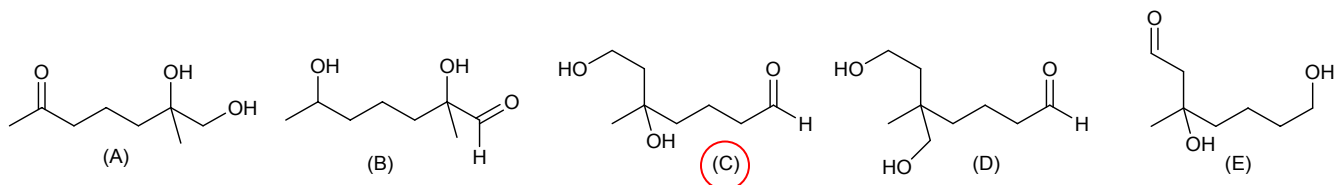
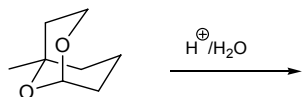
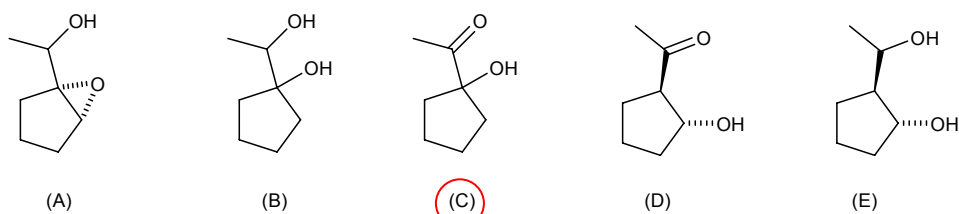
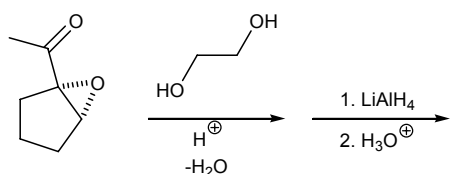


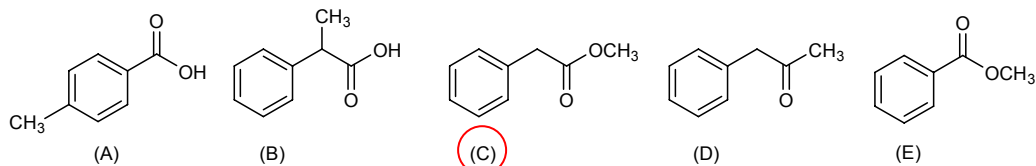
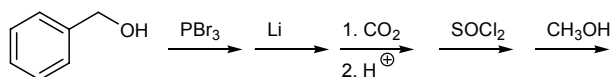
1. Choose the major product of the following reaction.



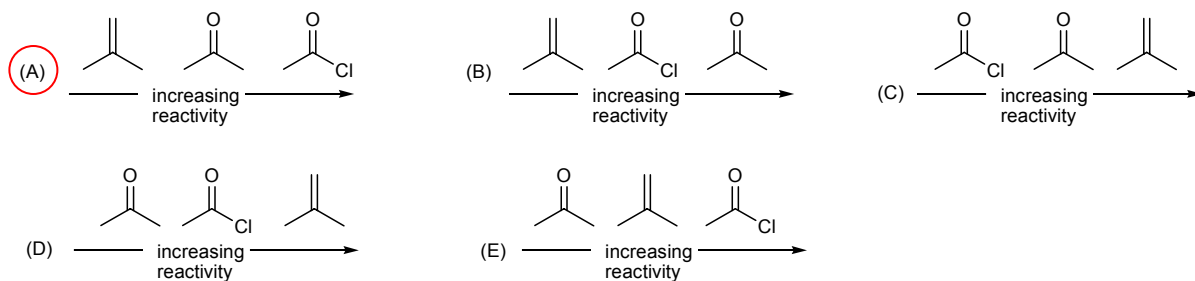
2. Choose the major product of the following reaction sequence.



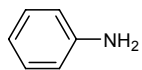
3. Choose the major product of the following reaction sequence.



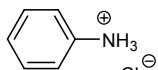
4. Choose the order that has the following compounds correctly arranged with respect to increasing reactivity with methyl lithium ( $CH_3-Li$ ).



