CHEMISTRY 3331: Fundamentals of Organic Chemistry I
Final Exam

Prof. Randy Thummel
Prof. Ognjen Š. Miljanić

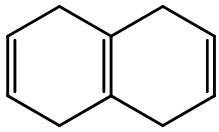
Name: _____
(print legibly) Last First

May 6, 2009

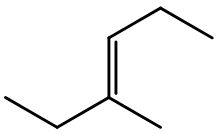
Last 4 Digits of Student ID Number: _____

Read all directions very carefully. Write your answer legibly in the designated spaces and **think** about what you are doing. Give **only one** answer for each question. Total number of points is 200.

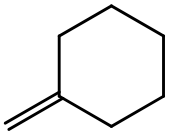
1. (60 points) For each of the following reactions or series of reactions, draw the structure of the product in the box. Be sure to clearly indicate stereochemistry where this is pertinent. Give **only one** answer for each question.



1) O_3
2) $(CH_3)_2S$



1) BH_3
2) H_2O_2 / NaOH
3) PCC



Br_2 / CCl_4

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FINAL SCORE

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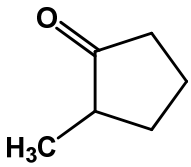
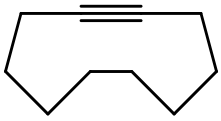


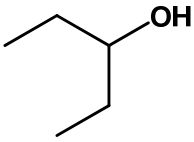
1) $NaBH_4$ / EtOH

2) H^+ / Δ

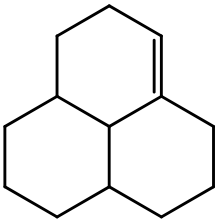


Na / NH_3 (liq)

