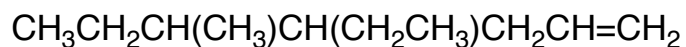
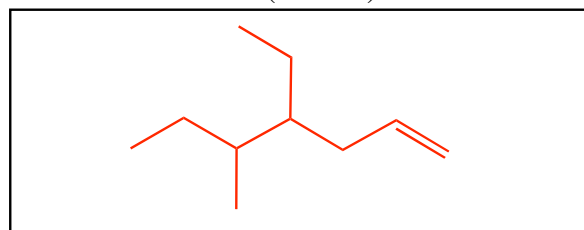


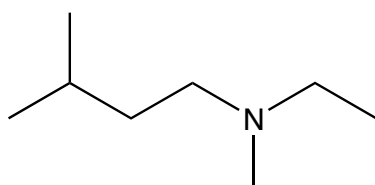
- 1) Translate the following structures to the representation requested and provide a name if indicated.  
(14 points)



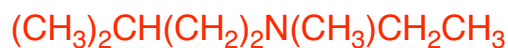
**Bond - Line** (skeletal) Formula



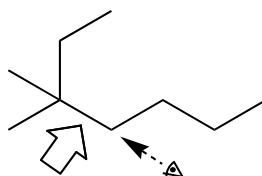
Name the above molecule: 4-ethyl-5-methyl-1-heptene



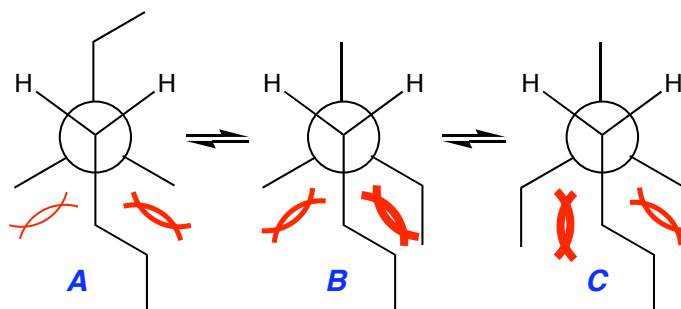
**Condensed Structural Formula**



- 2) Draw Newman projections of the 3 most stable conformations of the following compound viewed down the indicated bond. Circle the most favorable conformation. For full credit, briefly describe or illustrate why your choice is the most favorable. (10 points)



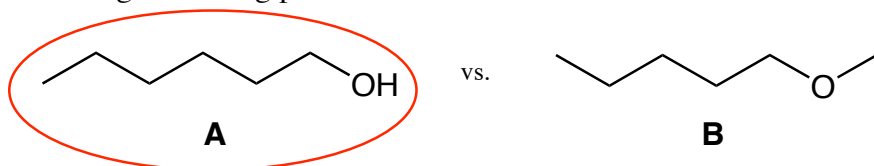
The 3 most stable conformers must be staggered. Shown here are the 3 with the rear group rotated at 120° increments.



Steric interactions from groups gauche to each other are indicated above. The larger the groups, the larger the interaction and the bolder the line. All conformers have 2 gauche interactions, but we can see that conformer **A** has the least steric strain of the 3 conformers because of the size of the groups interacting.

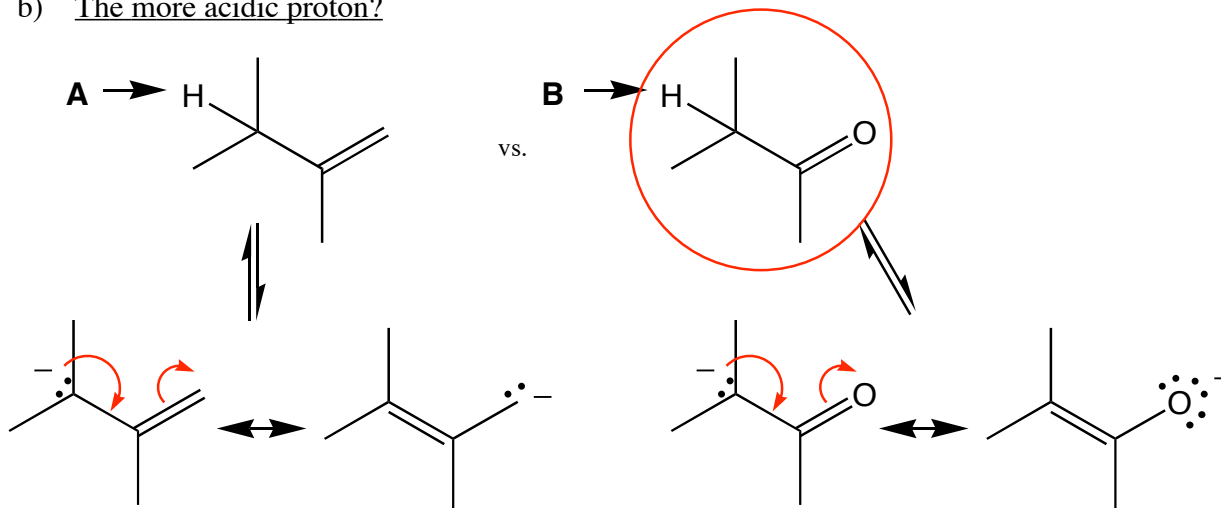
3) For each pair of molecules shown below, select the one that best fits the accompanying description by circling it. Provide a concise but thorough rationale for each of your decisions using words and/or pictures. *Note: a picture is required to receive full credit on most of these. Do not exceed the space provided.* (18 points)

