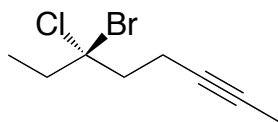
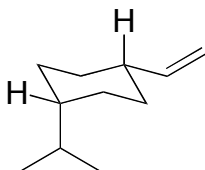
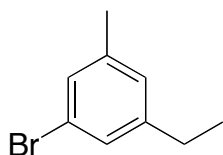


1. Provide an unambiguous (IUPAC or common) name for each of the following compounds. Be sure to indicate stereochemistry where appropriate. (15 points)

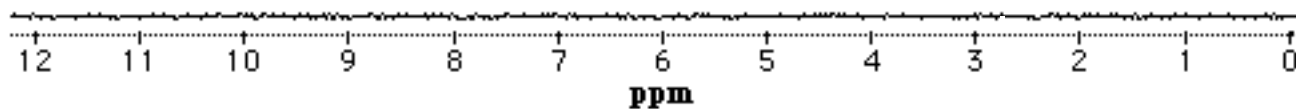
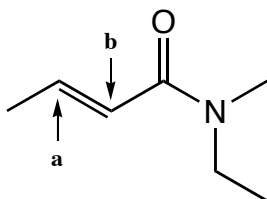






2. **Part A.** Predict the ^1H NMR of the compound shown by drawing the peaks onto the blank spectrum. Assign all peaks for full credit. *Hint: draw in **all** of the hydrogens before proceeding.* (12 points)

save this space below for part B



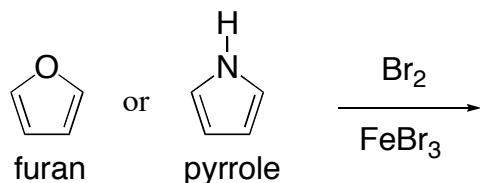
- Part B.** In the space next to the molecule, use pictures and words to explain why the proton attached to carbon **a** resonates more downfield than the proton attached to carbon **b**. (4 points)

- Part C.** What is the hybridization of the nitrogen atom? sp sp^2 sp^3 (circle one, 2 points)

3. Predict the two major diastereomeric E2 products that are formed when the following substrate is reacted with NaOH. Draw the Newman projections of the substrate conformations that lead to the two products. Explain why the major product is formed based solely on the Newman projections you drew. In other words, DO NOT discuss product stability. (8 points)

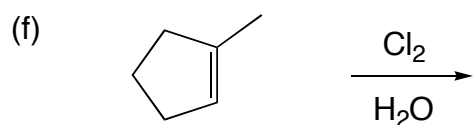
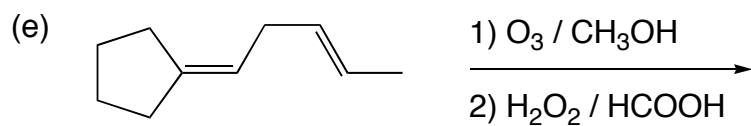
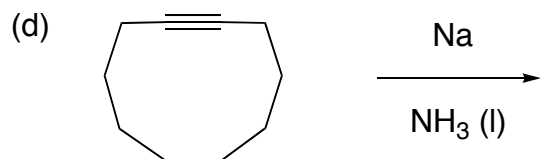
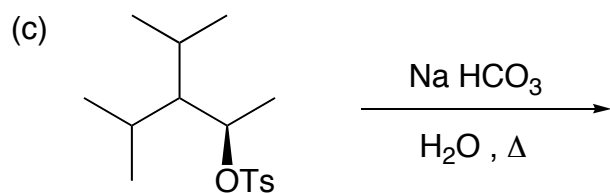
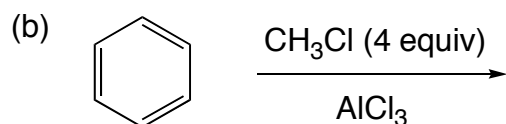
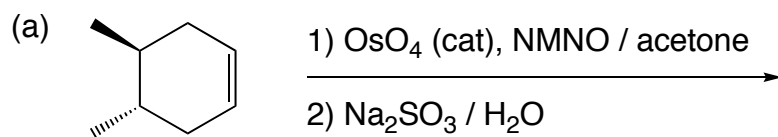


