

Name: KEY

Organic Chemistry Laboratory

ID #: _____

Fall 2004

EXAM #2, Friday, December 10, 2004

Before starting:

Check your exam to make sure that it is complete. Place the initials of your name on each page. The test makes up a total of 10 pages. Problems are on the front of each sheet.

Read each question carefully, making sure that you completely answer each question. You may use the back of a sheet for additional space if needed.

Remember: Questions answered in pencil, red ink, erasable ink, or that have white-out on them cannot be regraded.

Good luck.

Question #	Possible Points	Points Scored
1	35	_____
2	34	_____
3	21	_____
4	48	_____
5	45	_____
6	42	_____
	Total:	_____

1. Use the list of functional group tests to answer questions a to e below. Place the letter that corresponds to the functional group test in the space provided (35 pts.).

a. Which test allows you to distinguish

1°, 2°, and 3° alcohols? L

b. Which test involves a discharge of the

bromine color upon exposure to an

alkene? A

c. Which test allows you to identify nitro

groups? D

d. Which test allows you to identify the

presence of a methyl ketone? N

e. Which test suggests the presence of a

carboxylic acid by the evolution of

CO₂ gas? M

A. Bromine/CCl₄ test

B. Acidity test

C. Tollens test

D. Iron(II) hydroxide test

E. 2,4-Dinitrophenylhydrazine test

F. Hydroxyl amine/ferric chloride test

G. Hinsberg test

H. Basicity test

I. Ferric chloride test

J. Bromine/water test

K. Flame test

L. Lucas test

M. Sodium bicarbonate test

N. Iodoform test

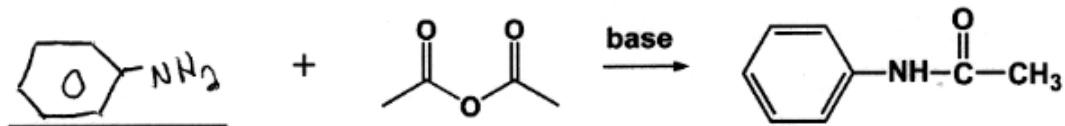
O. Silver nitrate test

P. Chromic acid test

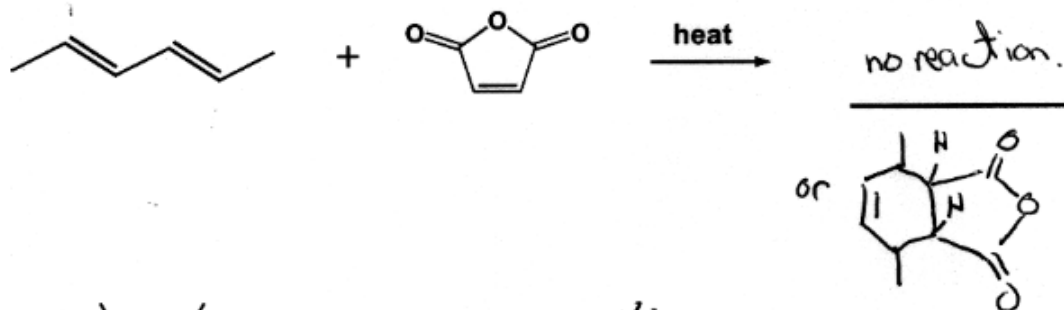
Q. Beilstein test

2. Fill in missing reagent(s) or product(s) or 'no reaction' for the following equations in the spaces provided (34 pts.).

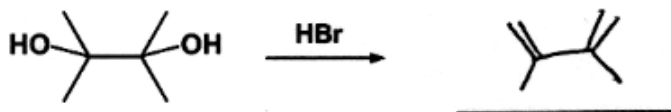
a)



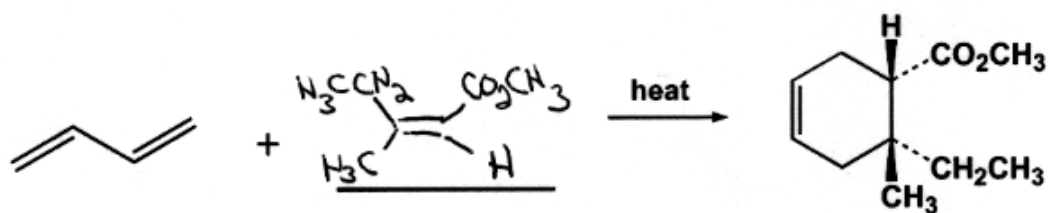
b)



c)



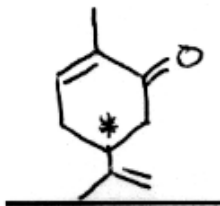
d)



3. Consider the information and answer questions a and b that follow (21 pts).

A student of organic chemistry plans to separate the two enantiomers of (\pm)-carvone from each other. The student decides to attempt to separate the two molecules by way of a fractional distillation.

a) Draw the structural formula of carvone and indicate the location of the chiral center.



b) Will the student be successful in separating the two enantiomers from each other? Explain.

