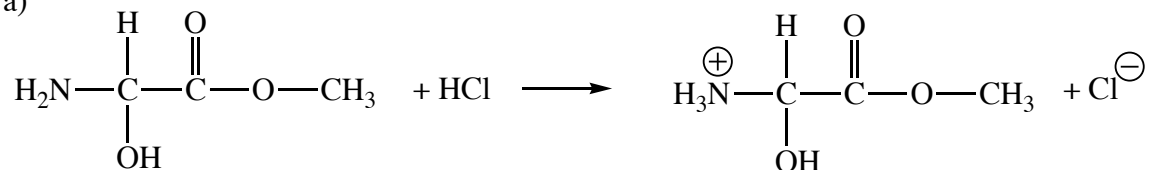


**Chemistry 250A -- Exam #1 Answer Key -- September 23, 2008**

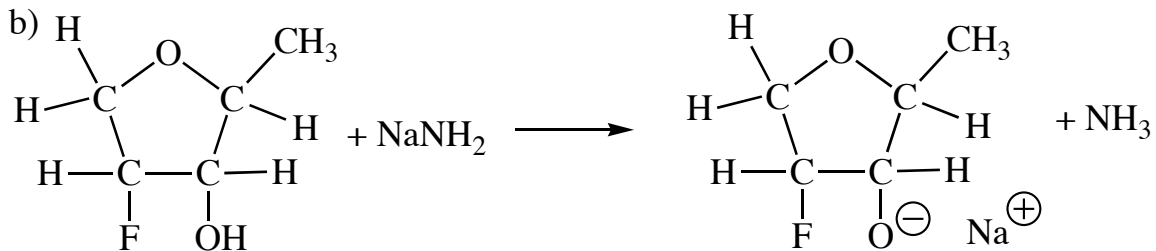
(There are 5 pages.)

1. (15 pts) Show the major product(s) from the following acid-base reactions. If there is no reaction then say "No Reaction".

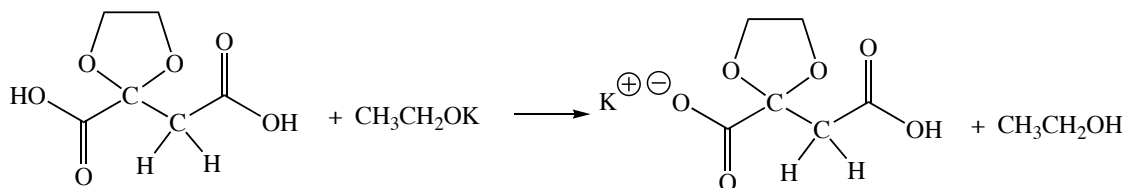
a)



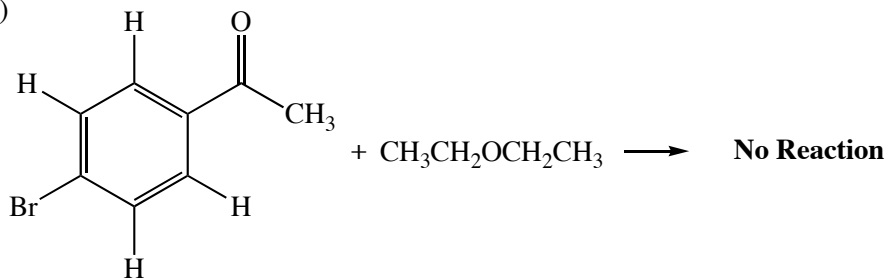
b)



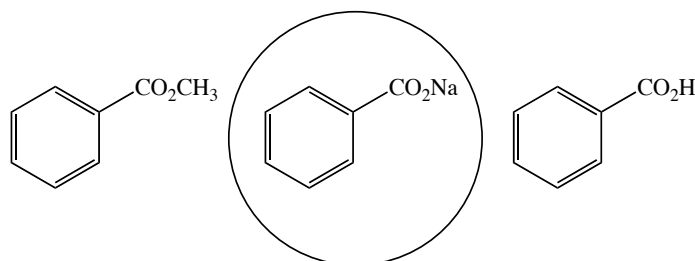
c)



d)