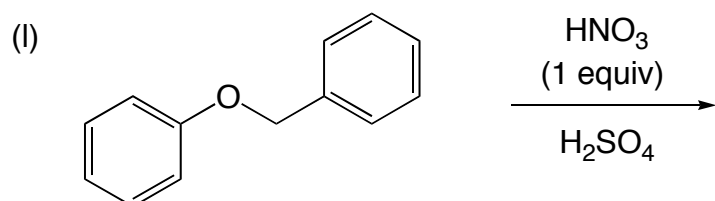
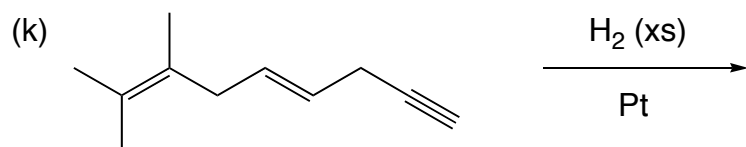
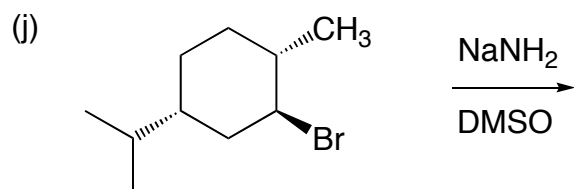
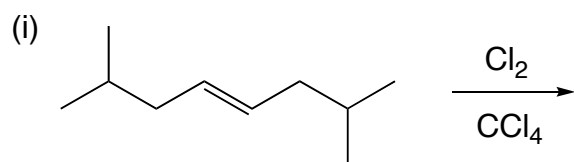
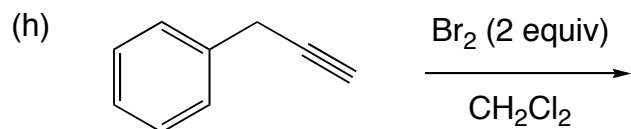
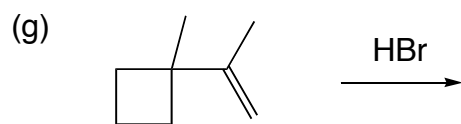
4. **Part A.** Furan and pyrrole both undergo electrophilic aromatic substitution with $\text{Br}_2/\text{FeBr}_3$ to give monosubstituted products at the same position of the ring. Using *either* furan or pyrrole, predict the major product of the reaction, provide a mechanism for its formation, and use resonance theory to explain why the major product is favored. You *will need to show* the intermediates of the major and minor products to best explain this reaction. (16 points total)



Part B. Which will react faster? pyrrole or furan (circle one) Explain using pictures or words.

5. Draw the **major product** of each of the following reactions. *Be sure to include stereochemistry in your answers where appropriate.* (4 points each)





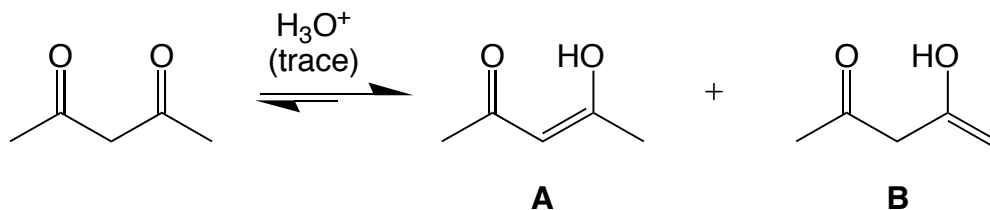
6. a) Draw, in the boxes below, the four most stable constitutional/configurational isomers of C_3H_6O that contain an sp^2 hybridized atom. (8 points)

| | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
|--------------------------|--------------------------|--------------------------|--------------------------|