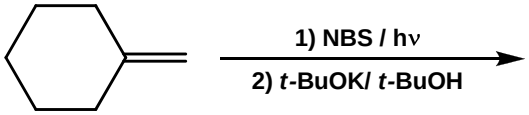
EtOH

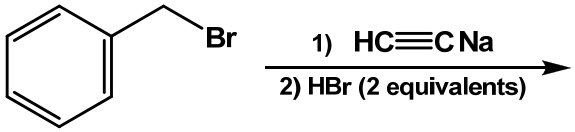


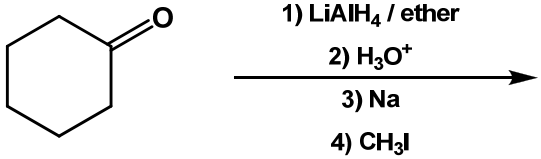
$SOCl_2$ / pyridine

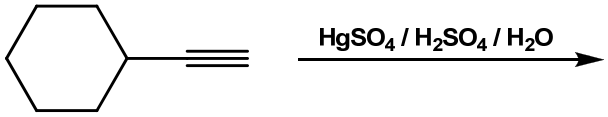


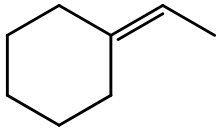
OsO_4 / H_2O_2



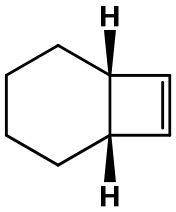






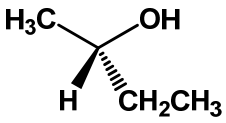


HBr / ROOR



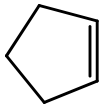
1) O_3

2) $(CH_3)_2S$



1) TsCl / pyridine

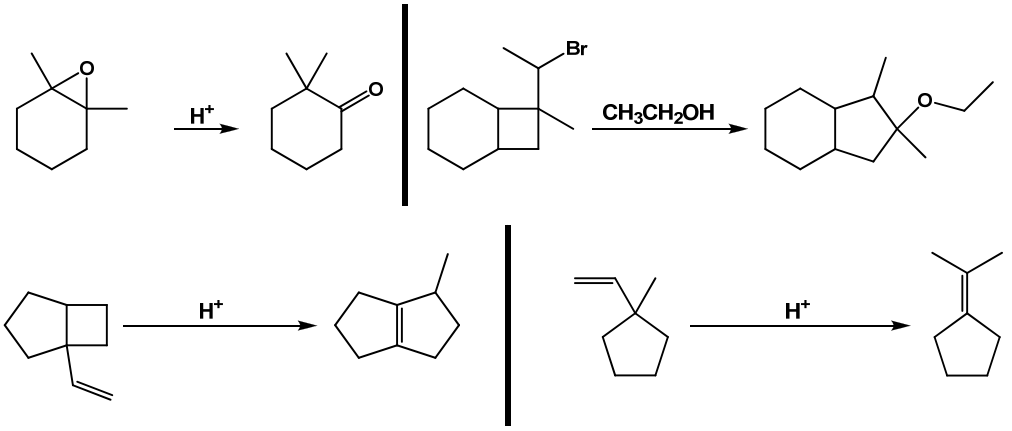
2) KCN



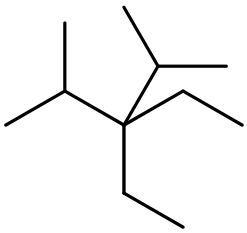
1) CH_3CO_3H

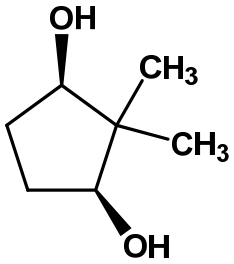
2) HBr

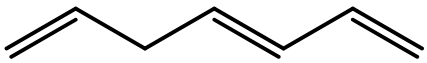
2. (24 points) **Choose only two of the four reactions given below**, and give detailed mechanisms which explain the reactions. Show all charges and intermediates, and use curved arrows to indicate the flow of electrons. Do not draw transition states.

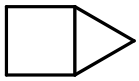


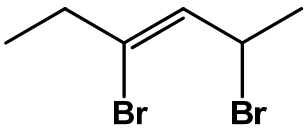
3. (24 points) For each of the following structures, give a **complete systematic IUPAC name**. Indicate the stereochemistry where needed.

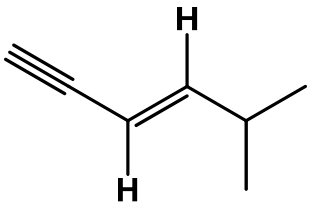




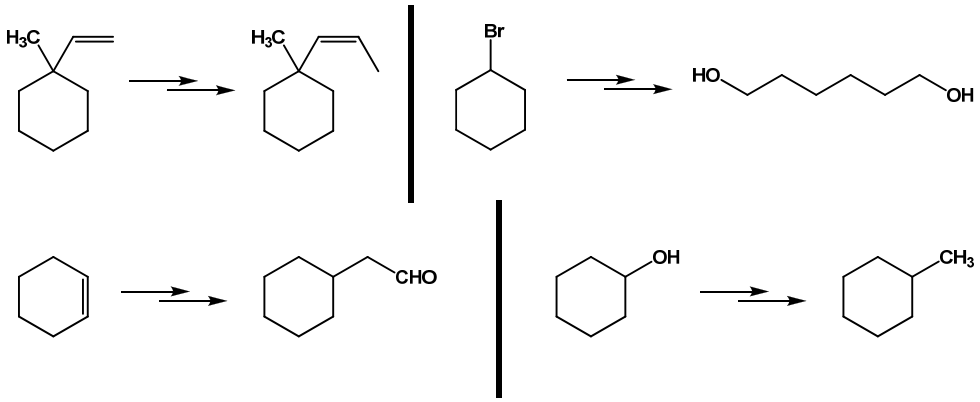




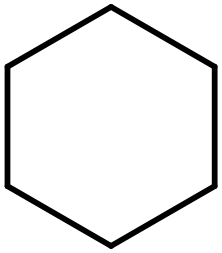




4. (24 points) **Choose only two of the four conversions given below**, and outline a series of synthetic steps which would efficiently accomplish the conversion. You may use any organic compound with two or less carbons, and any inorganic reagent. Give a step-by-step outline and **do not** give mechanisms.



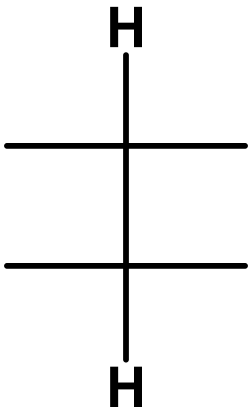
5. (12 points) Using the cyclohexane template given below, draw the structure of all-cis-1,2,4-trimethylcyclohexane.



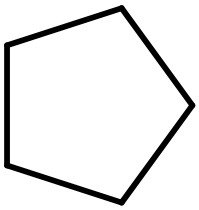
Now, draw both chair conformations for this molecule and circle the more stable one.

