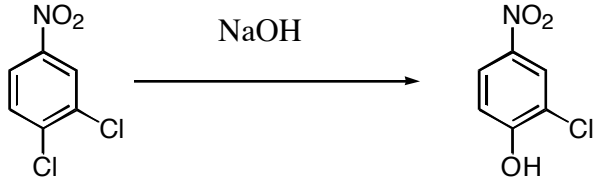
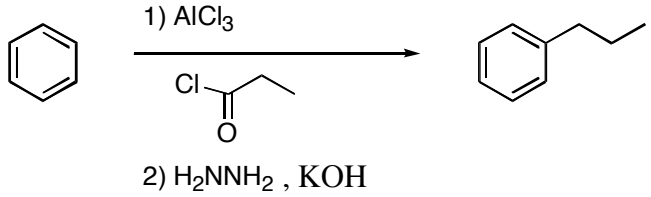
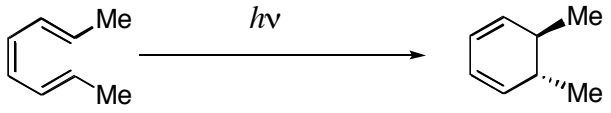
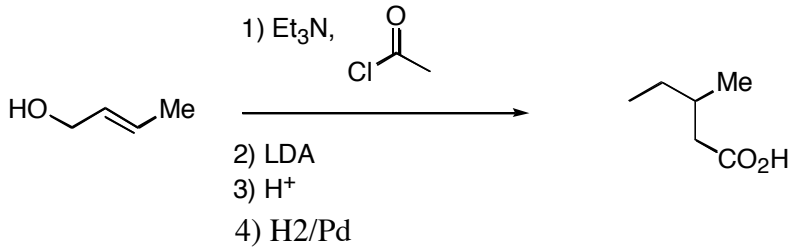
1. Provide reagents for the following transformations (2 pts each)