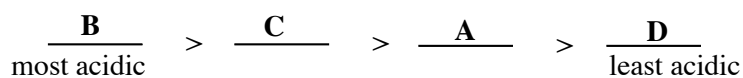
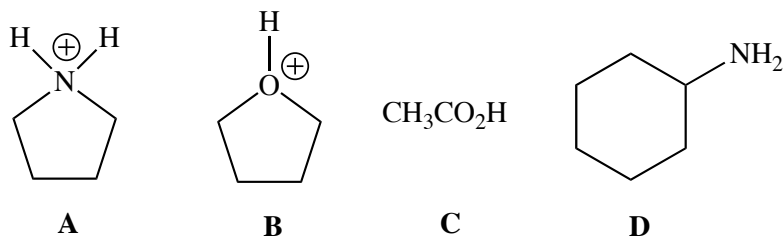


2. (3 pts) Circle the compound that is most soluble in water.

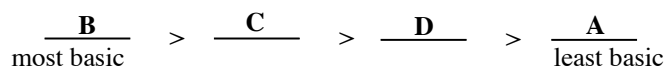
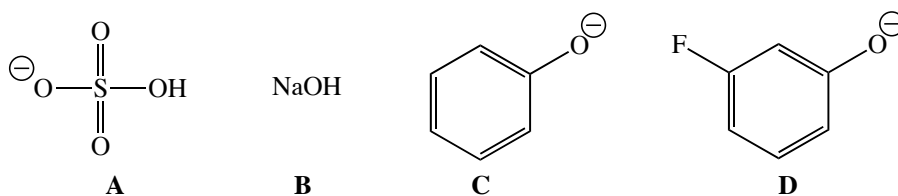


3. (20 pts) Rank the following compounds according to the indicated property.

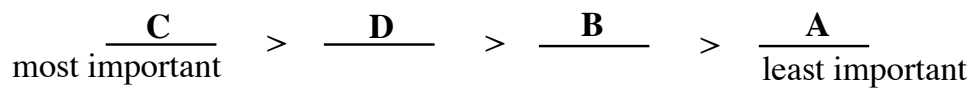
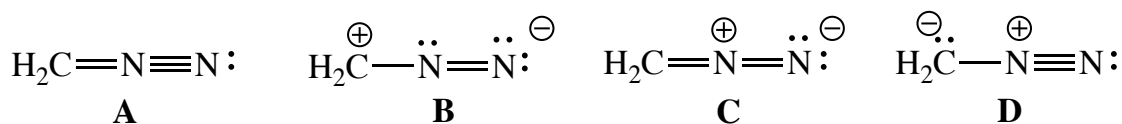
c) acidity



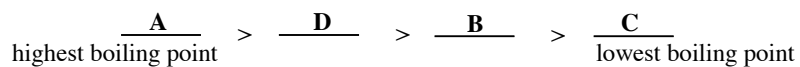
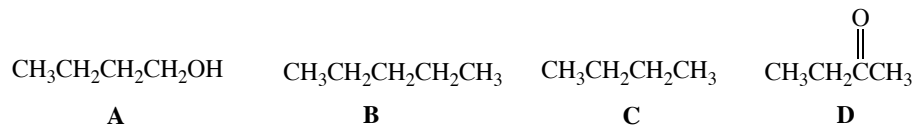
b) basicity



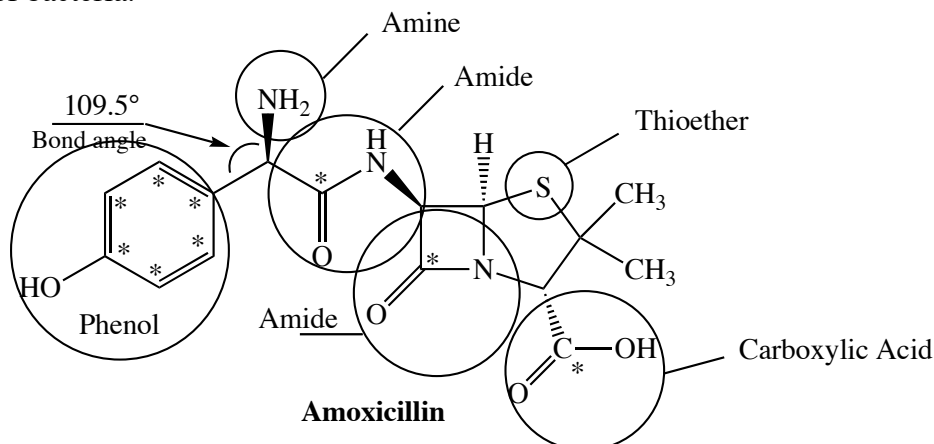
c) relative importance of resonance structures



d) boiling point



4. (16 pts) Amoxicillin (shown below) is a widely-prescribed antibiotic that is active against a variety of bacteria.

