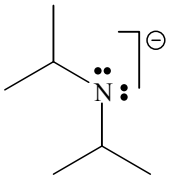
Name: _____

Organic Chemistry - CHEM 231A

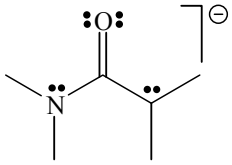
Final Exam

December 12, 2002

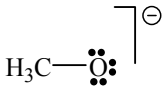
1. Consider the following molecules: (40 points)



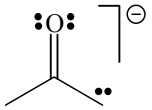
A



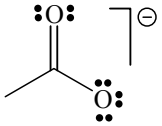
B



C



D



E

1a. What is a base? What factors are involved in making a base a strong base? (6 points)

1b. Circle the MOST basic atom(s) for each molecule. (3 points)

1c. Arrange the molecules in the order from most basic to least basic. (5 points)

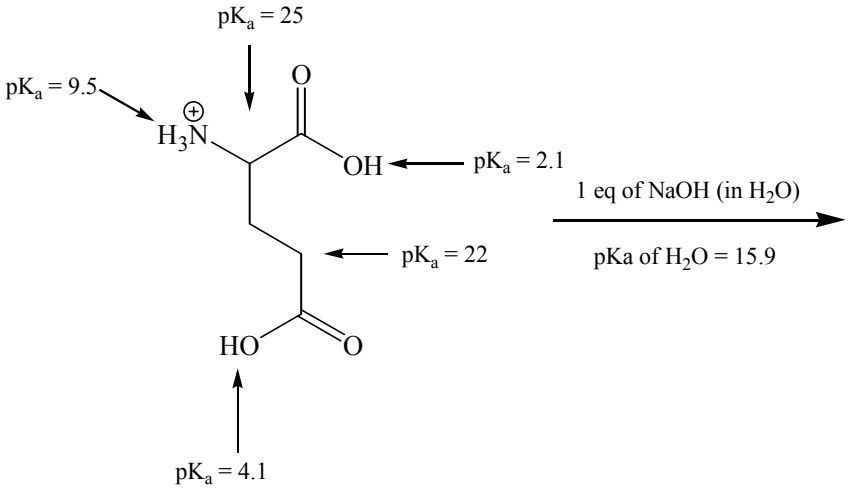
Most Basic ____ > ____ > ____ > ____ > ____ Least Basic

1d. Briefly explain your reasoning behind the ordering of the molecules. Include a discussion of why the characteristics for each specific molecule help us understand the basicity for EACH molecule. Discussing them in order may be appropriate. (2 pts for each molecule = 10 points)

1e. Briefly explain what the difference is between a base and a nucleophile? (5 pts)

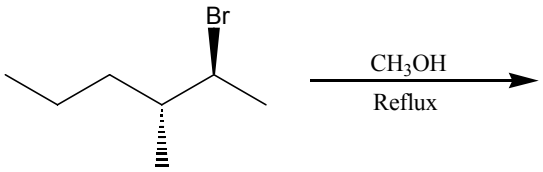
1f. Which of the above molecules are also nucleophiles? Explain very briefly. (4 points)

1g. Predict the product and the reaction equilibrium constant for the following reaction of glutamic acid (a naturally occurring amino acid) with 1 equivalent of sodium hydroxide (7 points)

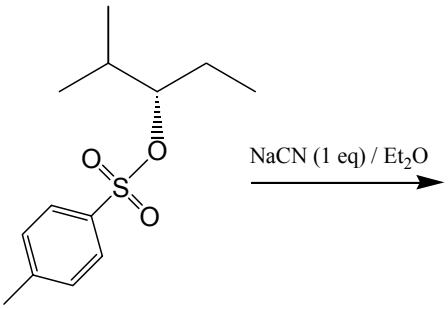


2. Predict the **MAJOR** product or products for the following reactions and very briefly explain your answer. (5 @ 7 pts each = 35 points)

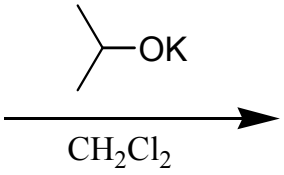
2a.



