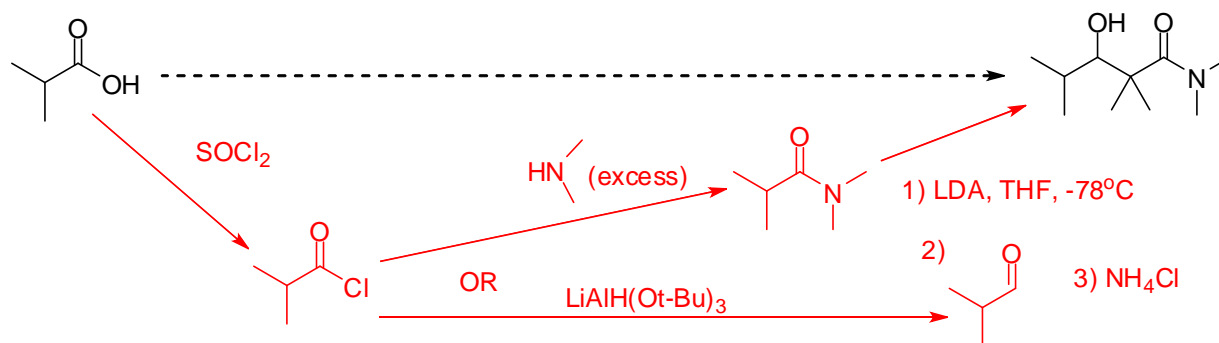


c) Identify the Nu and E+ in the first step of the reaction.

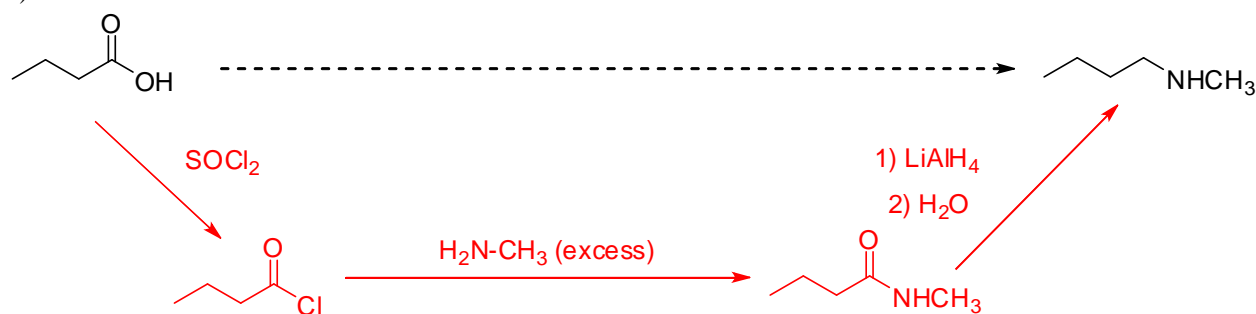


5. Suggest a series of reactions to take the starting material on the left to the product on the right. This will require two or three steps. You may use any inorganic reagent and any organic reagent. (7 pts. each)

a)

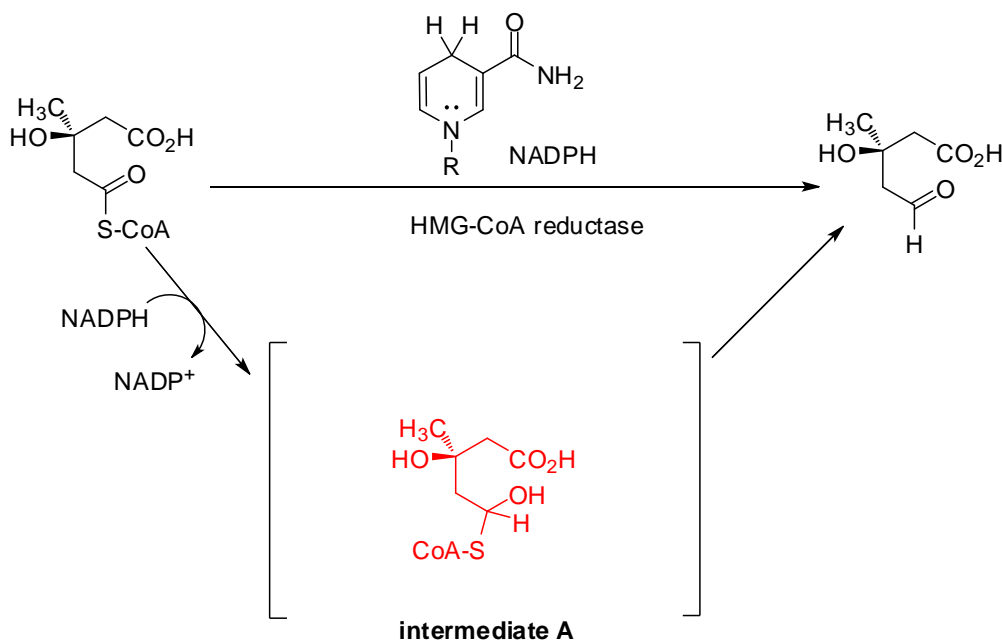


b)



6. As described in class, the HMG CoA reductase enzyme catalyzes the first step in cholesterol biosynthesis in the reaction shown below. For your reference, the structure of coenzyme A, CoA, can be found on the cover of the exam.

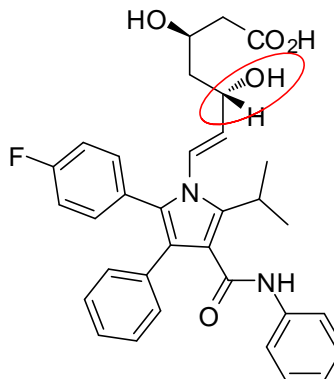
a) Provide the structure of intermediate A in the brackets below. You can assume water or extra protons are present in the reaction. (4 pts.)



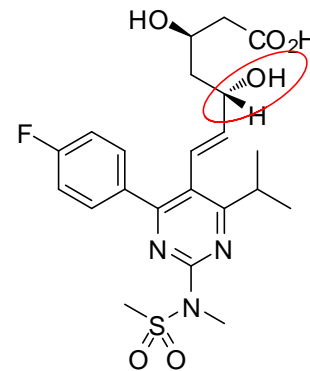
b) What is the name we attributed to this intermediate A? (2 pts.) tetrahedral intermediate

c) Statins are one of the biggest selling drugs of all time and they are used to reduce cholesterol biosynthesis by inhibiting the enzyme HMG CoA reductase. The structures of two popular statin drugs are shown below. These drugs are believed to mimic intermediate A drawn in the bracket in part a of this question. More specifically, a particular functional group in the statin drug is acting as a close analog or mimic of a critical part of intermediate A. Analyze the two statin drugs shown below and determine which functional group is imitating the critical portion of intermediate A. Circle this functional group on these drugs and briefly explain why it is an efficient mimic. (6 pts.)

Both statin drugs have a secondary alcohol group that has a tetrahedral  $sp^3$  hybridized carbon and a hydroxyl group; both groups help mimic the shape or geometry and functionality (-OH) at the reacting carbon atom in intermediate A.



Lipitor (atorvastatin)



Crestor (rosuvastatin)

/8 pts.