- b) Place an "X" in the box that contains the highest boiling compound and explain (below) why it boils higher than the others. (3 points)

- c) Place a "√" in the box that contains the lowest boiling compound and explain (below) why it boils lower than the others. (3 points)

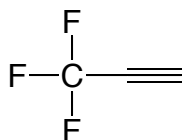
7. a) 2,4-pentanedione readily undergoes keto-enol tautomerization in the presence of trace amounts of hydronium to yield a product that gives ^{13}C NMR peaks at 202, 191, 100, 31, and 24 ppm. Compounds **A** & **B** were postulated to be the two most likely products. Circle the product that is supported by the data and provide a mechanism for its formation. Explain why the product you chose is formed preferentially over the other. (8 points)



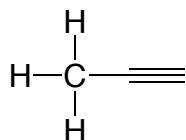
- b) How would the IR spectra of **A** and **B** differ? Explain using pictures and words. (4 points)

8. For each pair of molecules shown, circle the one that best fits the accompanying description and provide a concise rationale for your choice. Pictures *may* be required for full credit! (3 points each)

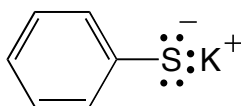
Most acidic compound



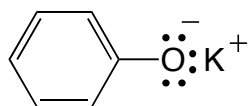
vs.



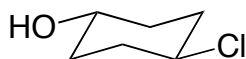
The better nucleophile in DMSO



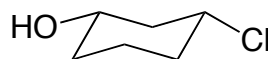
vs.



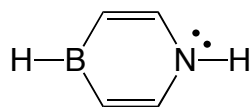
The compound that rotates plane polarized light



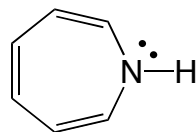
vs.



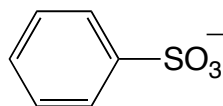
The most basic nitrogen



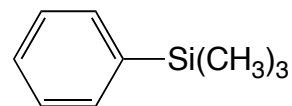
vs.



The compound that reacts faster with Br₂ / FeBr₃

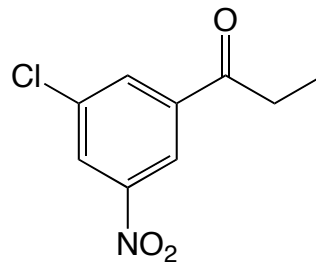
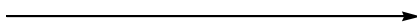
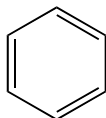


vs.



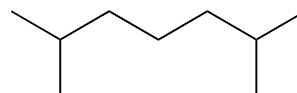
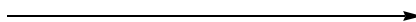
9. Propose a synthesis (sequence of reactions) that will accomplish each of the following transformations. *Be sure to include the products of each step.*

(6 points)



(8 points)

