Please print:

Last name:_____

First name: _____

Chem 2061 Final Exam

Fall 2005

Andy Aspaas, Instructor

Thursday, December 15, 2005

Instructions:

You may start as soon as you arrive. The exam was designed to be finished in 2 hours, but you may take up to 3 if you like. Use the included Blue Book as scratch paper. ***Do not remove any exam materials from this room!*** Doing so will void your final exam score.

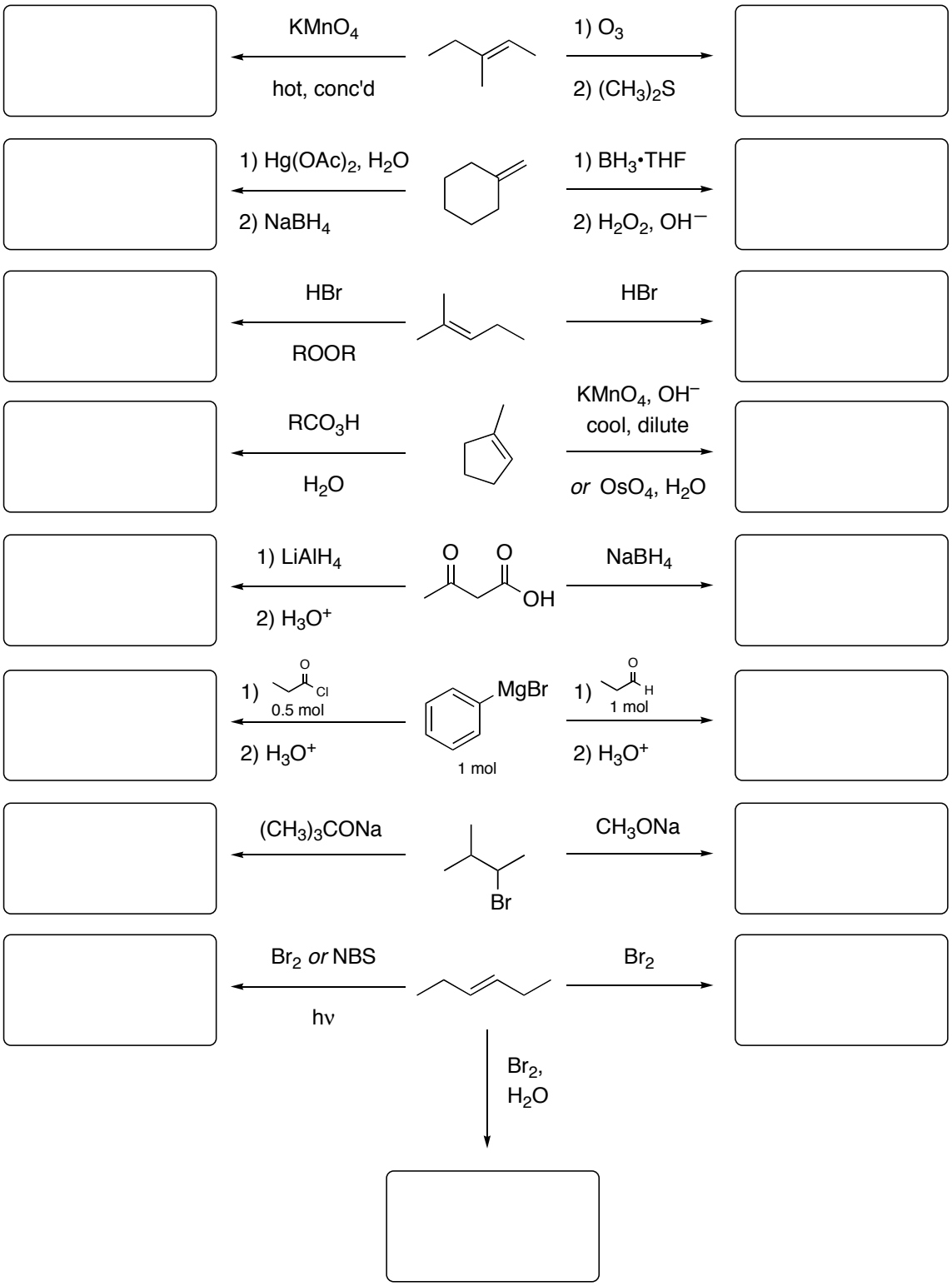
Calculators are ***not permitted*** on this exam.

