Chemistry 140B  
Whitesell  
Winter Quarter, 2013  
Final Exam, Friday, June 14

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<th>Points</th>
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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.

________________________
your signature (read the above before signing)

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

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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  □
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 > -NO₂ > -Cl

- OH > -Cl > -CH₃ > -NO₂

b. In the average bond energy scheme the contribution of the π bond is:

- C=C 143  C=O 179

- C=C 63  C=O 93

- C=C 83  C=O 86

- C=C 93  C=O 63

c. Free radical bromination is not a generally useful reactions because:

- lack of selectivity

- both of the above

- polyhalogenation

- neither of the above

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 π and sigma bonds between carbon and oxygen in the following compounds is:

- 173

- 179

- 176

- 179

- 179

- 173

- 179

- 176

f. The correct order for reactivity toward nucleophilic acyl substitution is:

- amide < ester < anhydride < acid chloride

- ester < amide < acid chloride < anhydride

- acid chloride < anhydride < ester < amide

- anhydride < acid chloride < ester < amide

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 show the flow of electrons for all bonds made and broken. Answers outside the provided box will not receive credit.
3. Provide an example of each of the five electrophilic aromatic substitution reactions covered this quarter. Provide all necessary reagents and the product expected. Place them in increasing order of reactivity of the product toward further electrophilic aromatic substitution (that is, the least reactive product at the top, most at the bottom).
4. Select a set of reagents that will effect each of the following transformations. Enter the appropriate letter in the box over the arrow. All of the reactions have an answer. Not all of the reagents are useful combinations.

A. NaBH₄, EtOH
B. C₂H₅₋S⁻(PP₃)²⁻
C. SO₃, H₂SO₄
D. Sn, HCl
E. Cr⁶⁺, H₂O
F. H₂SO₄, Na₂SO₄
G. Na, NH₃, EtOH
H. NaOH
I. CH₃OH, H⁺⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻ Osaka - OK
J. C₂H₅₋OH, H₂S

K. SO₃, H₂SO₄
L. NaOH
M. AlCl₃
N. PCC
O. H₂SO₄, CH₃OH
P. LiAlH₄
Q. H₂SO₄
R. HCl
S. NaOH
T. O₃
U. HNO₃, H₂SO₄
V. CH₃OH, H⁺⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻⁻ Osaka - OK
W. H₂SO₄

Your signature (in ink) ____________________________
5. Provided below is the proton NMR spectrum of an unknown with the formula C₉H₁₆O. In the box provided, draw a structure that is fully consistent with the spectrum.

1 ring/double bond
OH, so no C=O,
no "=C-C", thus
1 ring

CH₂OH
must be the same, thus

CH₂CH₃

C₅H₁₀₃₀
must be (CH₂)₅
as there are no other
CH₃ groups
6. 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.

Starting from \(\text{C}_2\) or \(\text{C}_1\)
7. Using the templates provided below, provide the phasing of the p orbitals the combination of which results in the three lowest lying molecular orbitals of a pentadienyl system (five adjacent carbon atoms all of which are sp2-hybridized). They must be in the correct order with the lowest lying orbital at the bottom (continue using the phasing show for the p orbital on the left).