**2 alkenes, both of which
must be 5 carbons or less**

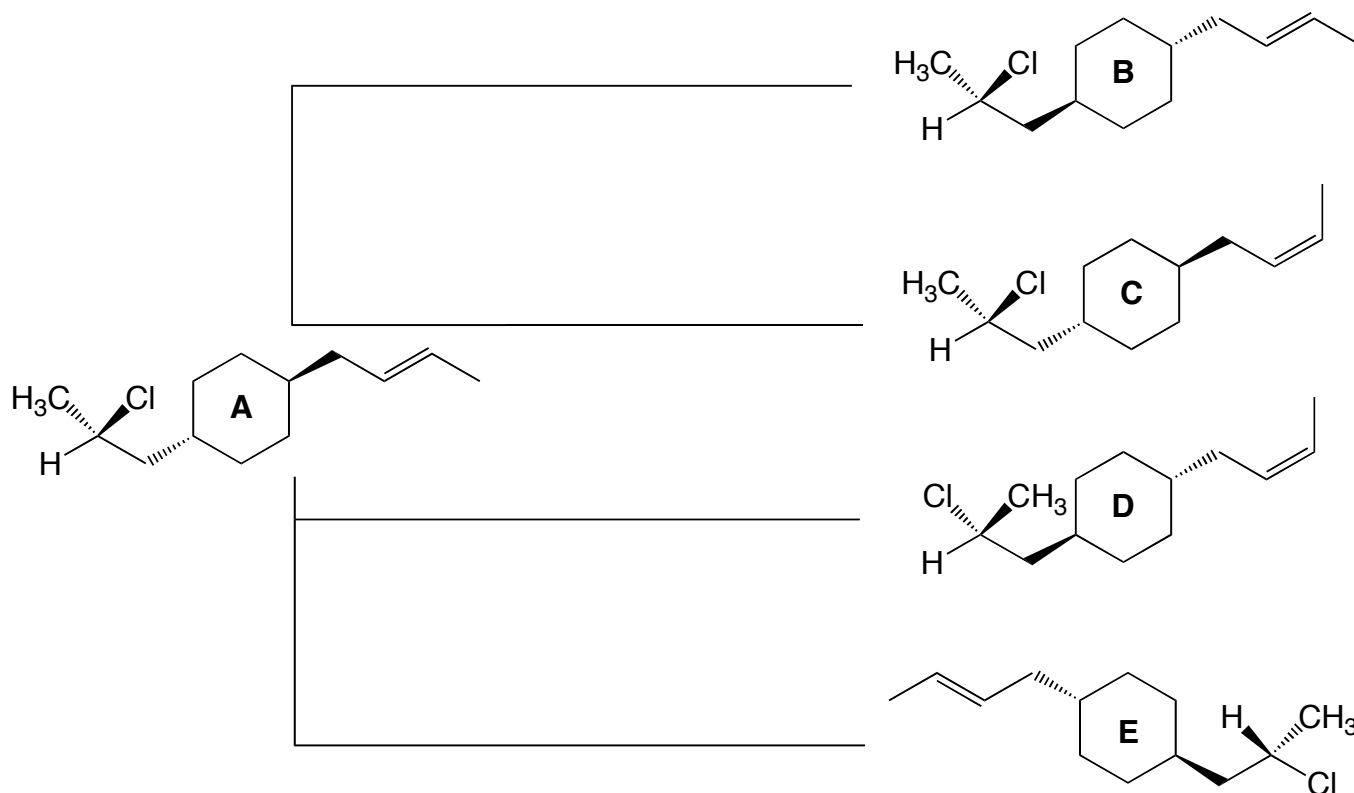


synthesis (cont'd)...