You may use an organic model kit if you like.

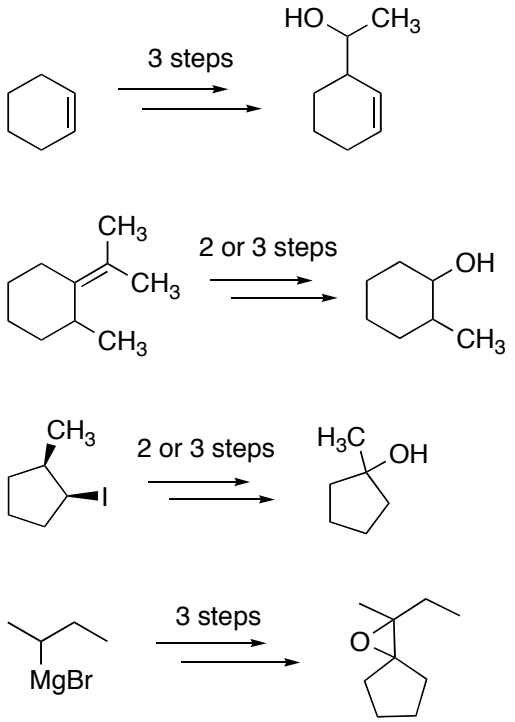
I, _____ have read and understand the directions given above, and pledge that I will follow all regulations with regard to Academic Dishonesty as outlined by this college when taking this exam.

Signature _____ Date and Time _____

1. Below are several sets of contrasting reaction conditions for a common reactant. Predict the major organic product of each reaction, being careful to show all appropriate stereochemistry (dashes and wedges) where applicable.



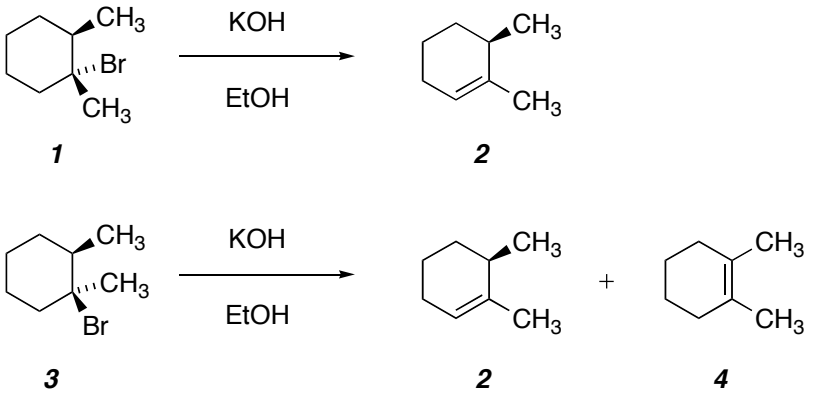
2. ***Choose only three*** of the following synthetic transformations, and show the reagents necessary to accomplish them using the suggested number of steps (not counting protonations/deprotonations). You may add any reagent or compound you like. Use this page and the next page.

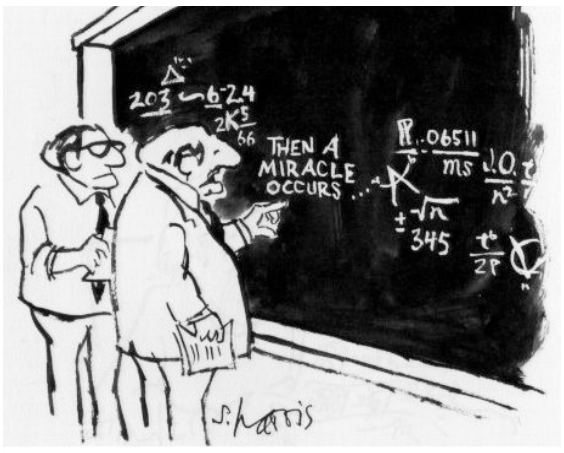


God as a kid tries to make a chicken in his room.