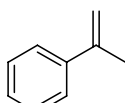
5. Choose the order that has compounds 1, 2, and 3 correctly arranged with respect to increasing solubility in water.



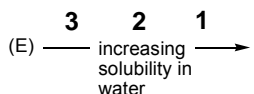
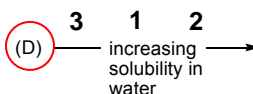
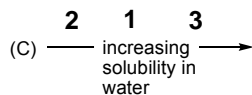
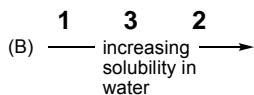
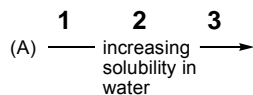
1



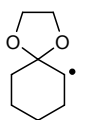
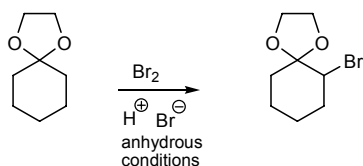
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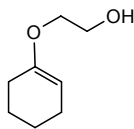
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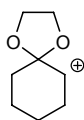
6. Choose the structure that is an intermediate in the following reaction.



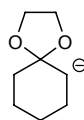
(A)



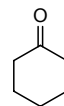
(B)



(C)

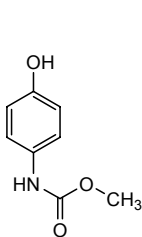
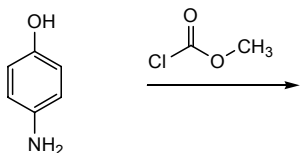


(D)

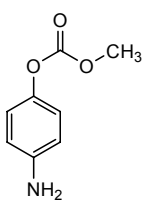


(E)

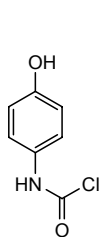
7. Choose the major product of the following reaction.



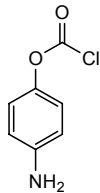
(A)



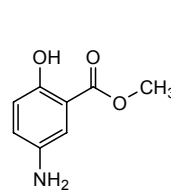
(B)



(C)

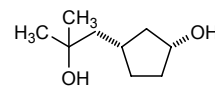
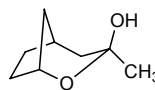
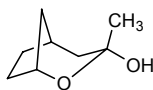
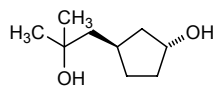
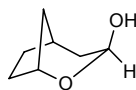
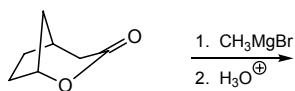


(D)

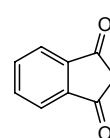
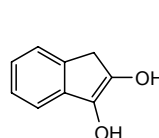
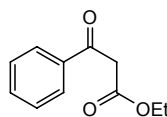
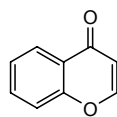
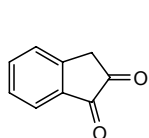
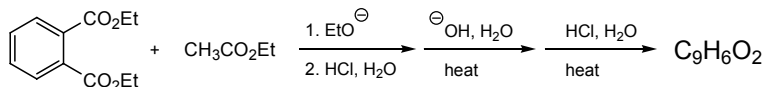


(E)

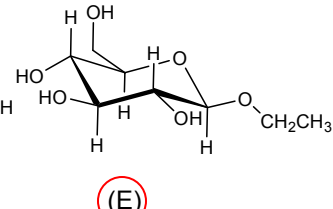
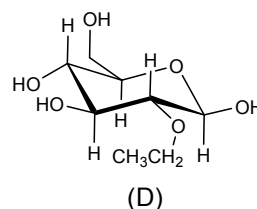
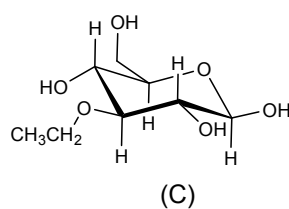
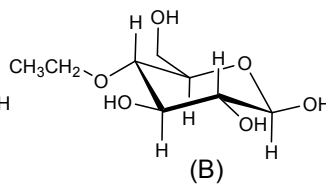
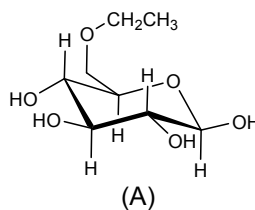
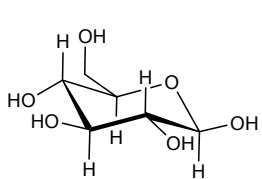
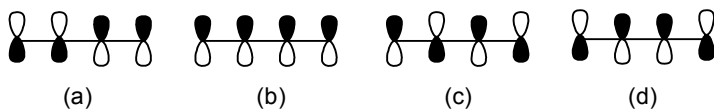
8. Choose the major product of the following reaction.