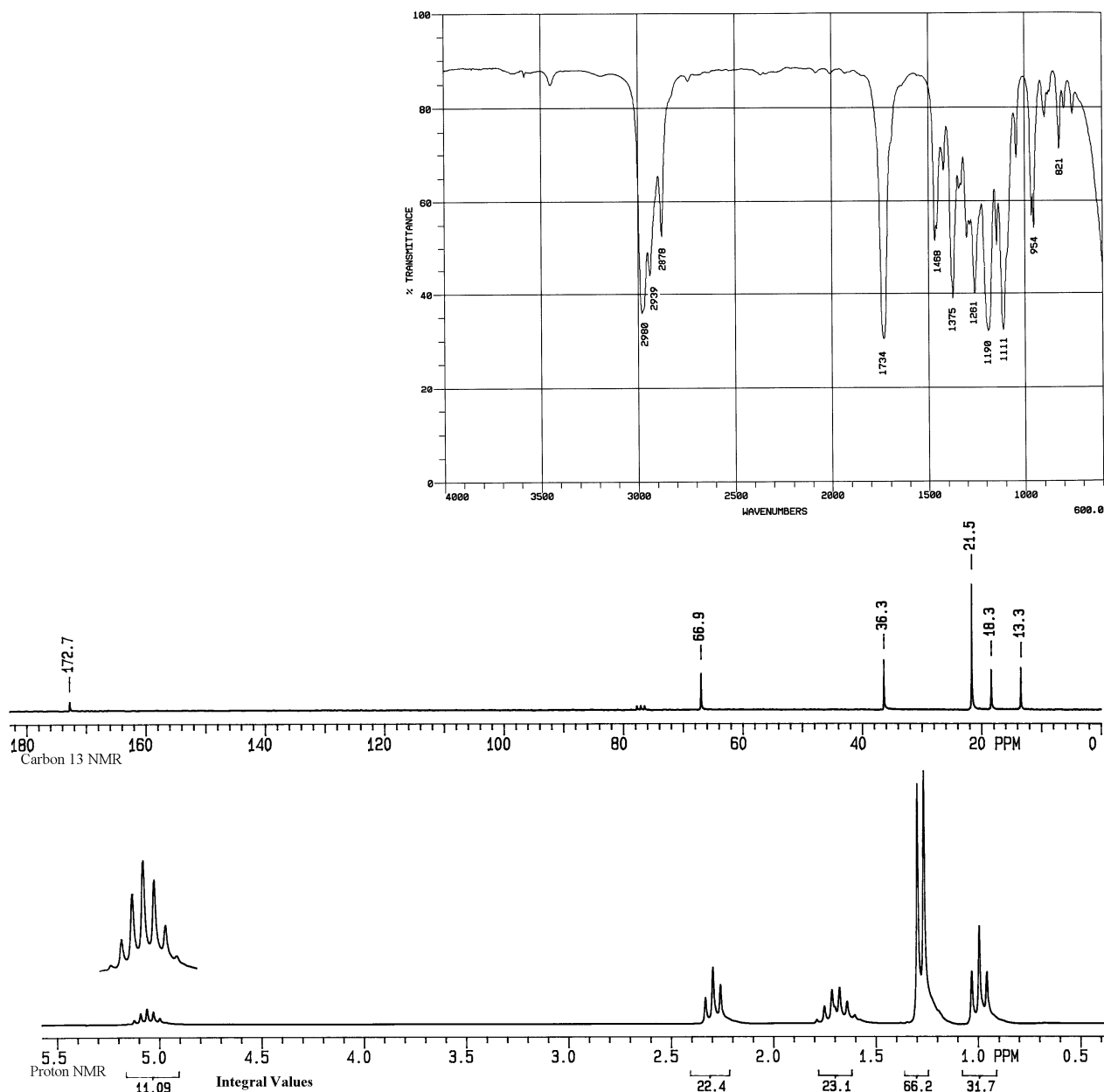
(12 points)



