Second Exam
CHEM 256 – Organic Chemistry II
Prof. Bastin
Spring 2015

Name Key _____ **Section** /

1. DO NOT START this exam until you are instructed to begin.
2. There are ELEVEN pages including this cover sheet and the IR frequency table - make sure they are all here!
3. Provide *CLEAR, CONCISE* answers using unambiquous, carefully drawn structures and mechanisms for the appropriate questions. *Be sure to read each question VERY CAREFULLY.*
4. Do not provide mechanisms for synthesis and product prediction problems.
5. You may only use a pen or pencil and the materials provided in this packet on this exam.
6. If you have papers and/or books with you, they are to be left on the floor **AT THE FRONT OF THE ROOM**. If you need scrap paper please ask.
7. Cell phones must be **OFF and placed on the table at the FRONT of the ROOM**.

1) _____/12 pts

2) _____/12 pts

3) _____/10 pts

4) _____/12 pts

Total: /100 pts

5) _____/8 pts

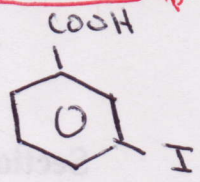
6) _____/12 pts

7) _____/10 pts

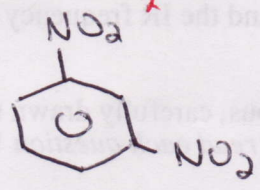
8) _____/24 pts correct 8b

1) (12 pts) Provide structures for the following compounds.

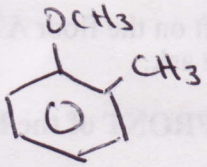
a) *m*-iodobenzoic acid



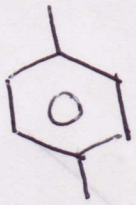
b) *m*-dinitrobenzene



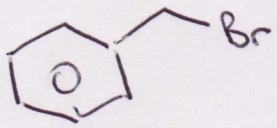
c) *o*-methylanisole



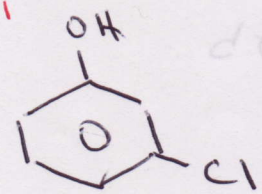
d) *p*-xylene



e) benzyl bromide

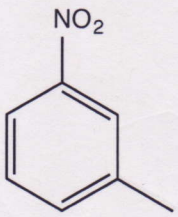


f) 3-chlorophenol



2) (12 pts) Provide either common or IUPAC names for the following compounds.

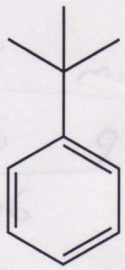
a)



m-nitrotoluene

½ ½ 1pt (½ pt spelling)

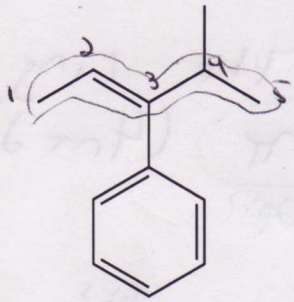
b)



t-butylbenzene

1pt ½ pt ½

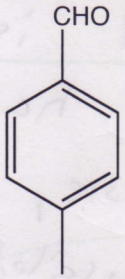
c)



(Z)-4-methyl-3-phenyl-2-pentene

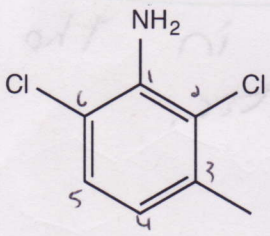
½ ½ ½ ½ order

d)



p-methylbenzaldehyde

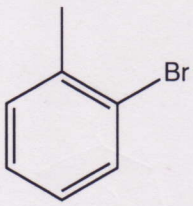
e)



2,6-dichloro-3-methylaniline

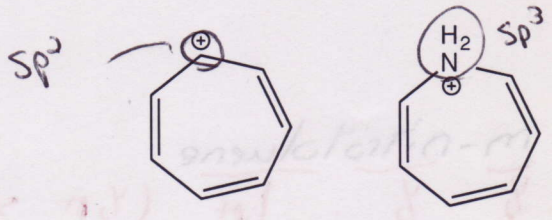
½ ½ ½ ½

f)



o-bromotoluene

3) (10 pts) The tropylium ion is aromatic. Ion X, however, is not. Explain



Tropylium ion **Ion X**

2 pts

The carbon circled in Tropylium ion is sp^2 hybridized & has a 2p orbital That is parallel to the 2p orbitals on the other six carbon atoms of the ring. Therefore, the ring is fully conjugated 2pts with 6 π (4n+2) electrons 2pts

~~Ion X~~

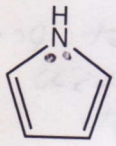
2pts

The ~~Be~~ nitrogen in Ion X is sp^3 hybridized & does NOT have an ~~SP~~ 2p orbital. ~~Be~~ Therefore, The N atom is not conjugated 2pts with the carbon atoms in the ring & Thus is non-aromatic.