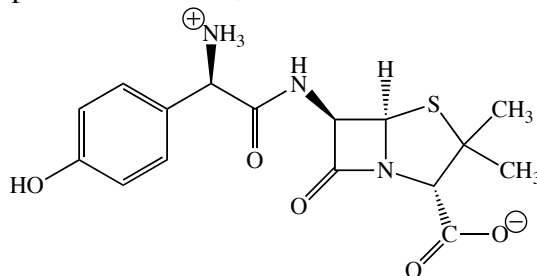


a) Identify the functional groups in amoxicillin. (I've done one for you.)

b) Put an asterisk by all  $\text{sp}^2$  hybridized carbon atoms.

c) Provide the approximate value for the indicated bond angle.

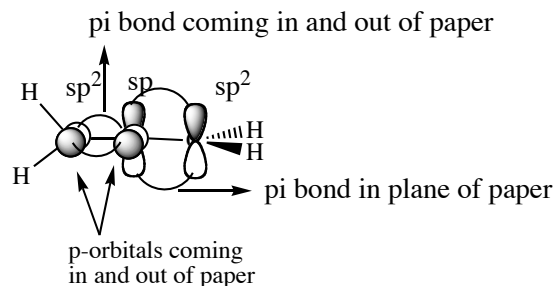
d) Although this is the structure that is usually drawn for amoxicillin (e.g., see Wikipedia), it is not accurate. Considering what you know about the acid-base properties of the functional groups in Amoxicillin, draw a more accurate representation.



The carboxylic acid and the amine will react with each other!

5. (10 pts) Allene has the structure  $\text{H}_2\text{C}=\text{C}=\text{CH}_2$ .

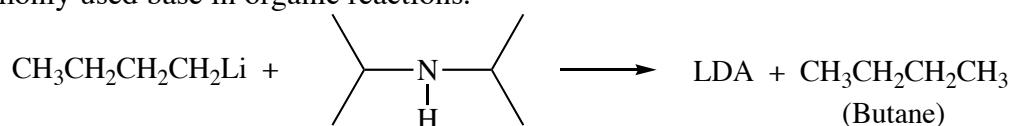
a) Draw an accurate 3D structure of allene. (Hint: It is not planar.) On this structure show the p-orbitals and how they overlap to form the pi bonds in allene. Clearly indicate the 3D orientation of the p-orbitals relative to the atoms in the molecule and to each other.



b) Label the hybridization on each carbon atom.

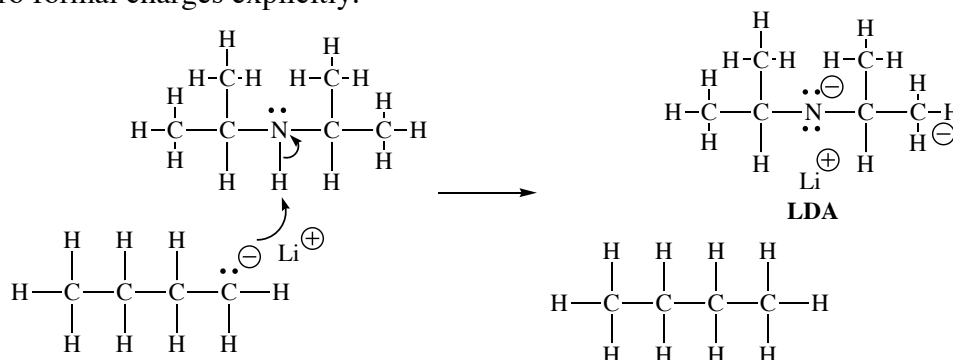
c) What are the approximate CCC and HCH bond angles?  **$180^\circ$  and  $120^\circ$  respectively.**

6. (24 pts) The reaction of butyllithium with diisopropylamine produces LDA, a commonly used base in organic reactions.



Diisopropylamine

a) Redraw butyllithium and diisopropylamine showing all atoms, bonds, lone pairs, and non-zero formal charges explicitly.