No. Enantiomers possess the same boiling point.

4. Consider the information and answer questions a and b that follow (48 pts.).

An unknown compound has been found to display the following:

Solubility: soluble in NaOH (aq), soluble in HCl (aq)

Functional Groups:

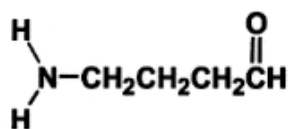
Beilstein test: a green flash upon heating a copper wire coated with the unknown

Flame test: black, sooty smoke

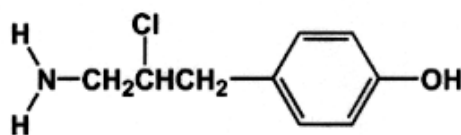
Hinsberg test: soluble in NaOH, forms precipitate upon neutralization with HCl

Ferric chloride test: gives an intense purple color

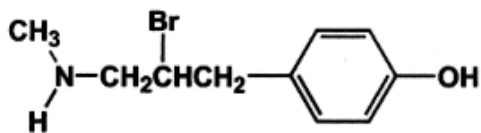
Which of the following compounds best fits the unknown? Use the following page to give your answer and your reasoning in terms of all of the information given.



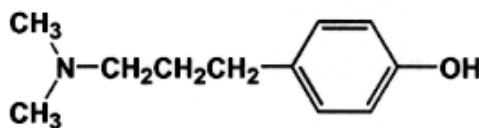
A



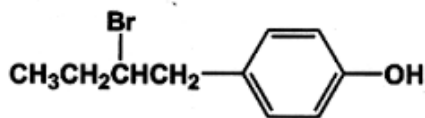
B



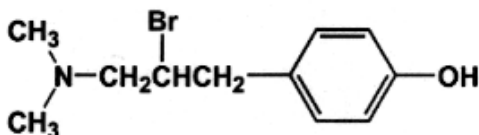
C



D



E



F

4. (cont.)

- a) The compound that best fits the unknown is Compound B.
- b) Give your reasoning for the identification of the unknown in terms of all of the information given.

Solubility

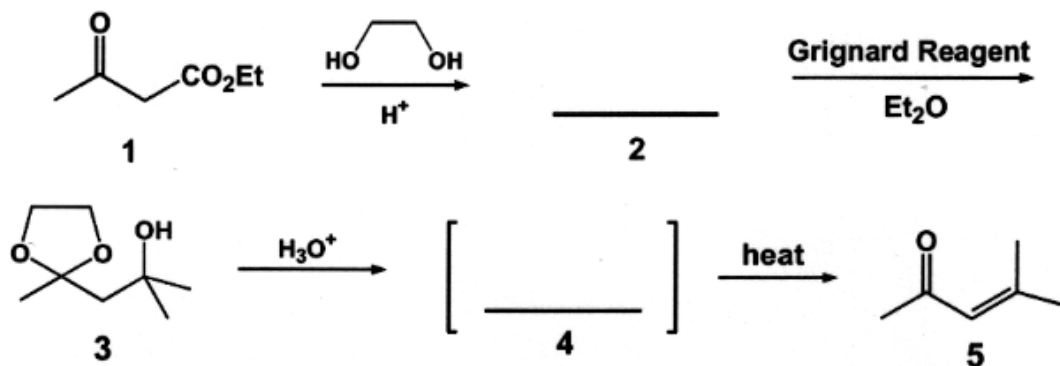
- solubility in NaOH is consistent with phenol.
- solubility in HCl is consistent with amine.

Functional Groups

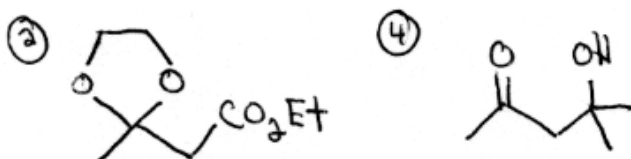
- Beilstein test is consistent with alkyl halide.
- Flame test is consistent with aromatic ring.
- Hinsberg test is consistent primary amine
 - ↳ solubility in NaOH suggests either primary or tertiary amine while precipitation upon neutralization suggests a primary amine.
- Ferric chloride test is consistent with a phenol.

5. Consider the information and answer the questions a to f that follow (45 pts.).

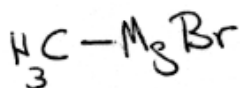
Compound 1 is transformed to compound 5 by way of a sequence of chemical transformations that involve a Grignard reaction.



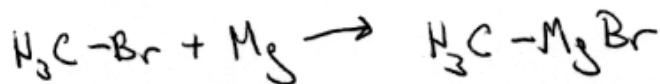
a) Draw the structures for compounds 2 and 4 above.



b) Identify the Grignard reagent used in the reaction sequence.



c) Give a reaction formula that shows how the Grignard reagent would be prepared.