9. Predict the product of the following reaction sequence.



10. Predict the product of the following reaction.

11. Choose the correct statement about the butadiene  $\pi$ -molecular orbitals shown below.

(A) Molecular orbital (b) is the HOMO of butadiene.

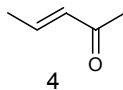
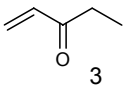
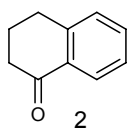
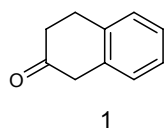
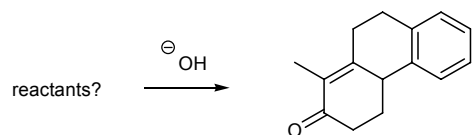
(B) Molecular orbital (d) is the LUMO of butadiene.

(C) Molecular orbital (a) is the least stable.

(D) Molecular orbital (c) is the most stable.

(E) Molecular orbital (c) has 0 nodes.

12. Choose the reactants (1-5) that when treated with base would give the following product.



(A) 1 + 5

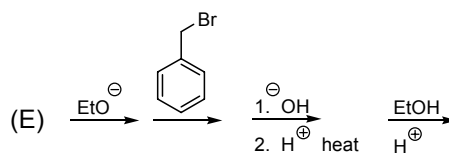
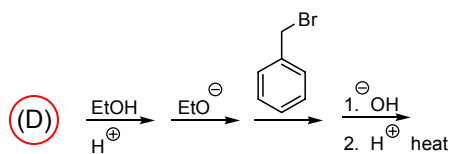
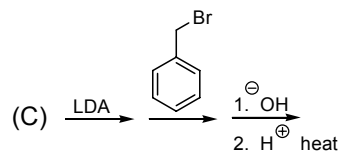
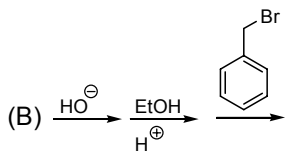
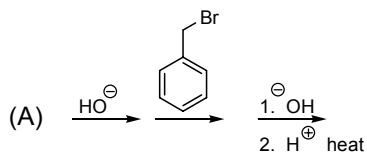
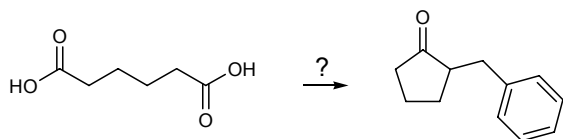
**(B) 1 + 3**

(C) 2 + 3

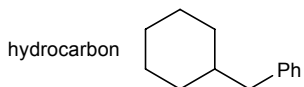
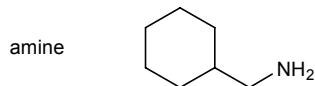
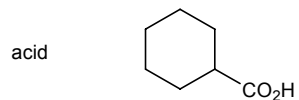
(D) 2 + 3

(E) 1 + 4

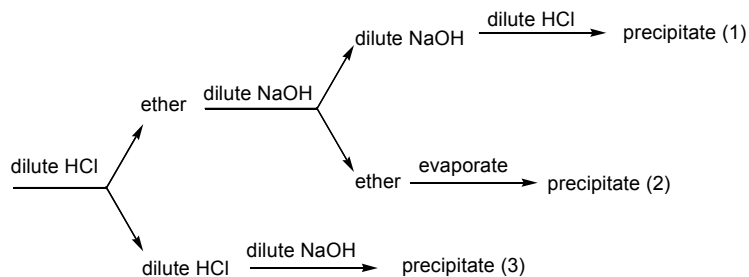
13. Choose the *best* method that could perform the following transformation.