2. (continued)

3. Treatment of compound **1** with KOH in ethanol gave compound **2**, whereas, treatment of compound **3** under identical conditions gave both compound **2** and compound **4**. Give detailed mechanisms (with all curved arrows) to explain these results based upon the ***conformations*** of **1** and **3.**

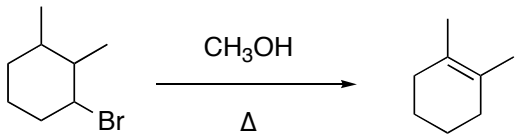




"I think you should be more explicit here in step two."

from *What's so Funny about Science?* by Sidney Harris (1977)

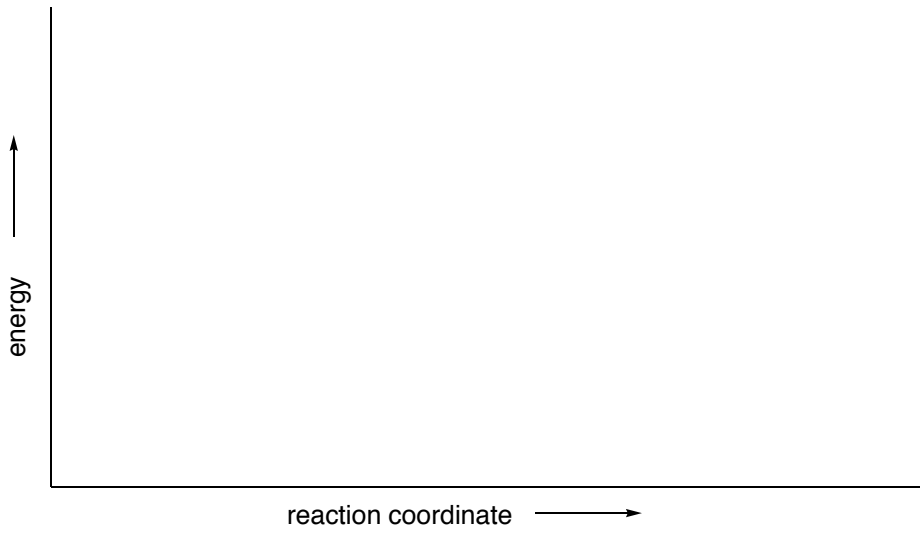
4. Consider the reaction below:



What type of reaction is this (including the kinetic order of the reaction)?

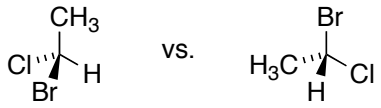
Draw a detailed mechanism (with all curved arrows) for this reaction. Label the two intermediates **A** and **B**.

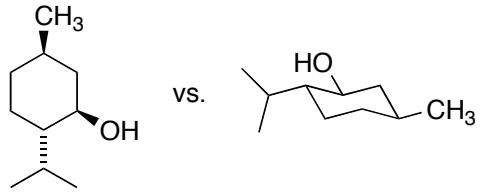
Draw a reaction energy diagram that corresponds to the above mechanism. Place the structures of the starting material, two intermediates, and product on the graph. Assume the overall reaction is exothermic and the first step is the rate-limiting step. Why is one intermediate more stable than the other?

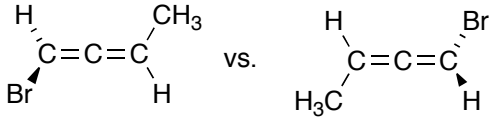


Give the structures of two additional products that are possible from these reaction conditions (minor products).

5. For the following pairs of molecules, assign the stereochemical configuration (*R* or *S*) to any unlabeled asymmetric carbons. Then, determine the stereochemical relationship between the molecules (enantiomers, diastereomers, same compound).







(2*R*, 3*S*)-2,3-dibromohexane vs. (2*R*, 3*R*)-2,3-dibromohexane

6. Draw a structure for each compound whose IUPAC name is given below, being careful to indicate the configuration of any double bond or the configuration at any asymmetric carbon.

(*Z*)-3-methyl-2-octene

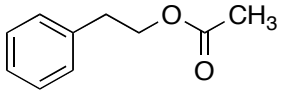
meso-2,4-pentanediol

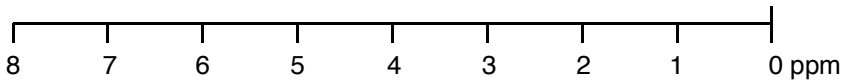
(*S*)-3-methylpent-1-en-4-yne

(3*Z*, 6*E*)-1,3,6-octatriene

(2*R*, 3*S*)-2,3-dibromohexane (as a Fischer projection)

7. Using the scale below, sketch the ^{1}H NMR spectrum for the following compound. Present the peaks with correct splitting patterns and at the approximate chemical shift (± 0.5 ppm). Just above each peak, indicate the relative integration value (e.g. "2H").





