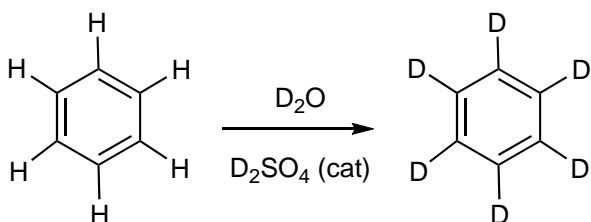


1. Explain, using a potential energy diagram, how hydrogenation data can be used to account for the stability of benzene. Exact numbers need not be used--use approximate relative energies to make your point. 10 pts.

2. Benzene- d_6 is a common NMR solvent. It is prepared commercially by heating benzene, D_2O (heavy water), and catalytic amounts of deuterated sulfuric acid (D_2SO_4). a. Write a mechanism to show how this works for the replacement of one C-H bond for a C-D bond. 8 pts



3. If propene is exposed to a strong base like $n\text{-BuLi}$, one of the methyl hydrogens is removed. On the other hand, if cyclopropene is treated the same way, one of the alkene hydrogens is removed. Use a molecular orbital analysis for each molecule to account for this difference in chemical behavior. 10 pts

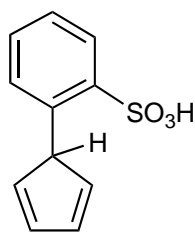


propene

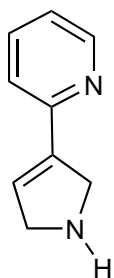


cyclopropene

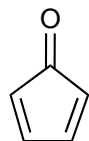
4. Which of the hydrogen atoms shown below is more acidic? Explain your answer. 6 pts



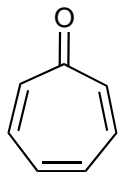
5. Which of the nitrogen atoms shown below is more basic? Explain your answer. 6 pts



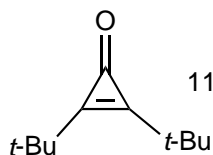
6. The relative basicity of carbonyl oxygen atoms can be measured by studying the strength of their participation in hydrogen bonding with a reference hydrogen bond donor (like an OH group). Rationalize the observed order of basicities (larger numbers mean greater basicity). 10 pts



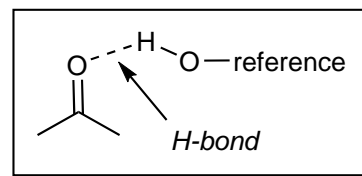
6.2



31.2

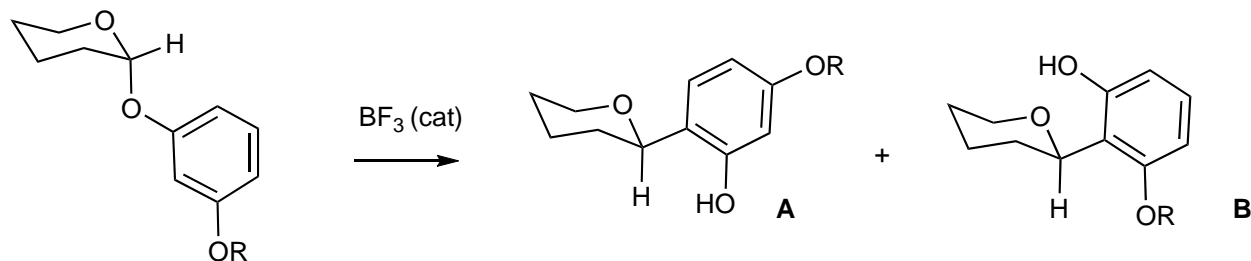


117

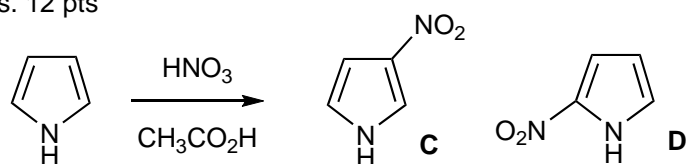


8. Write down a mechanism to account for the formation of sulfur trioxide when two sulfuric acid molecules self-react. 8 pts

9. The following intramolecular rearrangement has been used in the synthesis of a class of compounds called C-aryl glycosides. Propose an arrow-pushing mechanism to account for how the reaction proceeds to form isomer **A**. 12 pts



10. Pyrrole can undergo EAS chemistry (e.g. nitration) to produce monosubstituted pyrroles **C** or **D**. Analyze the mechanism and intermediate structures to predict which isomer predominates. 12 pts



2. Classify each molecule as aromatic, antiaromatic, or nonaromatic. For the aromatic and antiaromatic molecules, give the number of pi electrons in the ring. 12 pts