14. Choose the answer that has the following compounds located correctly in the separation scheme.



dissolved in ether



(A) 1 = acid, 2 = amine, 3 = hydrocarbon

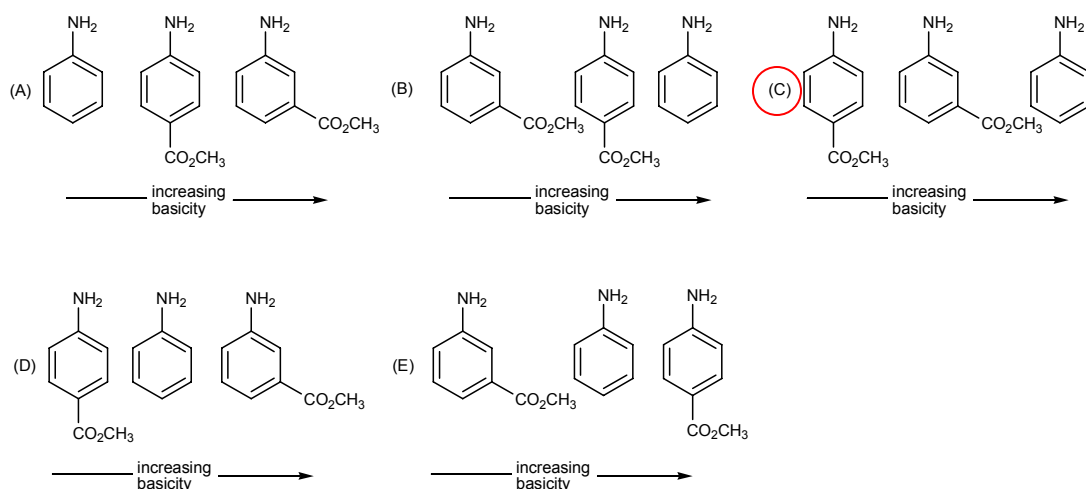
**(B) 1 = acid, 2 = hydrocarbon, 3 = amine**

(C) 1 = amine, 2 = acid, 3 = hydrocarbon

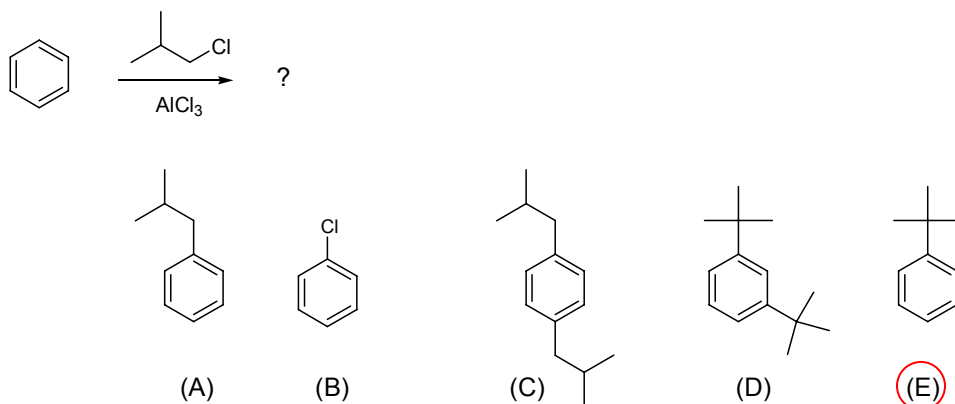
(D) 1 = amine, 2 = hydrocarbon, 3 = acid

(E) 1 = hydrocarbon, 2 = amine, 3 = acid

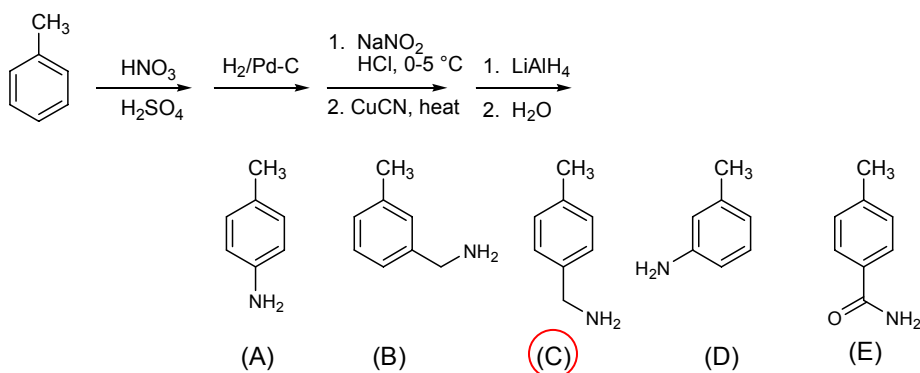
15. Choose the order that has the following compounds correctly arranged with respect to increasing basicity.