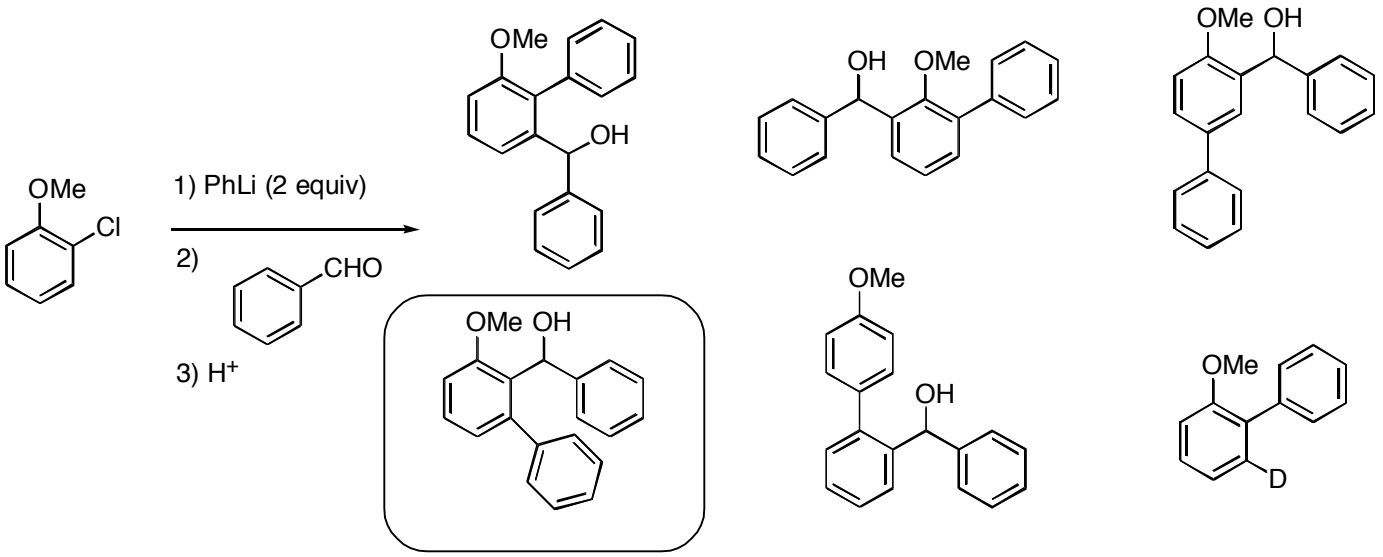




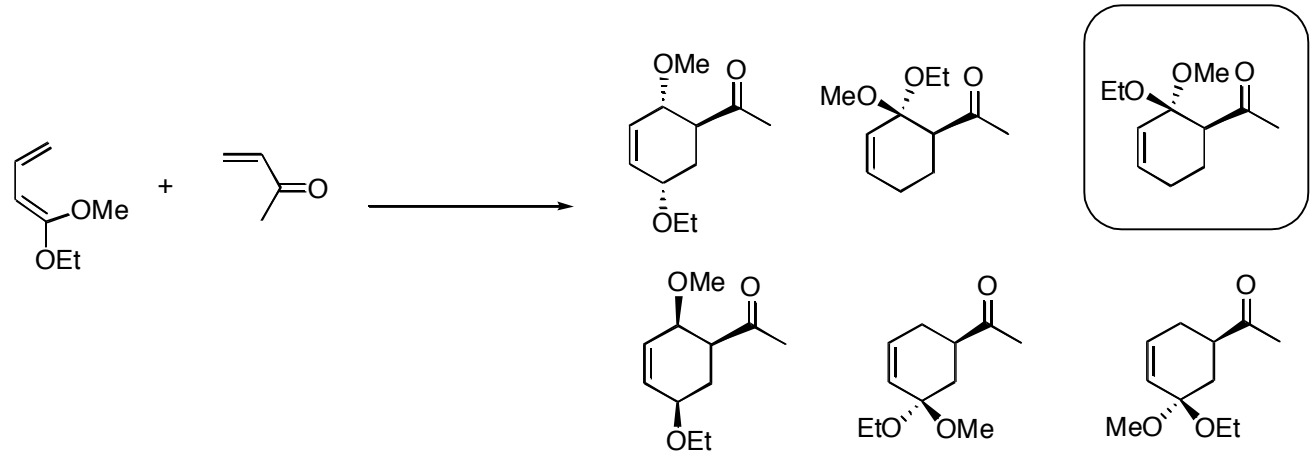




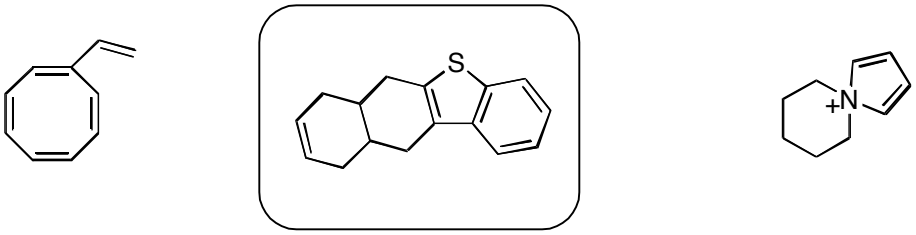
2a Circle the correct product (no mechanisms or partial credit). 3 pts



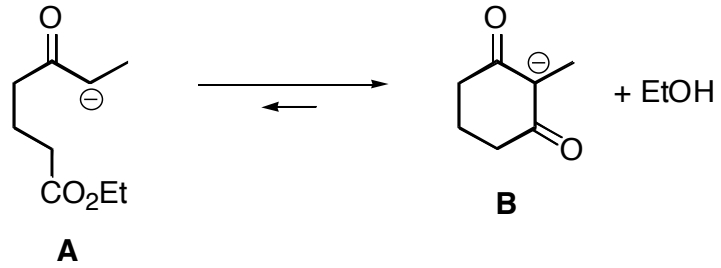
2b Circle the correct product (no mechanisms or partial credit). 3 pts



2c Circle the aromatic molecules. No partial credit. 3 pts each (points are also given for uncircled answers)

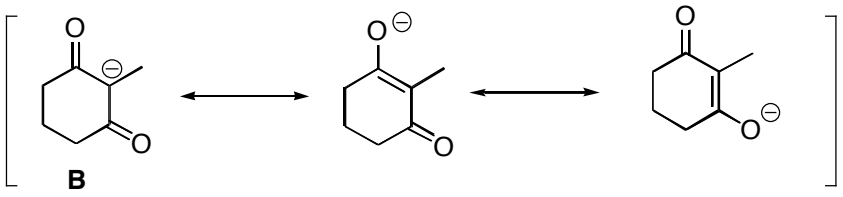


3 The reaction of anionic compound **A** to form **B** is fast, and the equilibrium lies strongly in the direction of **B**.



