Chemistry 232-001 (Prof. Grossman's Section)

First Examination

February 16, 2007

Name (please PRINT LEGIBLY) _____
(last) (first)

Student ID #_____

Problem	Score	
1(a–f).	_____	/24
2.	_____	/16
3.	_____	/16
4(a–c).	_____	/20
5(a–f).	_____	/24
Total.	_____	/100

Please observe the following.

1) Write LARGE and LEGIBLY. This will help me assign partial credit.

2) READ THE INSTRUCTIONS to each question CAREFULLY before answering. Many, many points are not awarded on each exam because of the failure of students to read the instructions.

TABLE OF ATOMIC WEIGHT MULTIPLES.

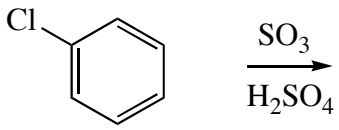
C_2	24	O_1	16
C_3	36	O_2	32
C_4	48	O_3	48
C_5	60	O_4	64
C_6	72	O_5	80
C_7	84	O_6	96
C_8	96		
C_9	108	N_1	14
C_{10}	120	N_2	28
C_{11}	132	N_3	42
C_{12}	144	N_4	56
C_{13}	156	N_5	70
$^{35}Cl_1$	35	$^{79}Br_1$	79
$^{35}Cl_2$	70	$^{79}Br_2$	158

TABLE OF IR STRETCHES IN INTERPRETABLE REGION.

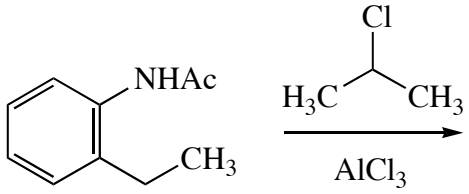
Functional Group	Absorbance
X–H region	2800–3500 cm^{-1}
O–H alcohol	about 3500 cm^{-1}, strong and broad
N–H	about 3300 cm^{-1}, strong
C–H	2850–3300 cm^{-1}, strong to moderate
C≡C–H	3300 cm^{-1}
C=C–H	3000–3100 cm^{-1}
$C(sp^3)$–H	2850–3000 cm^{-1}
O=C–H	2750 cm^{-1}
O–H carboxylic acid	2800–3500 cm^{-1}, strong and *very* broad
C(sp) region	2200–2300 cm^{-1}
C≡N	about 2250 cm^{-1}, moderate
C≡C	about 2200 cm^{-1}
R–C≡C–H	moderate
R–C≡C–R	no absorption seen
$C(sp^2)$ region	1500–1800 cm^{-1}
C=O	1670–1780 cm^{-1}, *very* strong
acyclic and 6–membered cyclic ketones	1715 cm^{-1}
3– to 5–membered cyclic ketones	1740–1780 cm^{-1}
aldehydes RCHO	1730 cm^{-1}
esters RCO_2R'	1740 cm^{-1}
amides $RCO_2NR'_2$	1670 cm^{-1}
any C=O adjacent to C=C or phenyl	subtract 20–25 cm^{-1}, sometimes more
C=C	1500–1650 cm^{-1}
(very sharp absorption; can vary from strong absorption to none.)	

1. (4 pts. each, 24 pts. total.) Draw the ***major*** product of each of the following reactions, including the stereochemistry, if appropriate. **Do not draw mechanisms!**

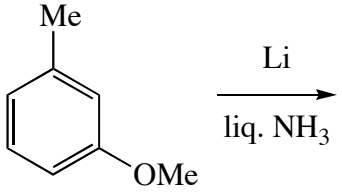
(a)



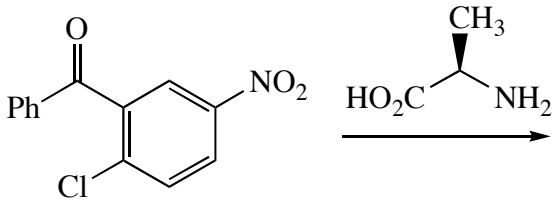
(b)



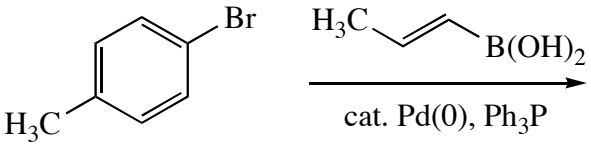
(c)