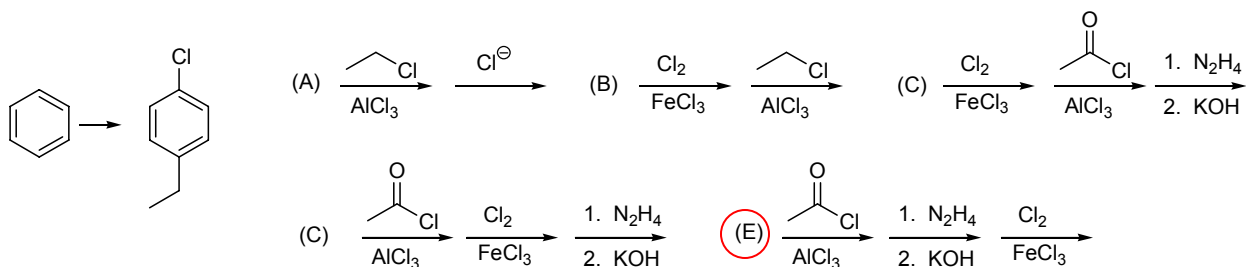
16. Choose the major product of the following reaction.



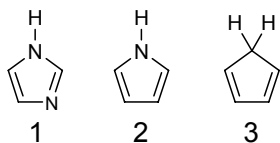
17. Choose the major product of the following reaction sequence.



18. Choose the *best* reaction sequence that could be used to perform the following transformation.

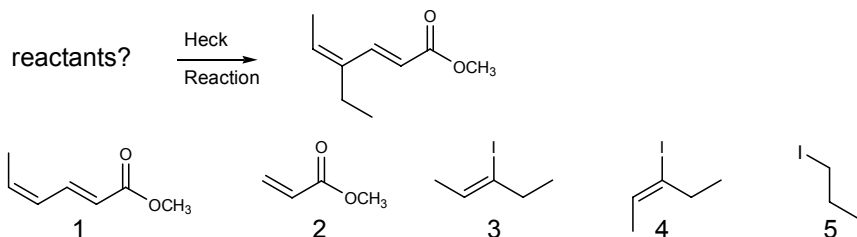


19. Choose the following species that would be predicted to be aromatic according to Hückel's rule.



- (A) 1    (B) 2    (C) 3    (D) 1 and 2    (E) 1 and 3

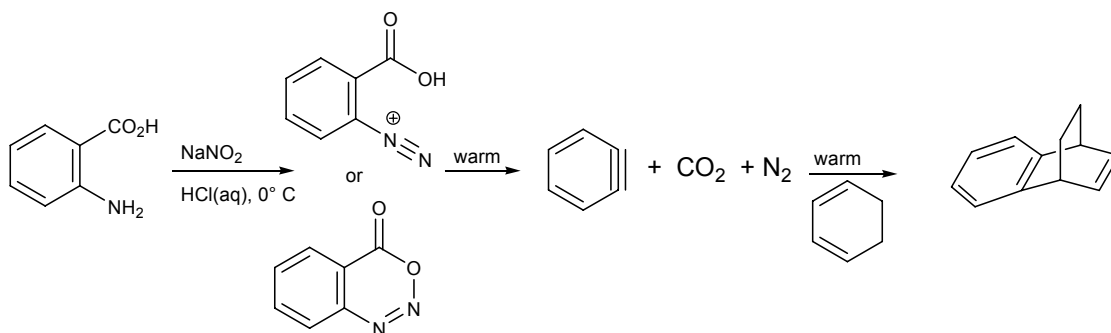
20. Choose the reactants that would produce the following compound using the Heck reaction.