6. (13 points) On the skeletons given below draw the structure of:

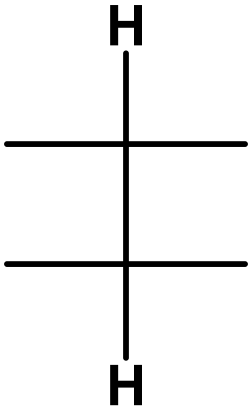
(a) (2*S*, 3*S*)-2-bromo-3-chloropentane



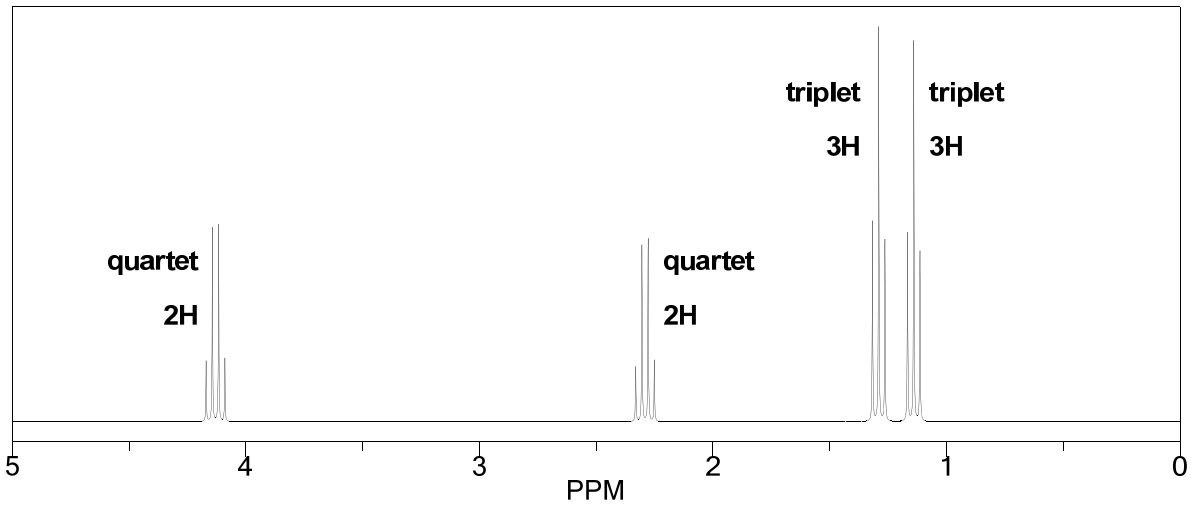
(b) (*S*)-3-ethylcyclopentene

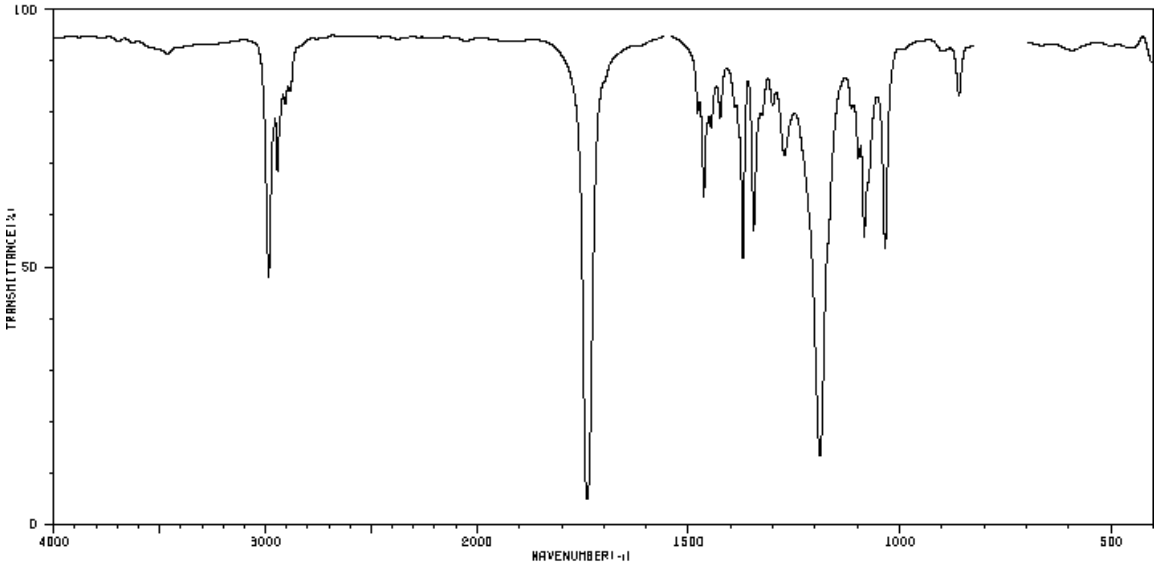


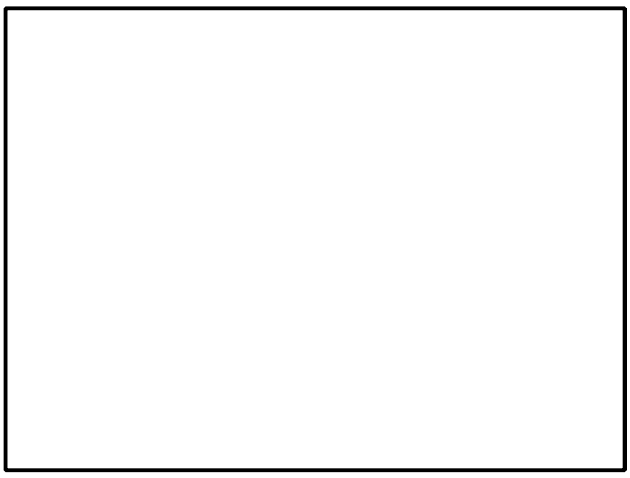
(c) *meso*-3,4-hexanediol



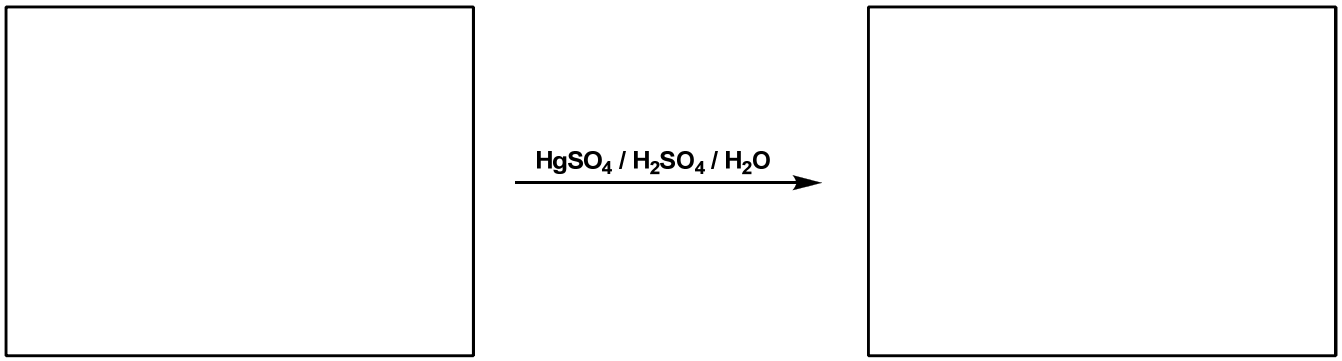
7. (15 points) A compound with a formula $C_5H_{10}O_2$ shows the following ^1H NMR and IR spectra. Propose its structure, and show your reasoning.







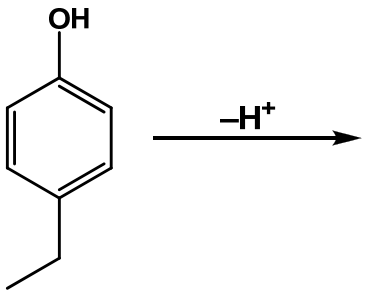
8. (16 points) A molecule **A** has the molecular formula $C_{10}H_6$ and shows two singlets in ^1H NMR spectrum at 7.45 (4H) and 2.51 (2H) ppm. It also shows an IR absorption at 2150 cm^{-1}. After treatment with aqueous $HgSO_4$ and H_2SO_4, **A** is converted to **B**, a structure with the formula $C_{10}H_{10}O_2$, which again shows two singlets in ^1H NMR at 7.36 (4H) and 2.20 (6H) ppm. This new compound shows a strong IR absorption at 1695 cm^{-1}. Based on this information, draw the structures of compounds A and B in the provided boxes, and show your reasoning.

