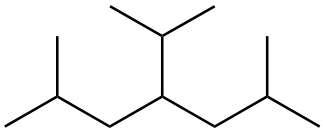
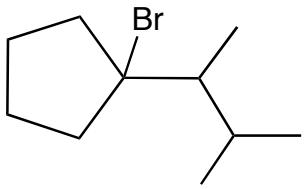
1) Provide an unambiguous name for each of the following compounds (5 points each)

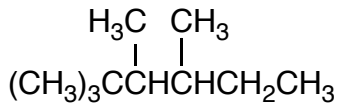


4-isopropyl-2,6-dimethylheptane

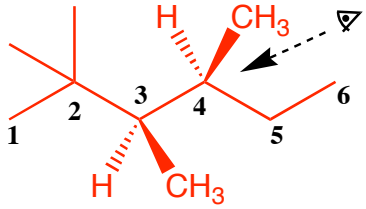


1-bromo-1-(1,2-dimethylpropyl)cyclopentane

2) In the space indicated, draw a perspective structure of 2,2,3,4-tetramethylhexane showing dashes and wedges on C_3 and C_4. Then draw Newman projections of the 3 most stable conformations of your perspective drawing viewed down the C_3–C_4 bond. Circle the most favorable conformation. For full credit, briefly describe or illustrate why your choice is the most favorable. (12 points)



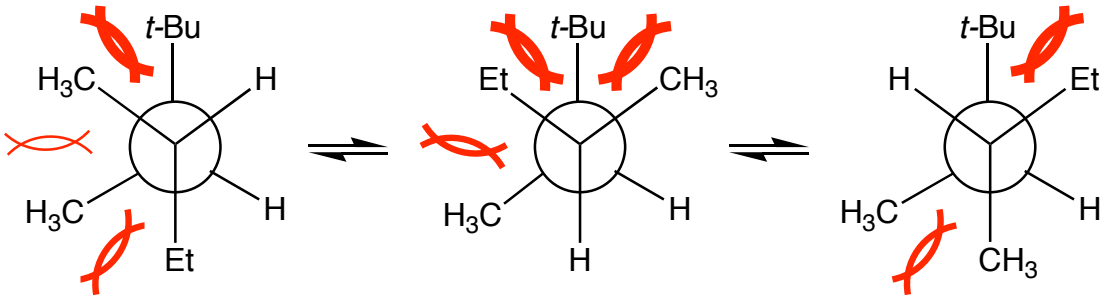
2,2,3,4-tetramethylhexane



perspective drawing

You may also have drawn perspective stuctures with one or both CH_3 groups on dashes. This would have been fine and your conformational analysis would have been slightly different.

The 3 most stable conformers must be staggered (not eclipsed). Shown here are the 3 with the frontmost group rotated at 120° increments.



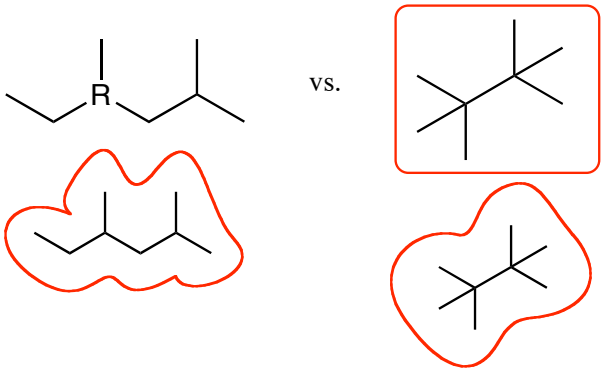
A ***B*** ***C***

Steric interactions from groups gauche to each other are indicated above. The larger the groups, the larger the interaction and the bolder the line. Conformer C has only 2 gauche interactions and will thus have the least steric strain of the 3 conformers because of the size of the groups interacting.

2) 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 pictures *and* words. (7 points each)

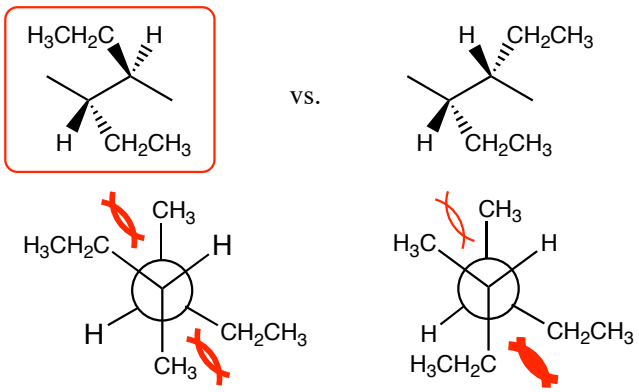
Rationale

The compound with the higher melting point?



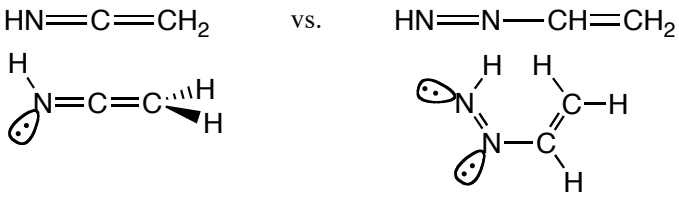
Molecules are packed closely together in the solid state. A molecule that is more symmetrical (less irregular) can pack more closely than one that is not symmetrical. This maximizes the intermolecular forces between them. The circled answer is more symmetrical than the other and because of the aforementioned factors, will have the higher melting point.

The more stable compound? (Note: compounds aren't necessarily drawn in their most stable conformation)



The circled compound has smaller gauche interactions than the other.

Compound in which *all* its atoms can lie in the same plane?

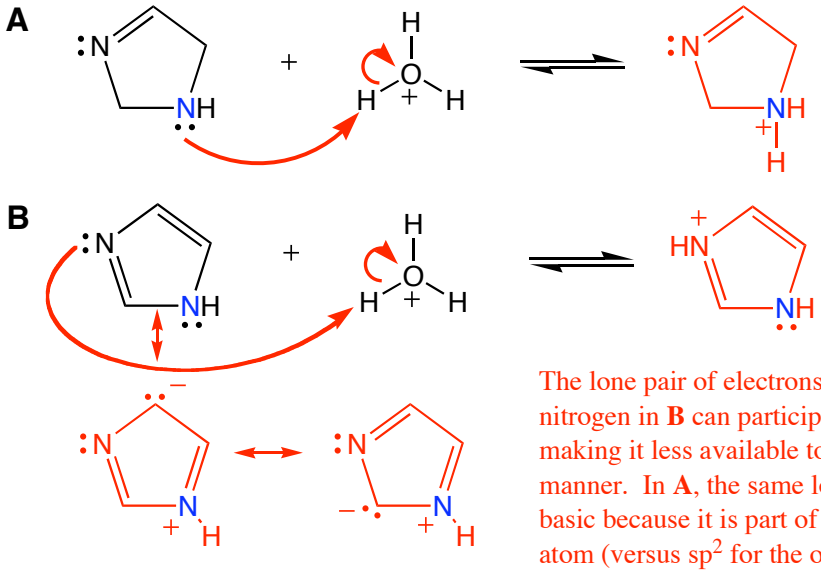


The circled compound has a conformation where all atoms can lie in the same plane. The other choice, because of VSEPR theory and the hybridization of its atoms must exist in the geometry shown where the lone pair of electrons and the hydrogen attached to N are perpendicular to the two hydrogens on the other side of the molecule.

The more acidic of the indicated protons?

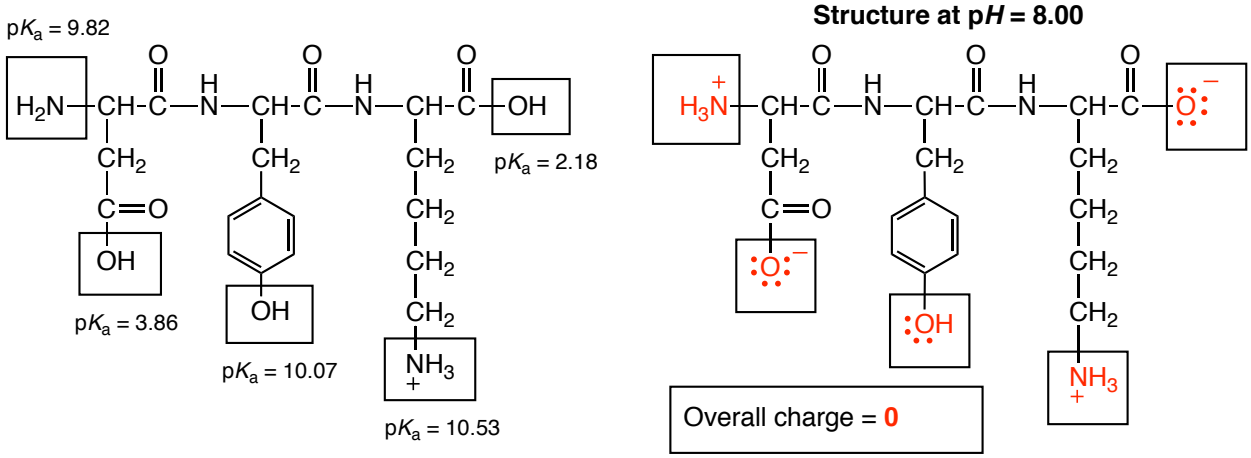
Both conjugate bases have two resonance structures, but the sulfur compound places a negative charge on sulfur. Since sulfur's valence shell is comprised of the 3rd shell of orbitals, it's electrons have more room to spread the negative charge about the sulfur atom, making it's neg. charge less localized and thus more stable. This makes the conjugate base more likely to form, which makes the acid more acidic.

4) Predict the products of reactions **A** and **B** and provide a mechanism for each. The basicity of the dinitrogen compound in reaction **A** differs from that of reaction **B**. Explain this difference using pictures and words. (12 points)

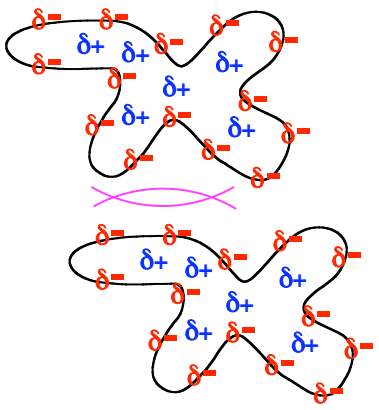


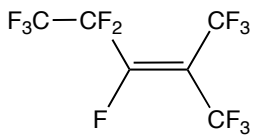
The lone pair of electrons on the blue nitrogen in **B** can participate in resonance, making it less available to act in a basic manner. In **A**, the same lone pair is *more* basic because it is part of an sp^3 hybridized atom (versus sp^2 for the other nitrogen).

5) In the empty boxes, complete the structure of the tripeptide shown when placed in a solution of p*H* = 8.00. Show lone pairs and formal charges. Indicate the overall charge in the box provided. (10 pts)

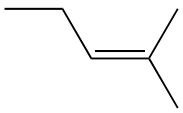


6) Explain why **A** has a lower boiling point than **B**? (only 3 points, don't spend lots of time on this)