a) The higher boiling point?



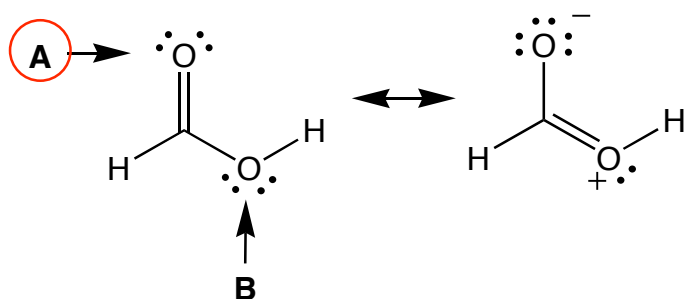
**Both are polar molecules due to the oxygen atoms and thus interact through dipole-dipole interactions. Molecule A, however, possesses an OH group which can undergo hydrogen bonding (another type of dipole-dipole interaction). This will increase the intermolecular attraction between the molecules of A and require more heat to break those interactions and thus to boil.**

b) The more acidic proton?



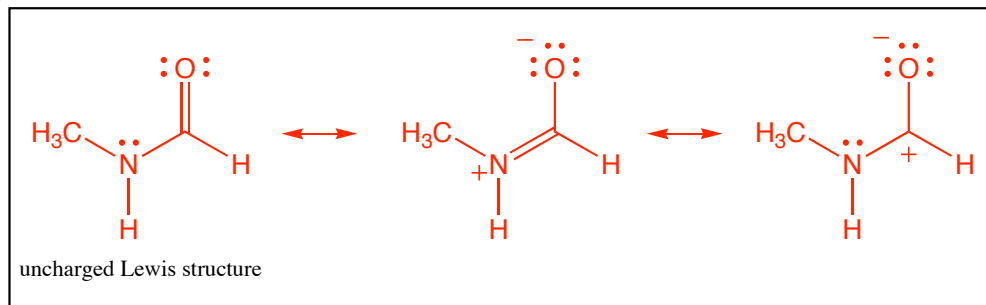
**The conjugate base for removal of proton B is more stable b/c its resonance structure places the negative charge on the electronegative oxygen. Since oxygen is more electronegative than carbon, it is better able to hold a negative charge. The more stable the conjugate base, the more likely the acid is to give up its proton to become the conjugate base.**

c) The more basic atom?

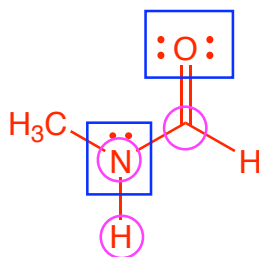


**The basicity of each oxygen is dependent on its ability to donate its lone pair of electrons. the resonance structure shows that oxygen B can utilize one of its lone pairs to contribute towards some double bond character. This leaves the B oxygen less electron rich and thus less basic.**