4) (12 pts) Predict whether each of the following molecules would be aromatic, non-aromatic, or anti-aromatic. Explain your reasoning.

4 pts each

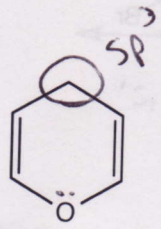
(a)



2 pts aromatic

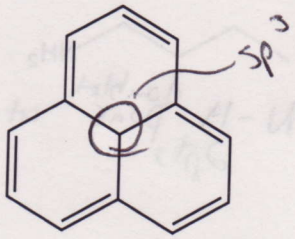
½ pt each
- cyclic
- fully conjugated
- 6 π electrons
- planar

(b)



non-aromatic
- cyclic
- 6 π electrons
- NOT planar
- NOT fully conjugated

(c)

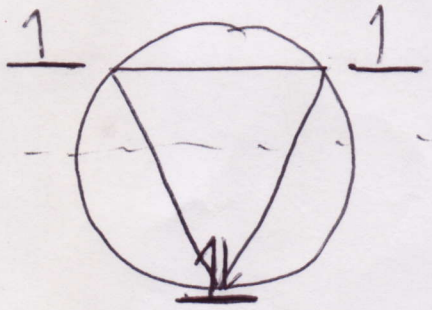


non-aromatic
- cyclic
- 12 π electrons (4n)
- NOT planar due to sp^3 in middle
- NOT fully conjugated

5) (8 pts) Using a Frost circle, draw the π MO energy diagram for the molecule below. Fill the orbitals with the appropriate number of π elections. Based on this diagram, should the molecule be aromatic or anti-aromatic? Explain.

4 π electrons

4 pts



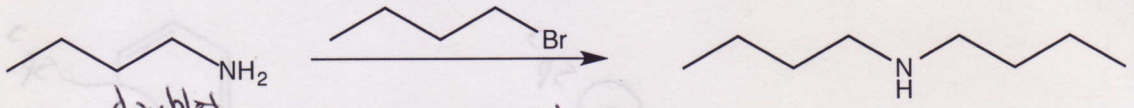
Orbitals Energies - 2 pts
electrons - # + spin - 1 pt
energy line - 1 pt

anti-aromatic 2 pts

2 pts There are electrons in the π* orbitals

6) (12 pts) What differences in the IR spectra of the reactant and product would enable you to tell that each of the following reactions took place? Be specific and give numbers. Show how IR spectroscopy can be used to distinguish between the compounds in each set. Include all distinguishing peaks.

(a)

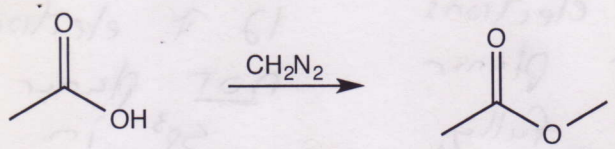


N-H doublet peak at 3100-3500 cm^{-1} 2pts

N-H singlet peak at 3100-3500 cm^{-1} 2pts

There are no other differences

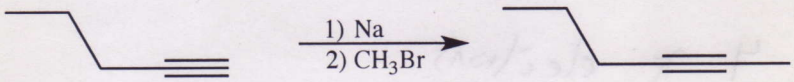
(b)



① Carbonyl at 1700-1730 cm^{-1} very broad carbonyl peak would be slightly shifted carbonyl at 1735-1750 cm^{-1}

② OH stretch at 3300-3650 cm^{-1} no OH stretch

(c)

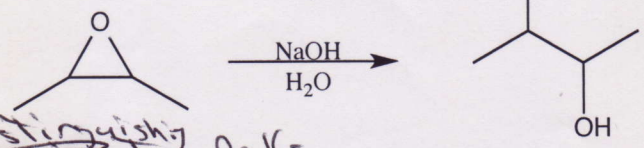


C-H alkyne stretch at 3300-3350 cm^{-1}

no C-H alkyne stretch

no other differences

(d)