A **B**

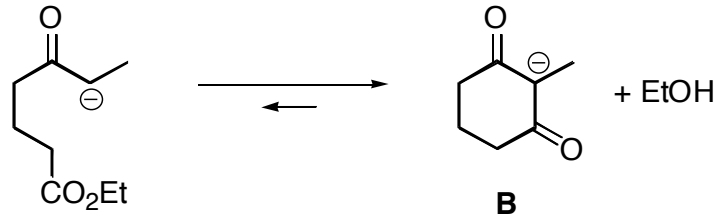
a. Explain why the equilibrium lies in the direction of **B**. You do NOT need to provide an arrow pushing mechanism, but do provide a clear picture that helps explain your answer. (3 points)



B

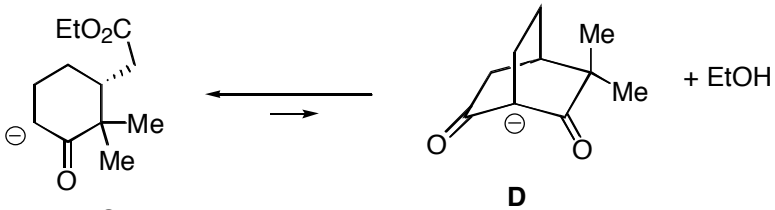
Anion **B** is delocalized over both carbonyls, and is therefore more stable than **A**, in which there is obviously only one carbonyl that can stabilize the anion. As a result of this special stability, the conjugate acid of **B** is acidic enough (pKa ~ 10) to be deprotonated by EtO^-, and therefore drives the equilibrium to the right.

3 The reaction of anionic compound **A** to form **B** is fast, and the equilibrium lies strongly in the direction of **B**.



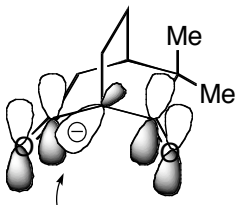
A **B**

b. In contrast to the above observation, it is found that the equilibrium of **C** and **D** lies in the opposite direction, and favors the formation of **C**. Explain in detail. Again, it is essential to provide a clear picture that helps explain your answer. (9 points)

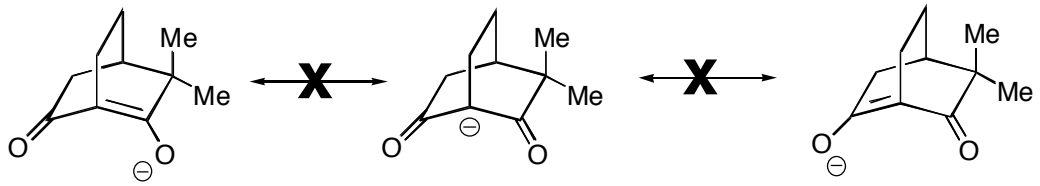


C **D**

if we draw an orbital picture of anion **D**, we see that there is very poor overlap between the anion and the neighboring carbonyls. Thus, there can be no conjugation with those carbonyls. Therefore, there is no special stability for this anion, as was the case with **C**. therefore, the anion **D** deprotonates ethanol, and drives the equilibrium back toward the starting materials



this anion is in an orbital that is ~ perpendicular to the plane of the carbonyls

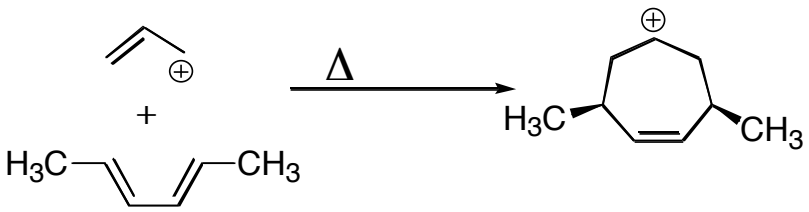


not a significant resonance form

D

not a significant resonance form

4 Consider the thermal reaction of trans,trans-1,4-dimethylbutadiene with allylcation:



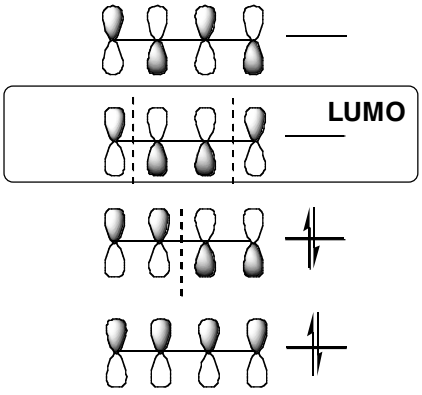
9 pts

Would you expect this to be a concerted process under thermal conditions? Explain in detail using an argument based in molecular orbital theory.