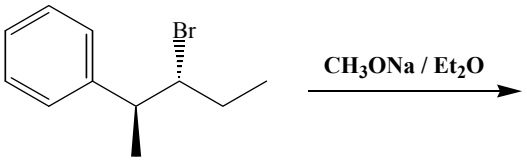
2b.



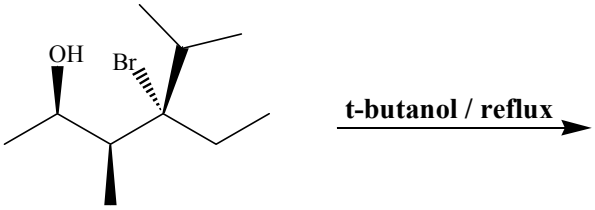
2c. [1R,2R,4S]1-bromo-2-ethyl-1,4-dimethylcyclohexane



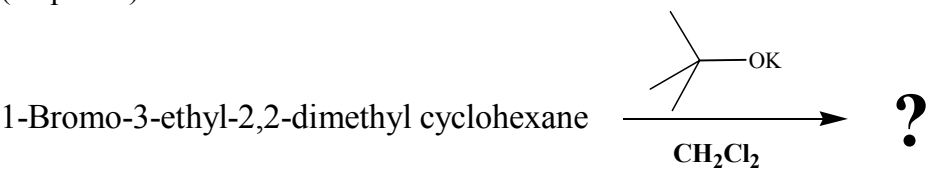
2d.



2e.



3. Consider the reaction of potassium t-butoxide with 1-bromo-3-ethyl-2,2-dimethyl cyclohexane: (25 points)



3a. How many stereoisomers exist for 1-bromo-3-ethyl-2,2-dimethyl cyclohexane? (2 points)

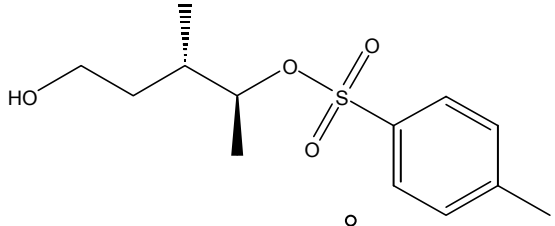
3b. Draw two of the diastereomers and name them. (4 points)

3c. For each of the two diastereomers, what product(s) is (are) formed? (6 points)

3d. Choose one reaction and propose a mechanism that explains the formation of this product? (6 points)

3e. One of the diastereomers reacts at a faster rate than the other diastereomer. Predict which diastereomer reacts faster and explain. Use of appropriate energy diagrams is strongly encouraged. (7 points)

4. Upon trying to make the following compound in the lab, you observe NMR and IR spectra that confirm this molecule and you observe only one peak from the chromatogram of the GC-MSD. The optical rotation you measure in lab is +32°. (20 points)



Reported Pure Optical Rotation = - 46°

4a. Did you make only this molecule? If not, what did you make? If there is more than one compound made, what is the relationship between the components and what percentages of each are present? (5 points)

4b. Calcium Hydride (CaH_2) is an extremely bizarre base. It is very effective at reacting with hydrogen – oxygen bonds, but is very poor at reacting with other types of hydrogen – atom bonds. Furthermore, CaH_2 is non-nucleophilic. Upon treating your molecule(s) with CaH_2 in DMF at room temperature, one product is observed by NMR and GC-MSD. The IR does not show the characteristic band at 3200 – 3400 cm^{-1} of an alcohol. Write a mechanism that accounts for the formation of this product. (6 points)

4c. If the reaction is heated in DMF in the absence of CaH_2, two products are observed by GC. They have nearly identical NMR and MSD spectra. Neither compound has an IR spectrum with the characteristic band at 3200 – 3400 cm^{-1} of an alcohol. What are the two products as delineated by NMR and GC-MSD. Write a mechanism that accounts for the formation of these products. (6 points)

4d. What is the enantiomeric excess of each product? Explain very briefly (3 points)