no distinguishing peaks

C-O stretches at 1350-1050

also has C-O stretches

no OH stretch

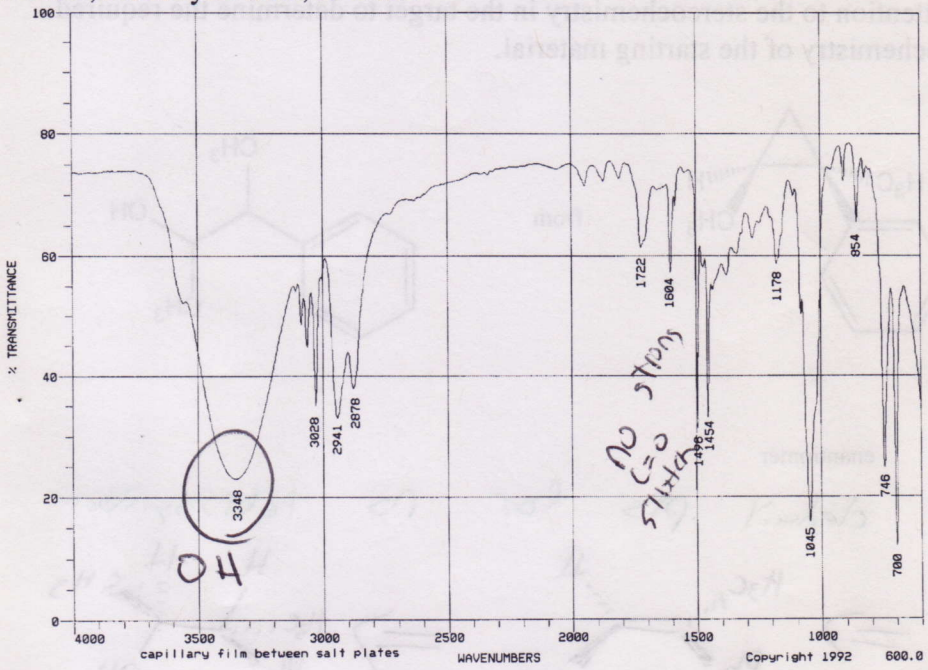
broad OH stretch at 3300-3650 cm^{-1}

5 pts each

7) (10 pts) For each of the following IR spectra (**a-b**) there is a choice of three possible types of compounds. For each spectrum, choose the most appropriate class of compound. Explain your reasoning by noting the presence or absence of characteristic bands in the spectrum.

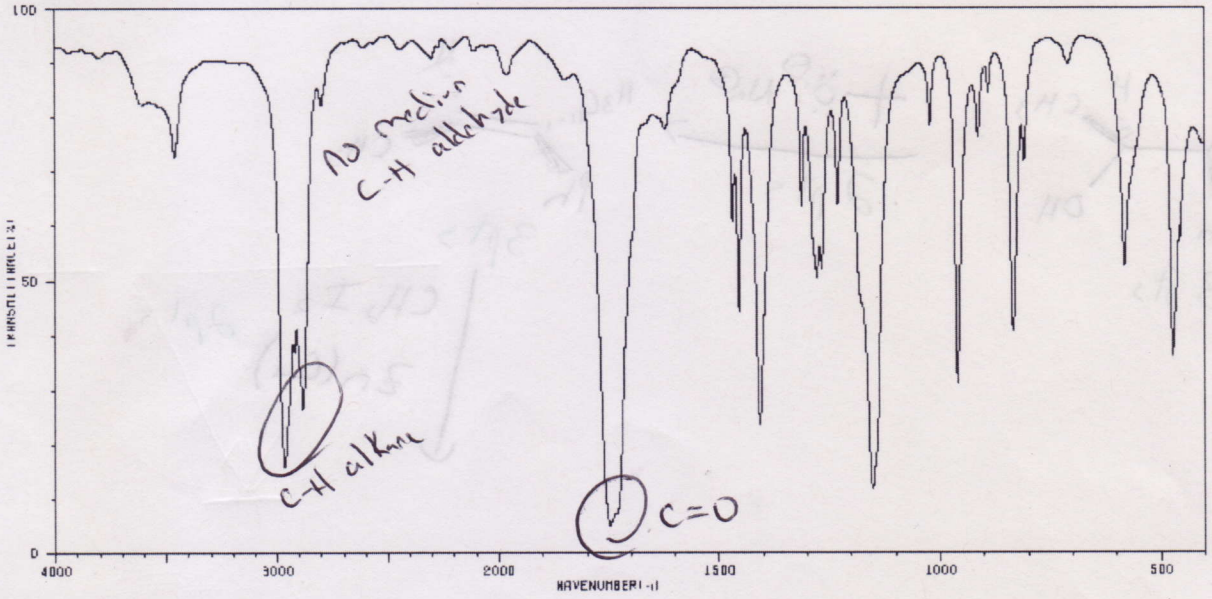
a) alcohol, carboxylic acid, or water

alcohol



b) aldehyde, ketone, or ether compound

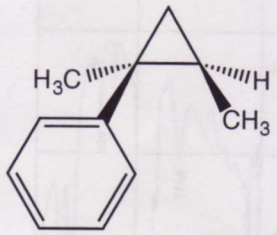
Ketone



Kurt 13.38

8) (24 pts) Devise (below and on the following blank page) a synthesis for the following transformations using any reagents that we have discussed, the indicated starting material, and any other stable organic starting materials needed. If you need more space, please use the back of this sheet and direct me there. For **FULL** credit be sure to show the retrosynthetic analysis AND the complete synthesis.