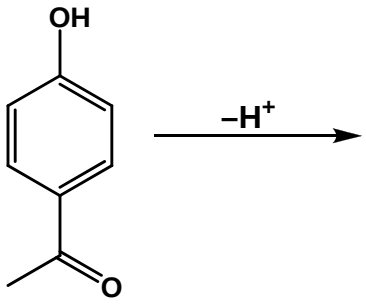


$C_{10}H_6$
7.45 (s), 4H
3.65 (s), 2H
ν_{IR} = 2150 cm^{-1}

$C_{10}H_{10}O_2$
7.36 (s), 4H
2.20 (s), 6H
ν_{IR} = 1695 cm^{-1}

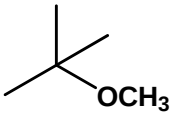
9. (12 points) Draw all the important resonance forms of the phenoxide anions which would be formed by the deprotonation of the two molecules shown below.

A 

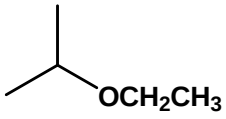
B 

Which one would show the lower pK_a value (A or B)?

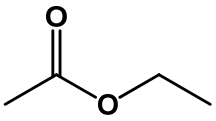
10. (9 points) EXTRA CREDIT! For each of the three pairs of molecules, indicate one (and only one!) spectral technique—IR, MS, or ^{1}H NMR—which would allow you to unambiguously distinguish the two compounds.



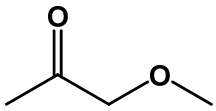
and



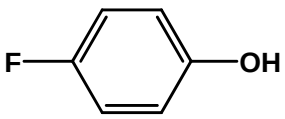
could be distinguished by



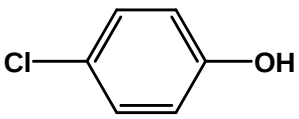
and



could be distinguished by



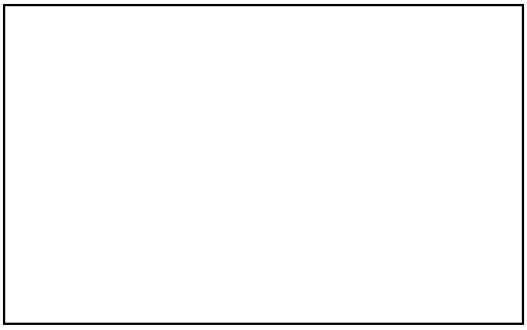
and



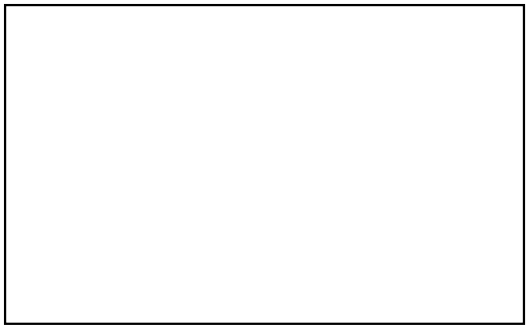
could be distinguished by

11. (10 points) EXTRA CREDIT! In a given box, provide an example of:

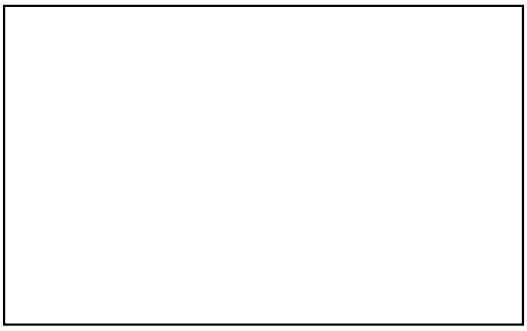
A chiral hydrocarbon with 6 carbons:



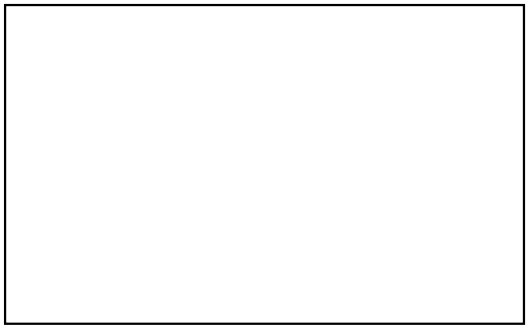
A Lewis acid containing only one atom:



An organic molecule more acidic than ethanol:



A neutral molecule with the formula C_3O_2:



The keto form of 1-hydroxycyclopentene: