Chemistry 222, Section 1, Spring 2013

Exam One Name: _________

INSTRUCTIONS: This exam must be started in the library before 8:00 PM on Sunday, March 3. This exam is governed by the Smith College Honor Code. This is an closed-book and closed-notes exam. You may use a calculator, but NOT any other electronic device–computer, smart-phone, ipad, etc.–during this exam. You may NOT talk to other people during this exam. You should keep your exam to yourself and NOT allow others to oversee your answers, and you, obviously, should NOT look at the answers of any fellow student who happens to be taking this exam at the same time. You should finish this exam in not more than two hours. The exam should be turned back into the librarian when you are finished.

Time checked out: ____________ Time checked in: ____________

1. (16 points)
   a. (2 pts) Draw the line structure (put in lone pairs) for 3-methyl-butanone and indicate the atom on that molecule that an electrophile would attack.

   ![Structure](image)

   b. (2 pts) What “kind” of compound could C₆H₁₂O be? HINT: There are several possible answers and I only want one, but some of those answers require more than one “kind” at the same time, for instance, “cyclic ketone”.

   alkene, cyclic compound, ketone, aldehyde

   c. (2 pts) Draw a line structure (put in lone pairs) for cyclopentanone and indicate the atom on that molecule that a nucleophile would attack.

   ![Structure](image)

   d. (2 pts) Fill in the blanks in this sentence: “In a Lewis structure containing nitrogen, the number of bonds to the N is 3 unless the N atom is charged positively, in which case the number of bonds is 4.”
e. (4 pts) Draw the Newman projection of the most stable form of 1-bromopropane looking down the C₁-C₂ bond.

\[ \text{Diagram of 1-bromopropane Newman projection} \]

f. (4 pts) Draw the Newman projection of gauche-1,2-dibromoethane.

\[ \text{Diagram of gauche-1,2-dibromoethane Newman projection} \]

2. (14 points)

a. (2 pts) A nucleophile attacks a carbonyl group in a molecule. Which atom will the nucleophile attack? __C__. From a molecular orbital point of view, is the nucleophile "looking" for an empty orbital or a filled orbital on the molecule? __empty__

b. (4 pts) In just a few words, why is the nucleophile looking for the kind of orbital you answered in part a?

A nucleophile donates an electron to a carbonyl group.

\[ \text{Diagram of a nucleophile donating an electron} \]

c. (4 pts) Sketch the orbital on the carbonyl containing molecule that the nucleophile will bind with. HINT: Pay attention to relative signs of the wave function and to relative sizes of the components of the molecular orbital.

\[ \text{Diagram of a carbonyl orbital with signs of wave function} \]

d. (4 pts) Where would a nucleophile attack this molecule?

\[ \text{Diagram of a molecule with a nucleophile attack point} \]
3. (13 points) Use epwa to show the reaction of butyl lithium with propanone followed by treatment with aqueous acid.

4. (7 points) A compound with an IR showing a sharp peak at 1650 cm\(^{-1}\) and a small peak at 3090 cm\(^{-1}\) is treated with ozone, O\(_3\), followed by Zn. The product shows an IR with a slightly broad, strong peak at 1730 cm\(^{-1}\). Describe what happened; an example would generate the best answer. HINT: NO epwa is expected.

5. (30 points) How would you synthesize 3-methyl-butane from compounds containing three or fewer carbon atoms? HINT: If you cannot figure this out, you may obtain partial credit by suggesting a synthesis of 3-methyl-2-butanol from compounds containing three or fewer carbon atoms.
6. (30 points) A compound of formula C₄H₈Br₂ has a \(^1\text{H} \) nmr with peaks at 1.35 \( \delta \) (t, 3), 2.62 \( \delta \) (q, 2), and 2.40 \( \delta \) (s, 3). What is the compound? HINT: For partial credit you must give reasoning. That doesn’t mean you have to write paragraphs: "A triplet, so this hydrogen has 7 neighbors" etc.

\[
\begin{align*}
\delta_{\text{H2}} &= 0 \\
1.35 &\text{ t } 3 \\
2.62 &\text{ q } 2 \\
2.40 &\text{ s } 3
\end{align*}
\]

\( \text{Q}_2 + t (3) \) is ethyl group

\( \text{no H} \)

That \( \text{CH}_2 \) is deshielded, but not a whole list.

The 2.40 s is also deshielded

\( \text{no H} \)

\[\text{S}_2\]
7. (40 points) A compound has a mass spectrum with a molecular ion peak of 180 and an (M+2)^+ peak at 182. These are of equal intensity. It has an IR peak at 1740 cm\(^{-1}\). The \(^{13}\)C nmr spectrum has peaks at 13 \(\delta\), 22 \(\delta\), 40 \(\delta\), 62 \(\delta\), and 171 \(\delta\). The \(^1\)H nmr has peaks at 1.17 \(\delta\) (t, J=7.0, 10), 1.63 \(\delta\) (d, J=7.2, 10), 3.91 \(\delta\) (q, J=7.0, 7), and 3.79 \(\delta\) (q, J=7.2, 3.5). What is the compound? HINT: For partial credit you must give reasoning; and since you have lots of data, there is a lot of reasoning to be given.

\[
\text{mass} \quad 79 \quad \text{Br} \\
\text{24} \quad \text{C} \\
\text{28} \quad \text{C} \\
\text{40} \quad \text{Br} \\
\frac{9}{180} \quad \text{OK}!!
\]