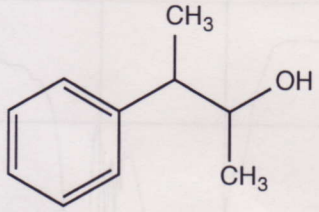
a) Pay attention to the stereochemistry in the target to determine the required stereochemistry of the starting material.



+

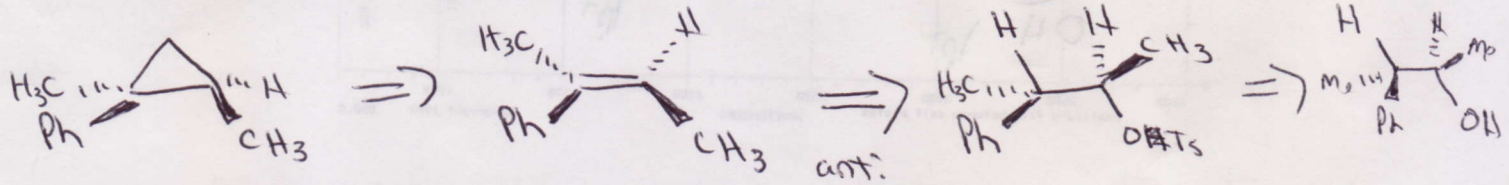
enantiomer

from

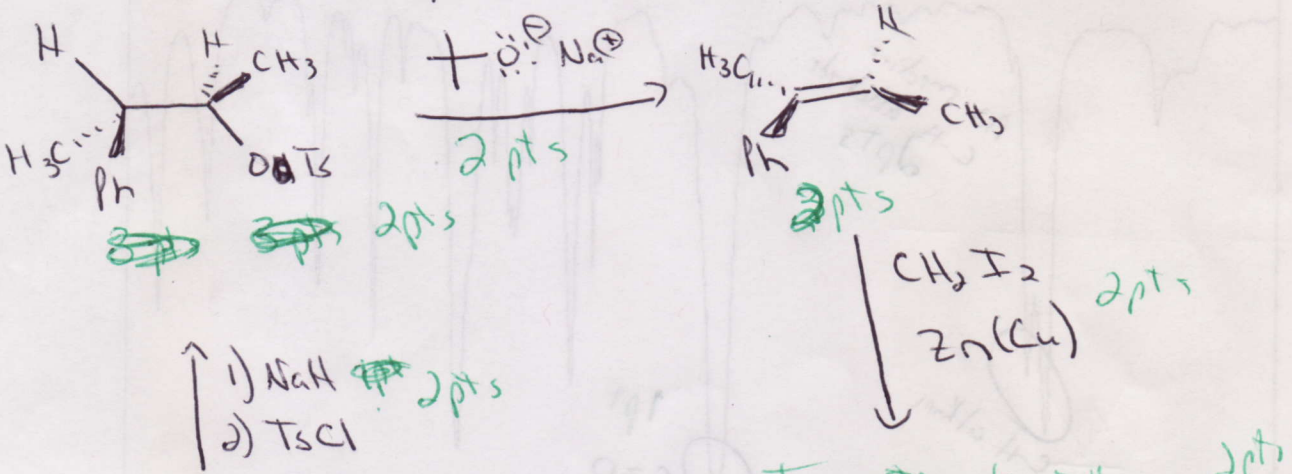


Retrosynthesis

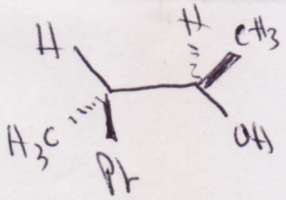
deduct pts for no retrosynthesis

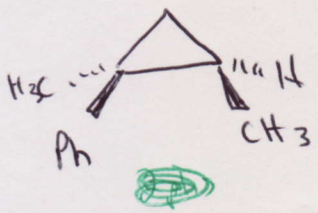


Synthesis

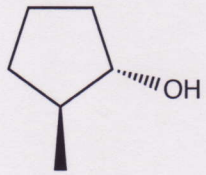


correct stereochemistry 2 pts

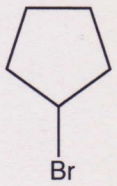




b)