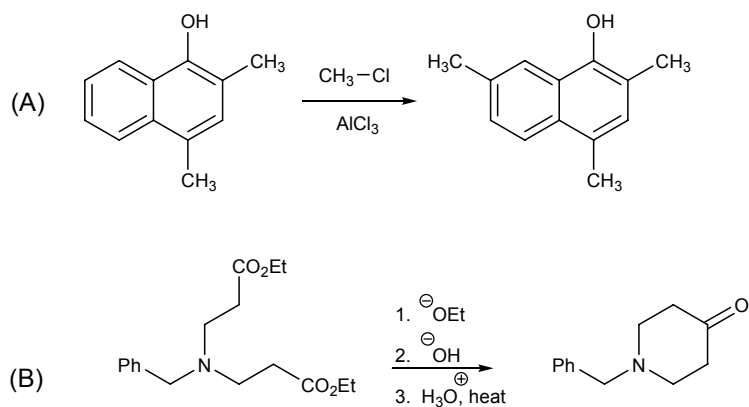
- (A) 1 + 5    (B) 2 + 3    (C) 2 + 4    (D) 1 + 3    (E) 1 + 4

**Short Answer Questions. 80 points.**

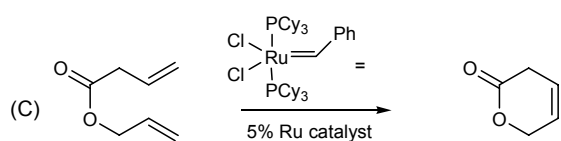
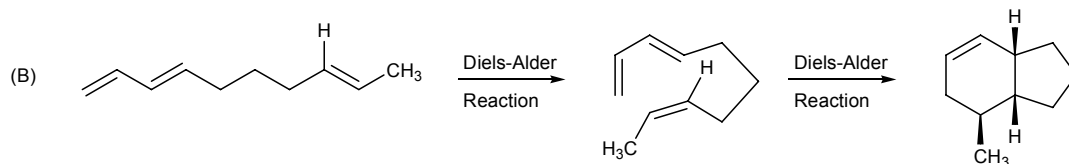
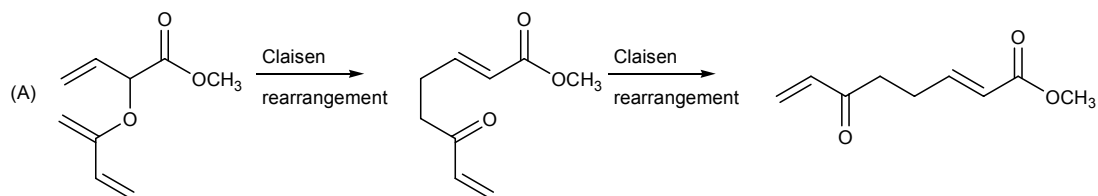
21. Give structures for A and B in the following reaction sequence. 10 pts



22. Give the major product produced in the following reactions.



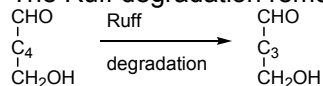
23. Give reactants for the following reactions. 15 pts



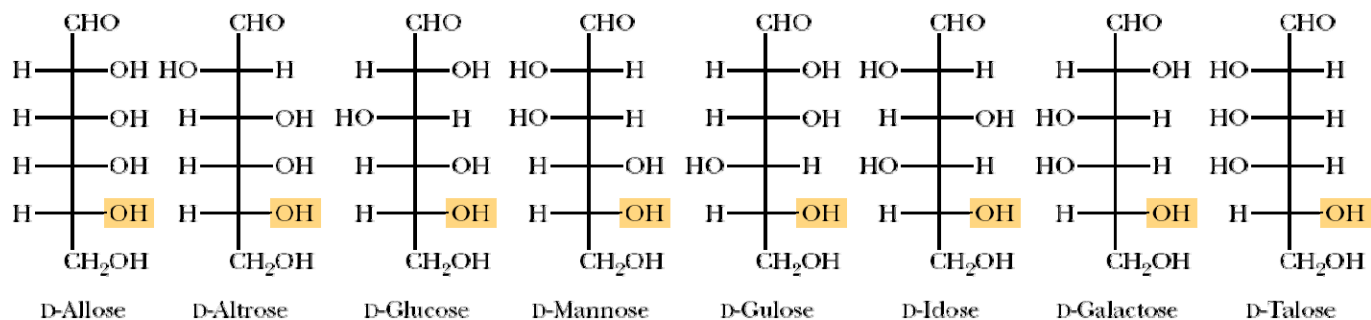
24. Give the names of the three D-aldohexoses, A, B and C, that have the following properties. 15 pts

(a) Treatment of A and B with  $\text{NaBH}_4$  gave the same optically active alditol whereas reduction of C gave a different alditol.

(b) The Ruff degradation removes C-2 of the carbohydrate. The Ruff degradation of A and B gave different D-pentoses.