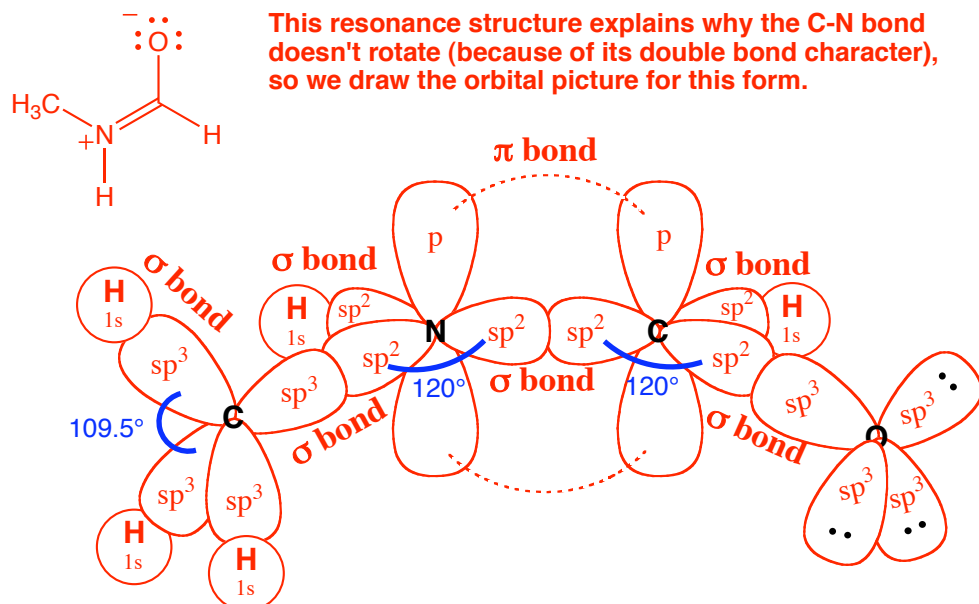
- 4) *N*-methylformamide has a condensed structural formula of  $\text{CH}_3\text{NHCHO}$ . Draw the uncharged Lewis structure of this molecule in the space indicated in the box below. In the remaining space, draw the two most valid resonance structures for *N*-methylformamide and answer the questions that follow. *Note: for full credit, be sure to show all lone pairs of electrons and charges where appropriate.* (15 points)



- a) Redraw the uncharged Lewis structure below and circle the atoms that would react with a Lewis base. Place a square around the atoms that would react with a Lewis acid. *Note: your circles and squares must be distinguishable for full or partial credit.* (6 points)

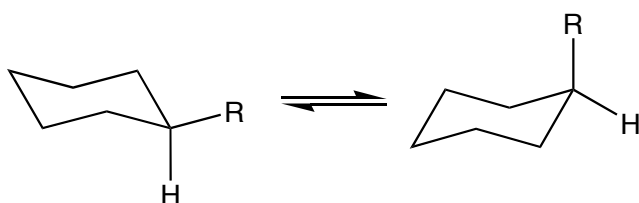


- b) Researchers have found that one of the CN bonds in *N*-methylformamide *does not* exhibit free rotation. Draw the orbital picture for *N*-methylformamide that explains this phenomenon and point out the orbital types, bond types, and bond angles in your picture. You will be graded on both the accuracy of your drawing and on whether or not it explains the experimental data indicated. (12 points)

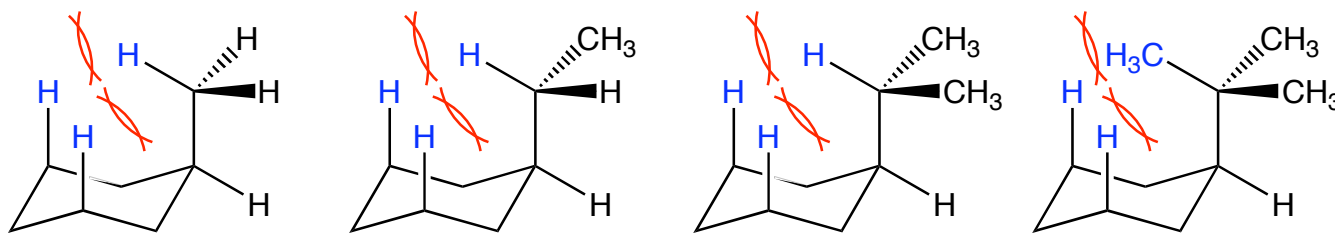


- c) Would you expect *N*-methylformamide to be soluble in water? **Yes** or No (circle one, 2 points)

- 5) The following trends have been observed for the amount of energy it takes to place a substituent in the axial position. As you can see in the table, going from H to CH<sub>3</sub> causes a drastic increase in free energy (1.74 kcal/mol). However, increasing the size of the 'R' group results in only a minor change in  $\Delta G$  even when the 'R' group is isopropyl (this only increases  $\Delta G$  by 0.41 kcal/mol). Using perspective (dash-wedge) drawings, illustrate and explain why the increase in  $\Delta G$  is only gradual up to isopropyl, but increases drastically when the 'R' group is *t*-butyl. (12 points)



R	$\Delta G$ (kcal/mol)
H	0
CH <sub>3</sub>	1.74
CH <sub>2</sub> CH <sub>3</sub>	1.75
CH(CH <sub>3</sub> ) <sub>2</sub>	2.15
C(CH <sub>3</sub> ) <sub>3</sub>	5.00



**The 1,3-diaxial interactions don't change much until a methyl group is forced to be in the sterically unfavorable position. All the substituents except for *t*-butyl can avoid this.**

- 6) Glutamic acid is one of the common amino acids found in nature. Draw the predominant structure of glutamic acid when placed in a solution of  $pH = 3.2$ . Also, indicate its overall charge. (11 points)