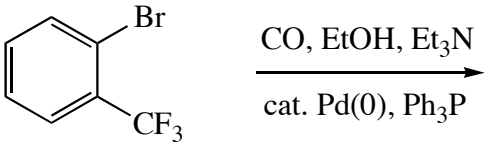
(d)



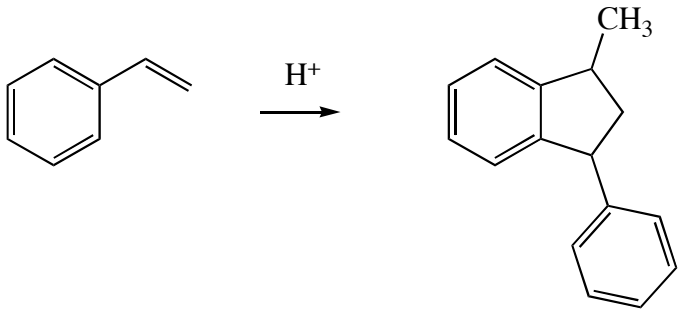
(e)



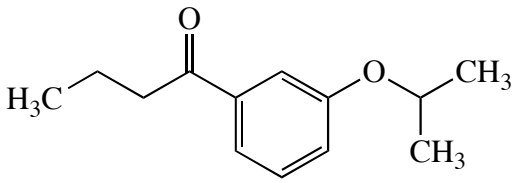
(f)



2. (16 pts.) Draw a reasonable mechanism for the following reaction. Use the conventional curved arrows to show the movement of electrons in each step. **You are strongly advised to obey Grossman's rule and to number your atoms.**



3. (16 pts.) Design a synthesis of the following compound from the given starting materials. The synthesis will require more than one step. Show each intermediate compound and all reagents you will need for each step. (Don't panic if you can't remember the reagents for a particular step; partial credit will be given.) There may be more than one correct answer. **Do not show mechanisms. You are strongly advised to do a retrosynthetic analysis before drawing the synthetic sequence in the forward direction.**



$\Longrightarrow$

benzene and any other starting materials that contain no more than four C atoms

4. (20 pts. total.) The last two pages of this exam show the MS and IR spectra of an organic compound. Answer the following questions using these spectra.

(a) (4 pts.) How many N, Cl, and Br atoms are present in this compound?

N:

Cl:

Br:

(b) (8 pts.) Based on the MS spectrum ***only***, propose ***two*** reasonable formulae for this compound, and indicate the number of degrees of unsaturation for each.

Formula 1: Degrees of unsaturation:

Formula 2: Degrees of unsaturation:

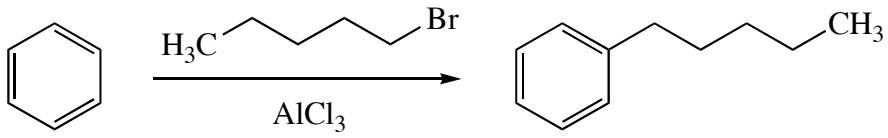
(c) (8 pts.) Draw ***two*** structures consistent with your answer to (b) ***and the IR spectrum***.

5. (4 pts. each, 16 pts. total.) Clearly explain why each of the following observations is ***WRONG***. Use one or two grammatically correct English sentences and as many structural drawings as you need. Simply rewording the assertion in the negative will not earn you any points; I want a physical or chemical explanation of why the assertion is incorrect.

(a) An alkene will always show an IR absorbance around 1600 cm^{-1}.

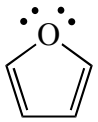
(b) If the heaviest peak in the MS of a compound weighs 101 amu, it must contain a N atom.

(c) The Friedel–Crafts reaction of 1-bromopentane with benzene (catalyzed by $AlCl_3$) will give pentylbenzene.



(d) Pd-catalyzed aromatic substitution reactions of aryl halides work because the Pd enables the nucleophile to do an S_N2 reaction on the aromatic ring.

(e) Furan has eight electrons (two π bonds and two lone pairs) in a cyclic array of p orbitals, so it is antiaromatic.



(f) F is the most electronegative element, so it acts as a meta director in electrophilic aromatic substitution reactions.