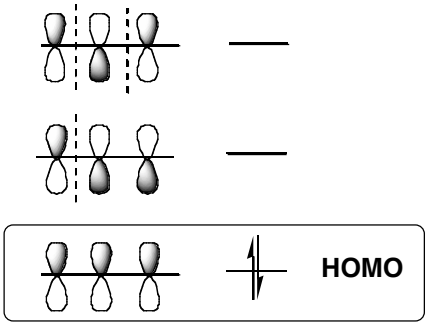
For this to be a concerted process under thermal conditions, the orbital symmetry of the HOMO of one reactant must match the LUMO of the other reactant. For the case here, we will identify the LUMO of the butadiene and the HOMO of the allylcation. (this analysis still works if we were to choose the LUMO of allyl cation and the HOMO of butadiene).

We treat the allyl cation as a two electron, 3-carbon system of pi-orbitals. Like any other system, we remember that the ends of the allyl system have like symmetry for the lowest energy orbital, unlike symmetry for the next orbital, etc. .

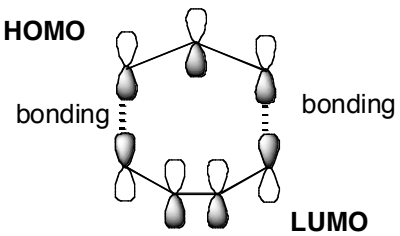
Butadiene



allyl cation

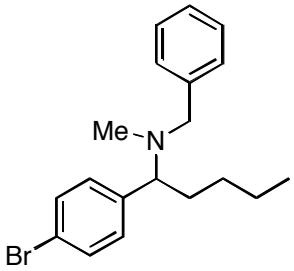


Note: is was Required to Show that there Are three carbons In the Pi system



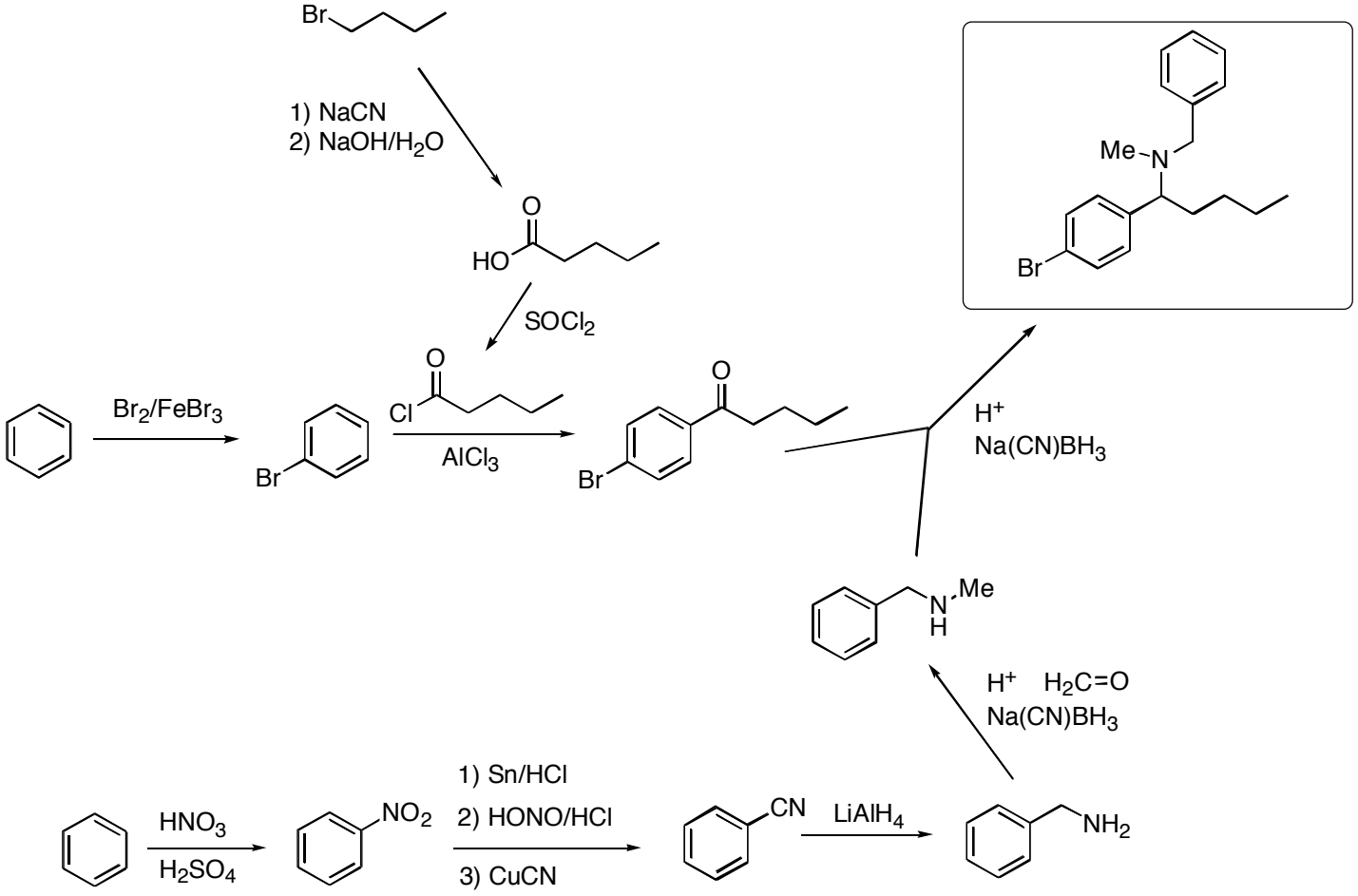
For the reaction to be concerted, we need to have bonding interactions at both termini of the reacting system. This is the case for the current reaction. The thermal reaction does take place by a concerted mechanism.