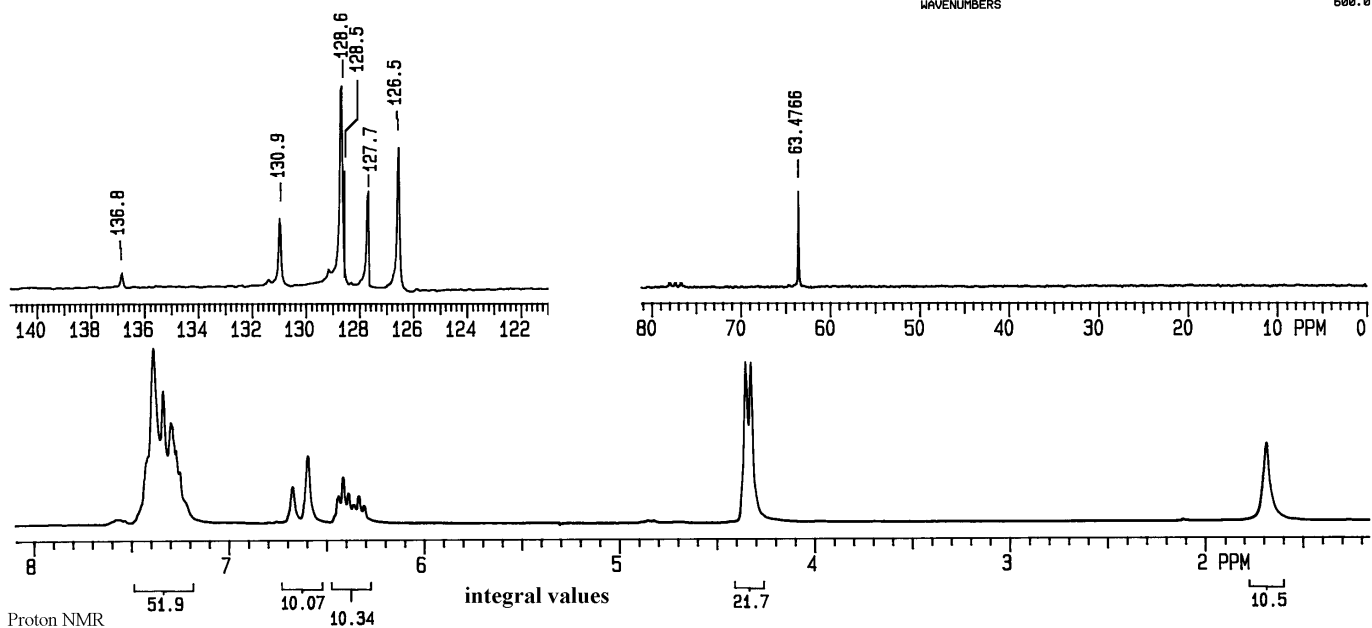
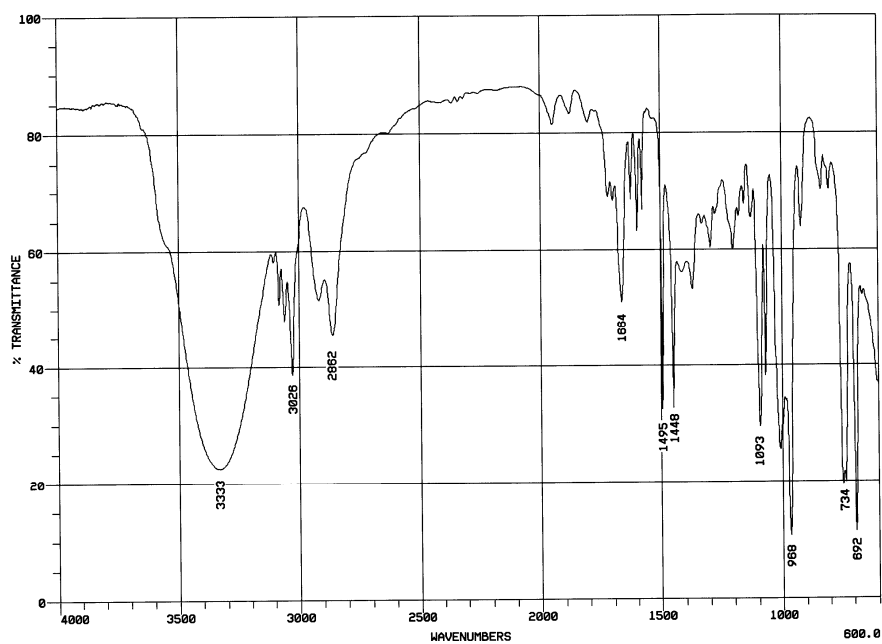
10. Indicate (along each connecting line) the relationship (identical, constitutional/configurational isomers, enantiomers, diastereomers, unrelated) of molecule **A** to each of the structures shown below. (8 points)



11. Determine the structure of the compound that produces the following spectra. For full credit, assign all peaks in each spectrum, including the IR. The M.F. for the unknown is $C_7H_{14}O_2$. (10 points)



12. Determine the structure of the compound that produces the following spectra. For full credit, assign all peaks in each spectrum, including the IR. The M.F. for the unknown is $C_9H_{10}O$. (10 points)



Proton NMR