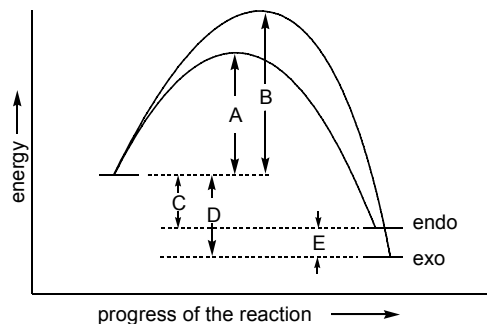
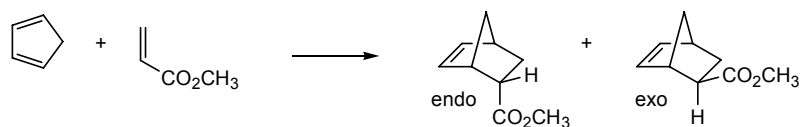


(c) The Ruff degradation of B and C gave the same optically active D-pentose.



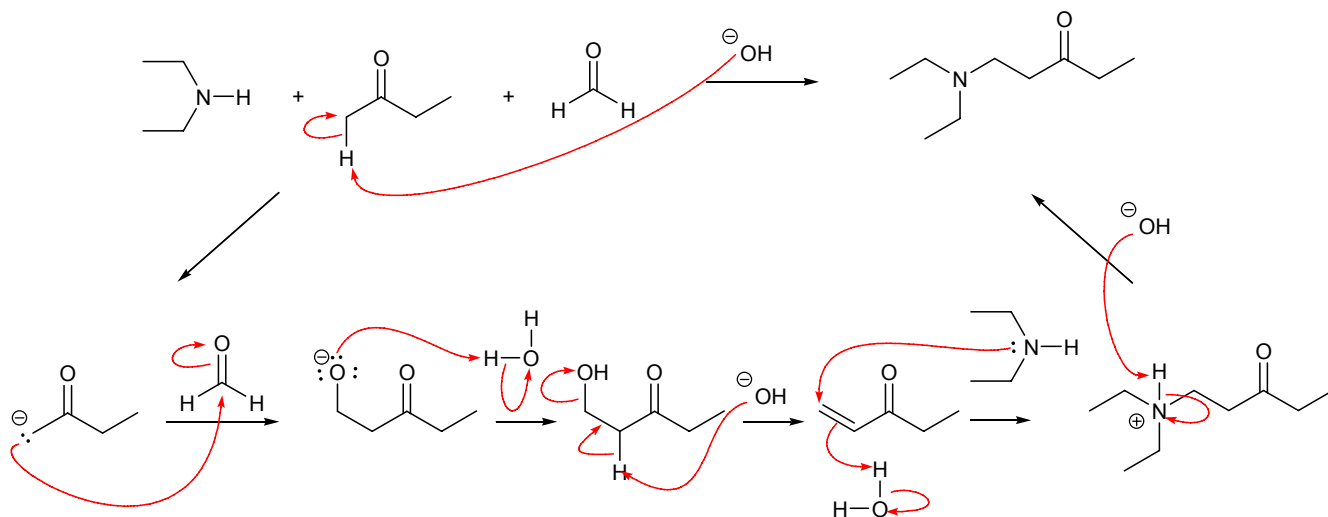
A = D-Altrose, B = Talose and C = D-Galactose

25. Cyclopentadiene reacts with methyl acrylate to give an *endo/exo* mixture of cycloadducts. Answer the following questions using the diagram shown below. 10 pts



- (a) On the answer sheet circle the major product, **exo** or endo, formed under *kinetic* reaction conditions.
- (b) On the answer sheet circle the thermodynamically more stable cycloadduct, exo or endo.
- (c) Give the letter representing the energy difference that could be used to calculate the rate of formation of the endo cycloadduct. **A**
- (d) Give the letter representing the energy difference that could be used to calculate the equilibrium constant of the reactants and the exo cycloadduct. **D**
- (e) On the answer sheet circle the correct stereochemical relationship (enantiomeric or **diastereomeric**) between the *endo* and *exo* cycloadducts.

26. Using the curved arrow formalism give a reaction mechanism showing the bond making and bond breaking in the following transformation. 10 pts



27. Propose a good synthesis of ibuprofen, an inhibitor of the cyclooxygenase enzymes, from benzene and compounds containing four carbon atoms or less. 10 pts