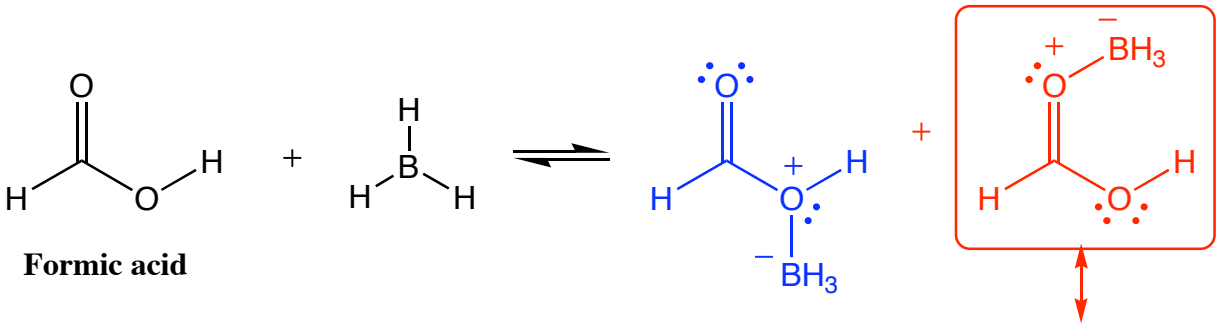
A
b.p. = 58 °C



B
b.p. = 67 °C

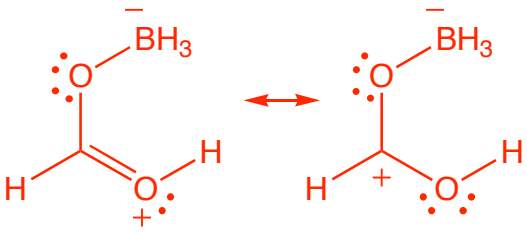
The highly electronegative fluorines in **A** are located at the periphery of the molecule. In a liquid, where intermolecular distances are greater and van de Waals interactions are minimal, the molecules of **A** will actually repel each other, requiring less heat to boil the molecule.

7) Draw the *two possible products* that can form from the Lewis acid-base reaction between formic acid & BH_3. Circle the major product and use curved arrows to provide a mechanism for it's formation. Show all charges & nonbonded electrons *in your products* for full credit. (10 points)



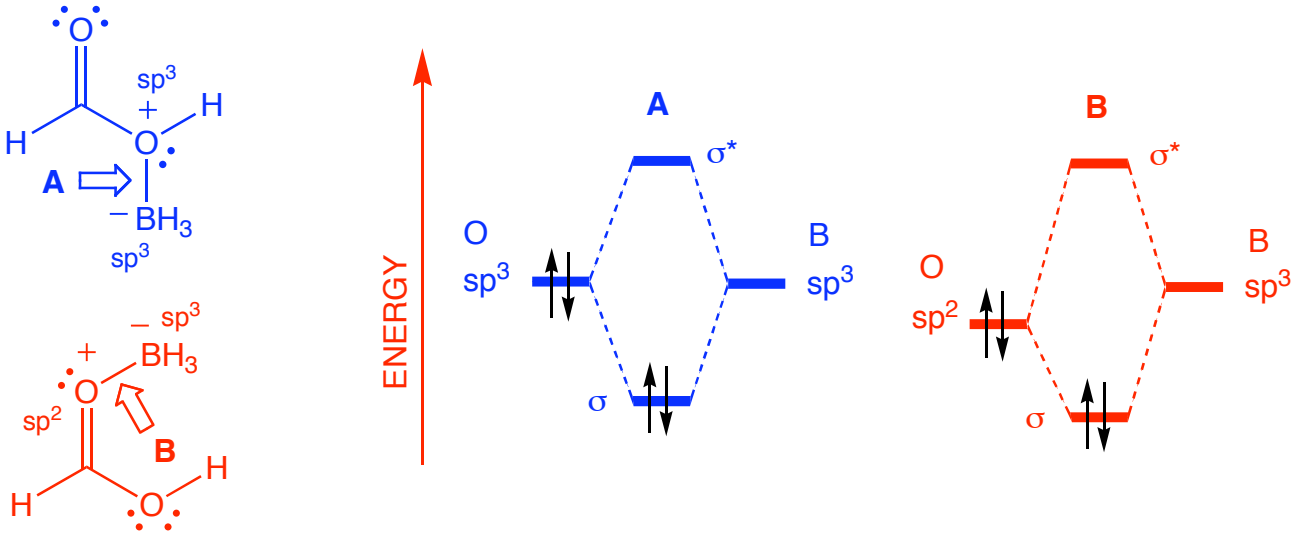
Formic acid

Use pictures and words to explain why the product you circled is favored over the other product. (Note: do not use MO theory to explain; you will be asked to use MO theory in the next section) (7 pts)



The product in red has 3 resonance structures that help to delocalize the positive charge on oxygen. Since charge delocalization makes a species more stable, the product in red should be favored.

Now use MO theory to explain why the product you circled is favored over the other. Be sure to label all atomic or hybridized orbitals and any new bonds that are formed. (8 points)



The sp^2 hybridized oxygen in **B**, with more s character, is lower in energy than the sp^3 hybridized oxygen in **A**. When the oxygens combine with boron to form the new bonds, the sigma bond formed in **B** will be lower in energy as a result. This leads to a more energetically favorable situation in **B**, and thus results in **B** being favored over **A**.