Chemistry 140B  
Whitesell  
Winter Quarter, 2013  
Final Exam, Wednesday March 20

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Your answers to this exam are to be only your own work. You may use no written information during this test period other than the eight pages of this exam. You may not use the back of any pages for answers. You may submit your exam for regrading if and only if you have made NO marks on the exam except for a star (*) ON THIS PAGE next to the number(s) of the question(s) you would like regarded and your signature(s) and check(s) below. Exams must be turned in no later than the first week of the Spring quarter.

**your signature (read the above before signing)**

To request regrading, sign below and check the appropriate box(es).

**your signature**

I would like the questions marked with a star (*) regraded (check box at right)  
If you feel that we have made an addition error in your score, check the box at the right  
If you believe your grade was recorded incorrectly on TED, check the box at the right  

a
1a. For electrophilic, aromatic substitution, the correct order of rates of reaction for the following substituent present on the ring is:

- -CH₃ > -OH > -NO₂ > -Cl
- -OH > -CH₃ > -Cl > -NO₂

b. For electrophilic, aromatic substitution, an -SO₃H substituent on a benzene ring is:

- Activating, o,p directing
- Deactivating, o,p directing

- Activating, m directing
- Deactivating, m directing

c. For electrophilic, aromatic substitution, an ethyl substituent on a benzene ring is:

- Activating, o,p directing
- Deactivating, o,p directing

- Activating, m directing
- Deactivating, m directing

d. A hydrocarbon with two rings, one double bond and no triple bonds has a formula:

- CₙH₂ₙ₊₂
- CₙH₂ₙ⁻₂

- CₙH₂ₙ
- CₙH₂ₙ₋₄

e. The correct average bond energies for the pi and sigma bonds between carbon and oxygen in the following compounds is:

- 173
- 179
- 176
- 173

- 179
- 176
- 179

- 173

f. Select the weakest bond from the following list:

- C—O
- O—H
- O—O
- C—H

- O—O
- C—H

g. The structure of hydroxyl amine is:

- H₂NNH₂
- H₂NOH

- NH₃
- N₂
2. Show the mechanism for the following reaction. Your mechanism must include curved arrows to show the flow of electrons for all bonds made and broken. Answers outside the provided box will not receive credit.
3. Provide the expected major organic product from each of the reactions below. You must provide stereochemistry if appropriate. If a racemic mixture is formed, show only one enantiomer. If two centers of chirality are produced, show relative stereochemistry but only one enantiomer.
4. Provide the expected major organic product from each of the reactions below. You must provide stereochemistry if appropriate. If a racemic mixture is formed, show only one enantiomer. If two centers of chirality are produced, show relative stereochemistry but only one enantiomer.

\[
\begin{align*}
\text{Br} & \xrightarrow{1) \text{PPh}_3, 2) \text{n-BuLi}} \text{H} \\
\text{O} & \xrightarrow{\text{NH}_3, \text{large excess}} \\
\text{CH}_3 & \xrightarrow{\text{H}_2\text{SO}_4, \text{EtOH}, \text{-H}_2\text{O}} \\
\text{CH} & \xrightarrow{1) \text{LiCu(CH}_3)_2, 2) \text{H}_2\text{O}} \\
\text{CH} & \xrightarrow{1) \text{LiCH}_3, 2) \text{H}_2\text{O}} \\
\text{C} & \xrightarrow{\text{Zn(Hg)}, \text{HCl}} \\
\text{N} & \xrightarrow{1) \text{Sn, HCl, 2) NaOH}}
\end{align*}
\]
5. Show the mechanism for the following reaction. Your mechanism must include curved arrows showing the flow of electrons for all bonds made and broken. Answers outside the provided box will not receive credit.
6. Provided below are the proton nmr spectra of two isomeric compounds with the formula; \( \text{C}_6\text{H}_{12}\text{O} \). In the boxes provided, draw structures that are fully consistent with the spectrum for each isomer. In the same box, provide that (or those features) of the spectrum that are consistent with only the structure you provided. That is, you must explain why your proposed structure is the only one that fits the data. For the left spectrum, the area under the peaks is: 2:3:2:2:3; for the right spectrum: 4:2:3:3 (do not mistake the line at 1 in the right spectrum for a peak).

\[ \text{C}_6\text{H}_{12}\text{O}, \text{ one ring or } = \]
\[ \text{no CH-O, no OH, no } \]
\[ \text{H, therefore a ketone} \]
\[ \text{no tertiary, 2 CH}_3 \]
\[ \text{therefore no branching, thus either} \]
\[ \text{CH}_3 \text{ singlet} \]

Ditto, 2 CH\(_3\) triplets
= 2 CH\(_3\)CH\(_2\) groups
Thus
7. Provide a sequence of reactions that could be used to prepare the alcohol shown below. Provide all necessary reagents for each step. Your answer must fit entirely with the box provided.