5 Provide a synthesis of **A** using benzene and any other materials that contain **4 carbons or less.**

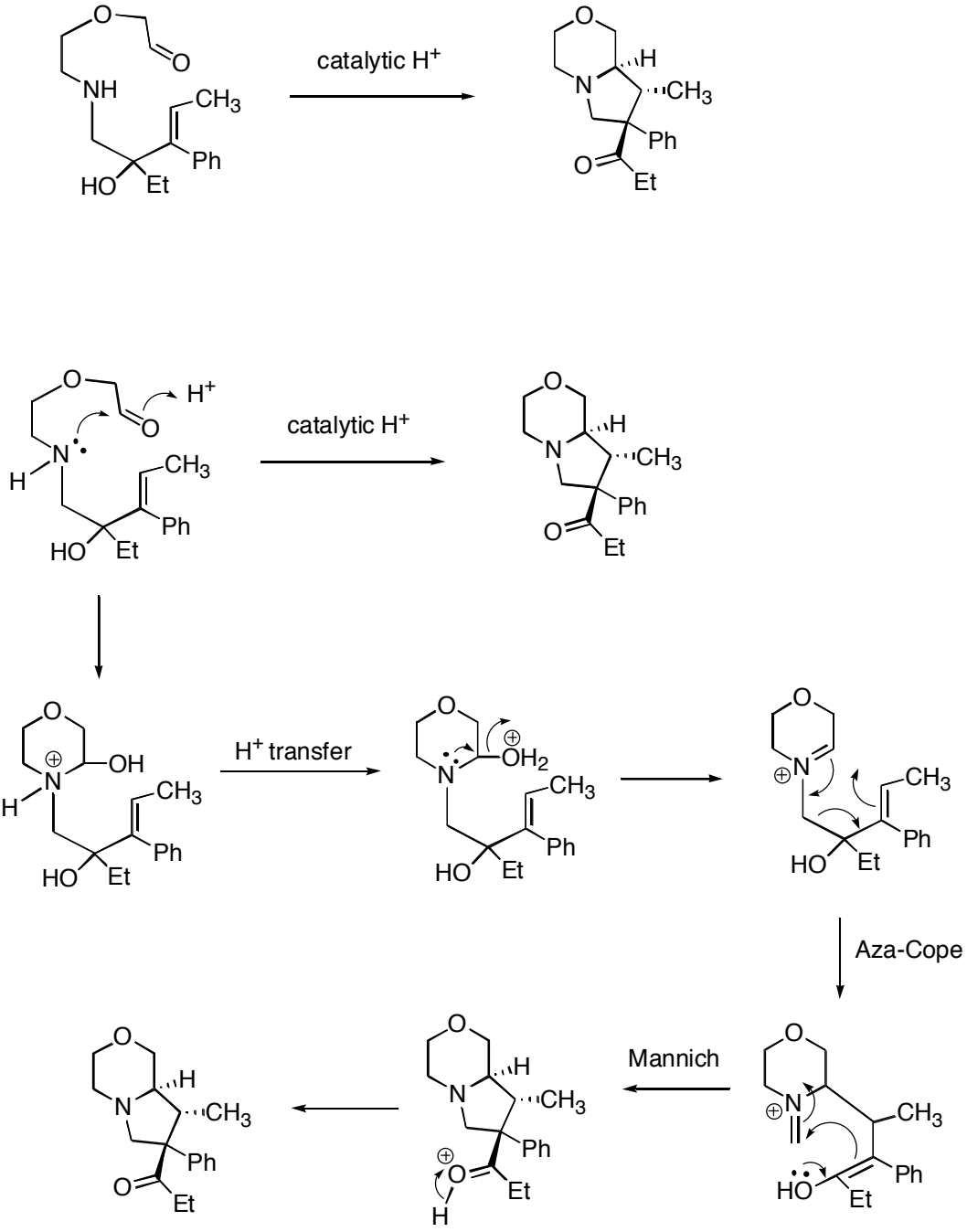


A

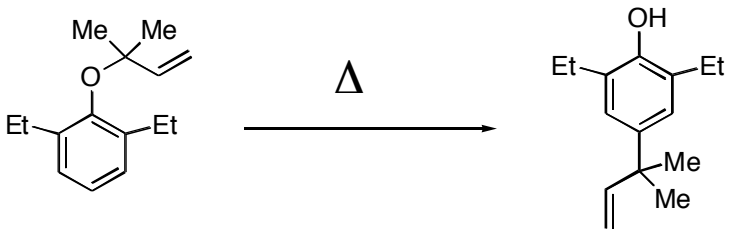
12 pts



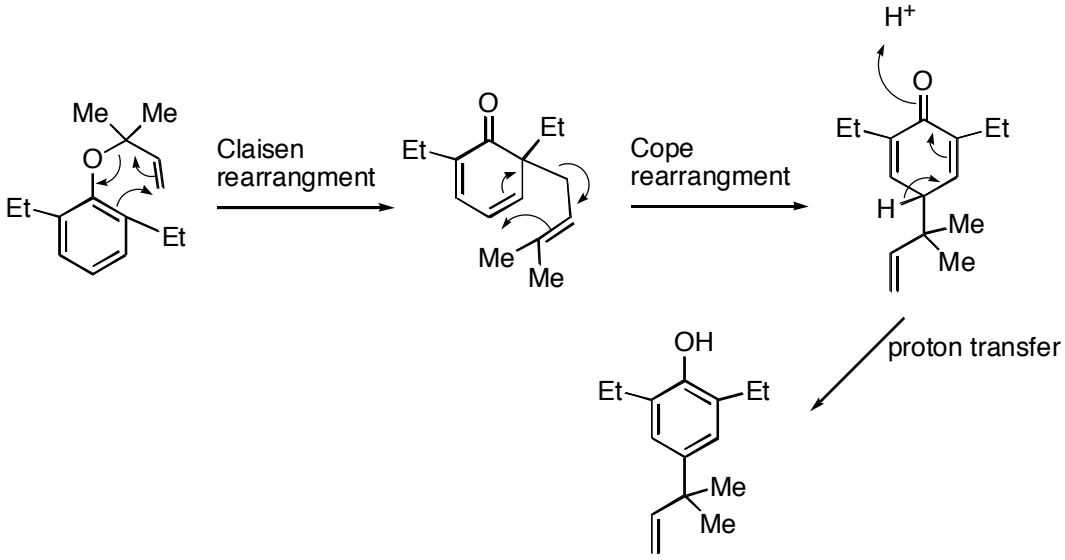
6 Provide a detailed arrow pushing mechanism. Hint: this reaction is sometimes classified as an "Aza-Cope-Mannich reaction" (Aza means "contains nitrogen") (12 points).