8. The IR spectrum of an unknown compound notably shows a broad peak with two spikes around 3300 cm^{-1}. What specifically does this indicate?

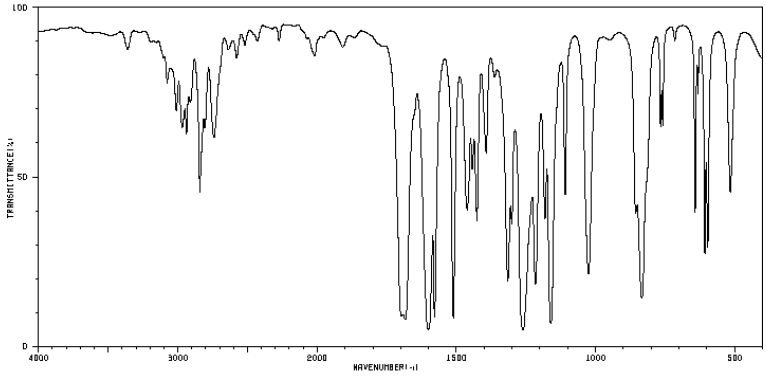
   The mass spectrum shows a molecular ion peak at 59 m/z. What specifically does this indicate (other than the molecular weight is 59 amu)?

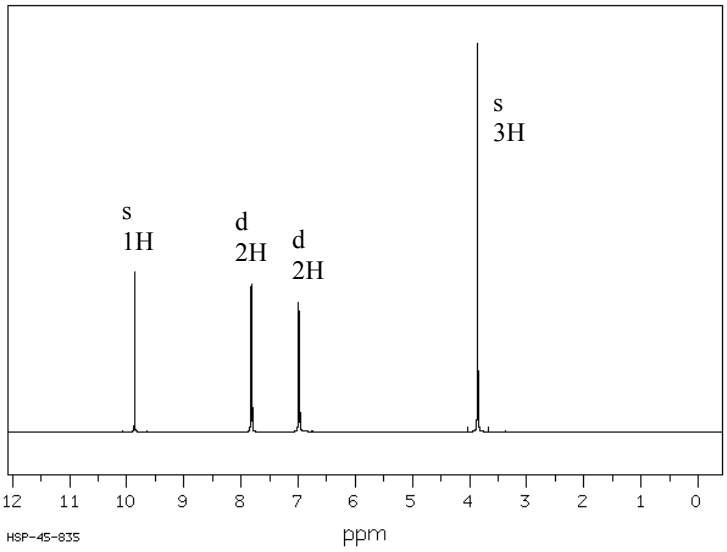
   The base peak is at 30 m/z. What is the most likely fragment that could be ***lost*** from the molecular ion to make this peak?

   Only one molecule will yield data consistent with that presented above. What is its structure?

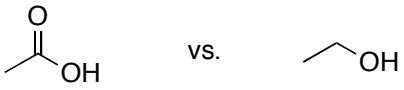
   (*6 pts extra credit*) The cation that the base peak represents has two resonance structures. Draw these structures in the proper format.

9. Draw the structure of the molecule with the formula $C_8H_8O_2$ and the following IR and NMR spectra. Assign all relevant peaks on the spectra. Show all your work. *(20 pts)*

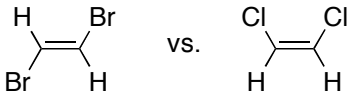




10. Circle the compound which is more acidic, and briefly explain why.



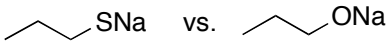
Circle the compound with the higher boiling point, and briefly explain why.



Circle the compound which is more basic, and briefly explain why.

$NaNH_2$ vs. CH_3Li

Circle the compound which is more nucleophilic, and briefly explain why.



IR Stretching frequencies (cm^{-1})

3300 alcohol O–H (broad)
amine N–H (broad with spikes)
alkyne sp^3 C–H

3000 alkene sp^2 C–H (just above 3000)
alkane sp^3 C–H (just below 3000)
aldehyde C–H (two peaks: 2700, 2800)
acid O–H (broad)

2200 nitrile C≡N (just above 2200)
alkyne C≡C (just below 2200)

1710 carbonyl C=O (esters higher, conjugated and amides lower)

1660 alkene C=C (conjugated lower, aromatic lower yet

NMR Chemical Shifts (ppm)