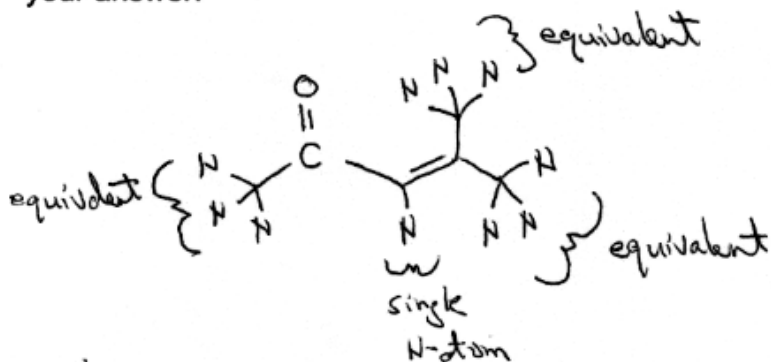
d) How many equivalents of the Grignard reagent were used to produce compound 5?

Hand-drawn answer: Two

e) Why was ethylene glycol used in the reaction sequence? Explain.

Used as a protecting group. The carbonyl group would otherwise react with the Grignard reagent.

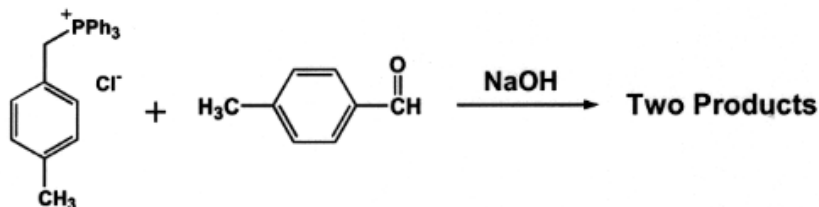
f) How many different hydrogen atoms (i.e. magnetically inequivalent protons) are in compound 5? Explain using a labeled structure drawing of the molecule to support your answer.



There are a total of four different N-atoms in compound 5,

6. Consider the information and answer questions **a** and **b** that follow (42 pts.)

A student conducted the following reaction:



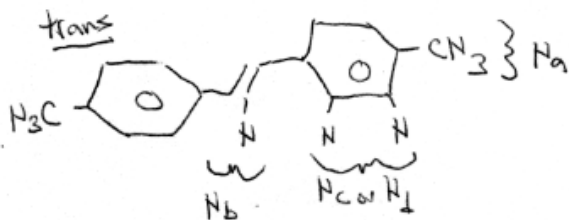
Organic products of the reaction were isolated by way of CH2Cl2/H2O extraction. The CH2Cl2 was removed using a rotary evaporator to produce a white solid. A TLC analysis of the white solid revealed that two products formed. The solid was analyzed by way of $^1\text{H NMR}$ spectroscopy and showed the following:

$^1\text{H NMR}$ data (ppm, multiplicity, relative integration): 2.1 ppm (singlet, 6H), 2.3 ppm (singlet, 3H), 6.7 ppm (singlet, 1H), 7.2 ppm (doublet, 2H), 7.3 ppm (singlet, 2H), 7.4 ppm (doublet, 2H), 7.5 ppm (doublet, 4H), 7.6 ppm (doublet, 4H)

The white solid was then dissolved in CH2Cl2. Iodine was added to the CH2Cl2 and the solution was allowed to reflux for approximately 30 minutes. The CH2Cl2 was then removed using a rotary evaporator to give a second white solid. A TLC analysis of the second solid revealed that one product was present, along with iodine. The product was separated from the iodine and was analyzed by way of $^1\text{H NMR}$ spectroscopy. The NMR spectrum of the product (same NMR solvent as above) showed the following:

$^1\text{H NMR}$ data (ppm, multiplicity, relative integration): 2.1 ppm (singlet, 6H), 7.3 ppm (singlet, 2H), 7.5 ppm (doublet, 4H), 7.6 ppm (doublet, 4H)

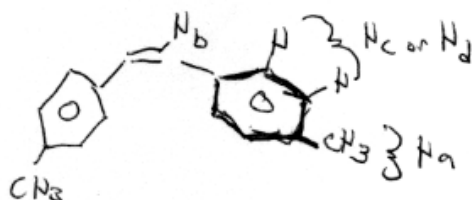
a) Use the $^1\text{H NMR}$ data above to assign structures of the two products of the original reaction. Be sure to illustrate how each piece of information supports your answer.



N_a : 2.1 ppm, singlet, 6H

N_b : 7.3 ppm, singlet, 2H

N_c or N_d : 7.5 ppm, doublet, 4H
7.6 ppm, doublet, 4H



N_a : 2.3 ppm, singlet, 3H

N_b : 6.7 ppm, singlet, 1H

N_c or N_d : 7.2 ppm, doublet, 2H
7.4 ppm, doublet, 2H

b) What was the ratio of the two products of the original reaction? Explain.

The ratio of the trans-isomer to the cis-isomer is 2:1.
This is illustrated by the integrations of all of the trans protons which are twice that of the cis protons.