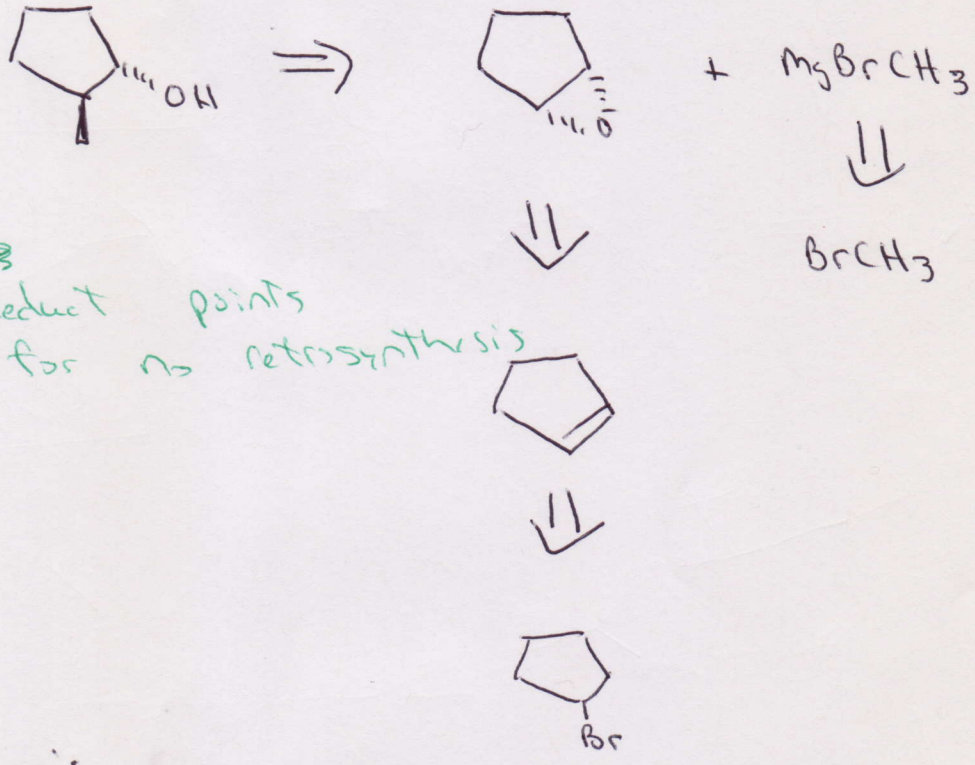
from



+

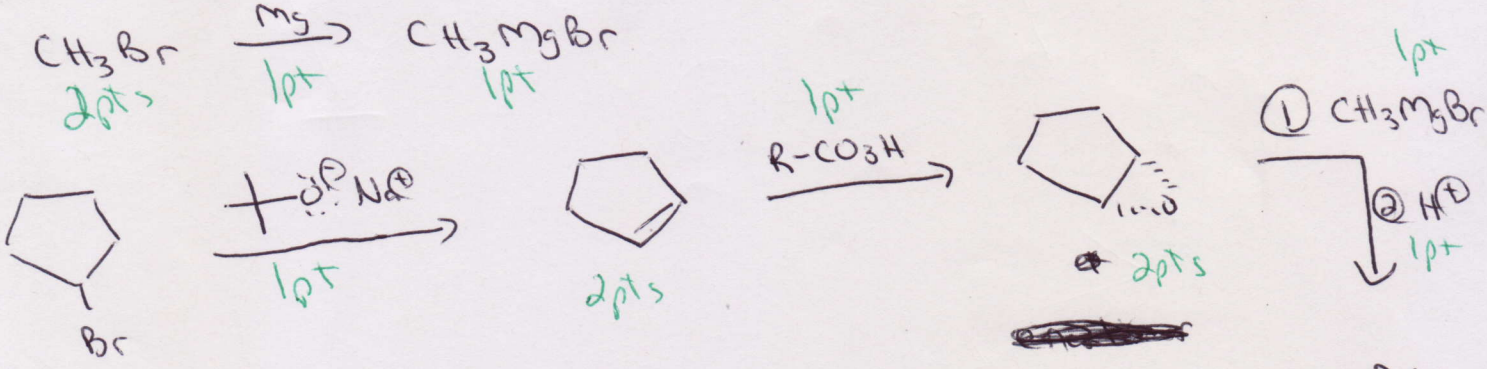
enantiomer

Retrosynthesis



~~-5~~ deduct points for no retrosynthesis

Synthesis



9 pts