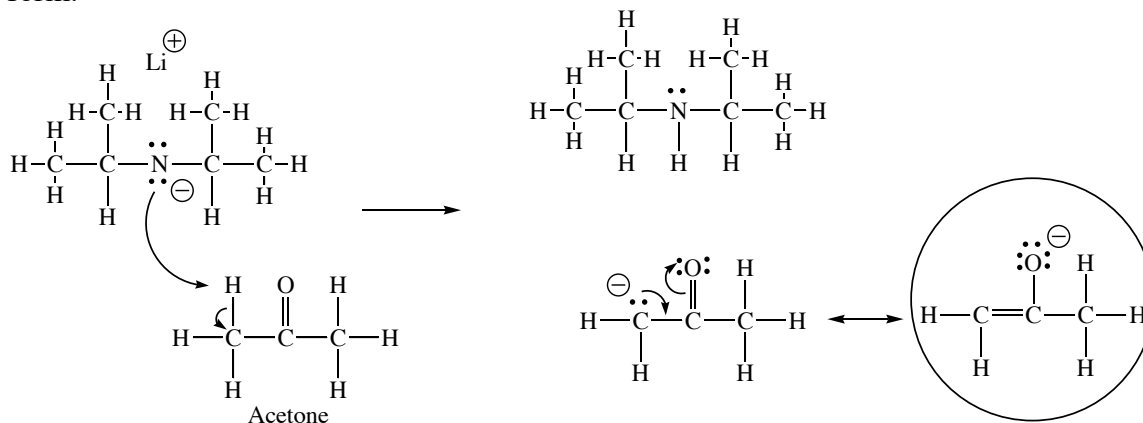


b) Use **curved arrows** to show the reaction of butyllithium with diisopropylamine to form LDA and butane. (Draw a complete Lewis structure for LDA.)

c) Provide a brief rationale for why this reaction is favorable.

**The nitrogen is more electronegative than the carbon, therefore the negative charge "prefers" to reside on the nitrogen, thus making the reaction favorable.**

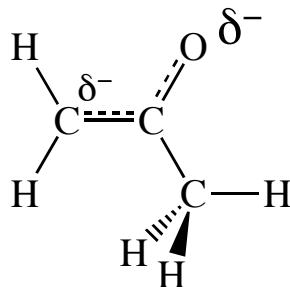
d) LDA undergoes an acid-base reaction with acetone to produce an enolate. Use curved arrows to show this reaction. Draw a full Lewis structure for the product and use curved arrows to find other important resonance forms. Circle the most important resonance form.



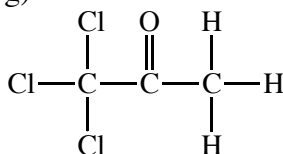
e) Provide a brief rationale for why the reaction of acetone with LDA is favorable.

**The negative charge is delocalized by resonance in the product enolate, but not in the LDA. The most important resonance form of the enolate has the negative charge on oxygen which is more electronegative than nitrogen. Both of these effects result in the negative charge being more stable in the product enolate than in the starting LDA, thus making the reaction favorable.**

f) Draw an accurate 3D structure of the enolate of acetone and, using dashed lines to represent partial bonds and deltas to represent partial charges, depict the structure of the "resonance hybrid".



g) Is trichloroacetone more or less acidic than acetone? Briefly explain.

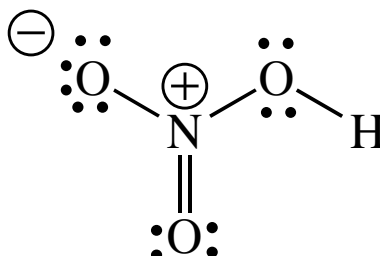


Trichloroacetone

**Trichloroacetone is more acidic than acetone. The electronegative chlorine atoms inductively withdraw electron density, thus stabilizing the adjacent negative charge in the conjugate base. This makes deprotonation more favorable.**

7. (12 pts) Draw complete Lewis structures for the molecules indicated below. **Show all atoms, bonds, lone pair electrons, and non-zero formal charges.**

a) Nitric acid ( $\text{HNO}_3$ ). (Hint: There will be formal charges.)



b) Draw 3D-accurate Lewis structures for the three stable isomers with the formula  $\text{C}_2\text{H}_2\text{Cl}_2$ . Show all lone pairs. Circle the isomer that has no dipole moment. For the other two, show the direction of the net dipole moment.