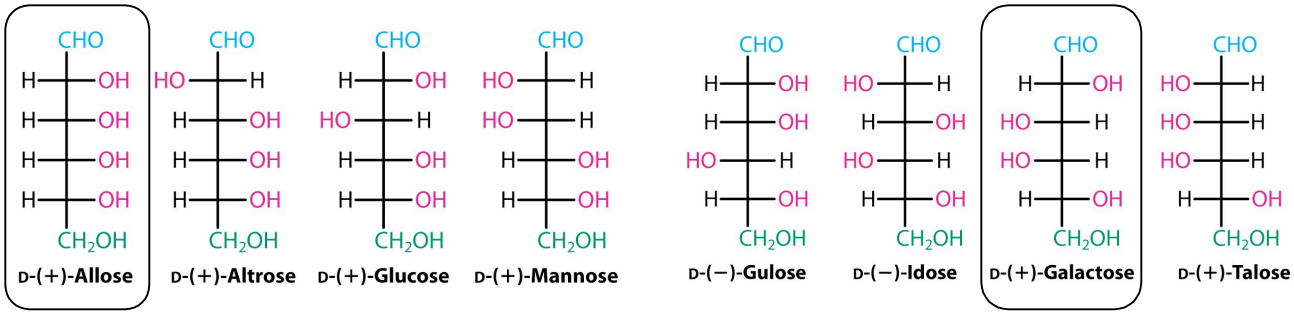
7 Provide a detailed arrow pushing mechanism.



12 pts

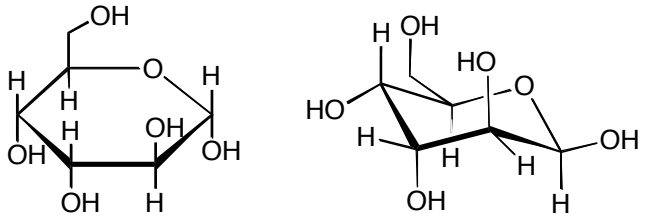


8 Circle the structures of the D-aldohexoses (shown below) that give meso compounds upon oxidation with HNO3.



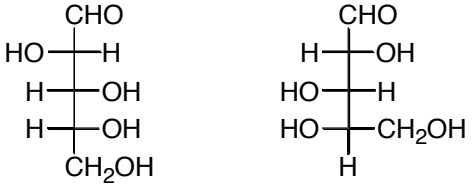
1 point each (points are also given for uncircled answers): 8 points total

9 Identify the following pairs as identical, anomers, enantiomers, or (non-anomeric) diastereomers. Write your answers on the line below the structures. (3 points each)



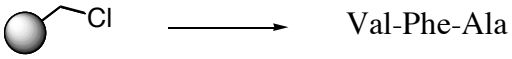
anomers

enantiomers



Non-anomeric diastereomers

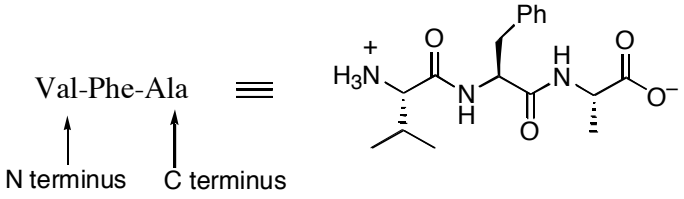
10 Using Solid phase synthesis, show how to synthesize the tripeptide Val-Phe-Ala. As starting materials,you should use any of the naturally occuring amino acids, Merrifield resin, and any other materials. (10 points)



Merrifield Resin

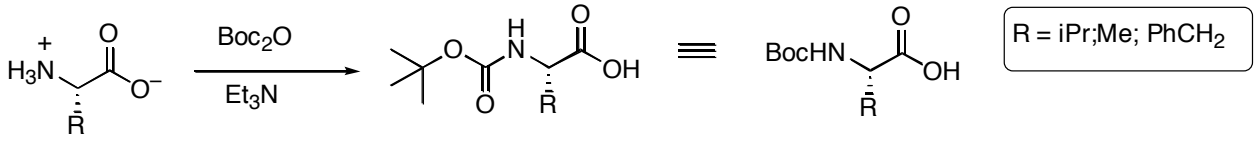
Your final product should be cleaved from the Merrifield resin and free of any protecting groups. Be sure to draw the chemical structures of your product and intermediates (i.e., do not use the three letter abbreviations.)

ANSWER ON NEXT PAGE



This is the amino acid that we are building. On solid support, we begin building at the C-terminus and we end at the N-terminus

BOC protection of amino acids



Synthesis