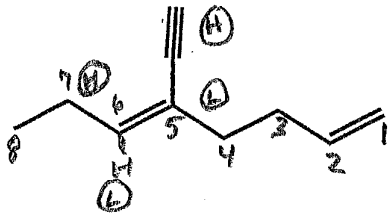
Final Exam Fall 2023

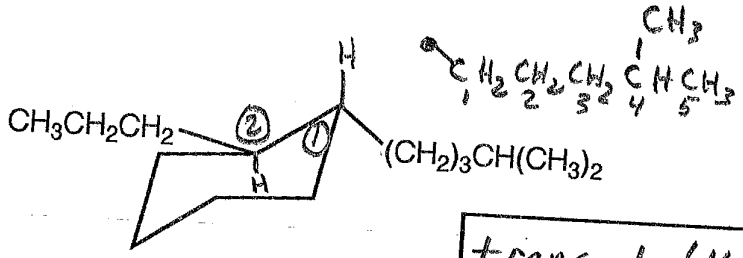
A. Nomenclature: (9 points)
Give an acceptable IUPAC name for each compound. Be sure to indicate the **stereochemistry** where appropriate.

1.



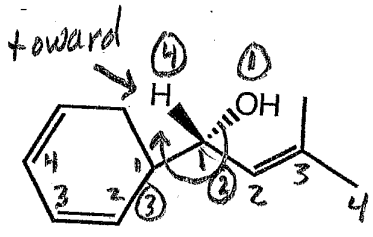
(Z)-5-ethynyl-1,5-octadiene OR

2.



trans-1-(4-methylpentyl)-2-propylcyclohexane

3.



(S)-1-(2,4-cyclohexadienyl)-3-methyl-2-buten-1-ol OR

B. Facts: 27 points

1. Compare the reaction rates of reaction **a)** and reaction **b)**, and place the letter of the faster reaction the box. If both have the same rate, put **S** in the box. (2 pts.)

a) $(CH_3)_3CBr \xrightarrow{H_2O} (CH_3)_3COH$

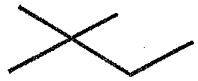
3° → S_N1

b) $(CH_3)_3CBr \xrightarrow{\ominus OH} (CH_3)_3COH$

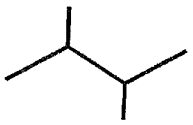
3° cannot react by S_N2

[S]

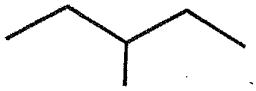
2. Place the compounds in order of increasing melting point. (1=lowest, 3=highest) (3 pts.)



[3]



[2]



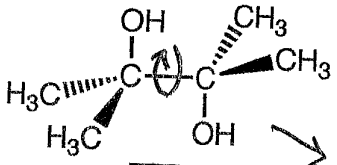
[1]

greater branchi
higher mp

3. If a compound below will undergo periodic acid cleavage, place a Y in the box. If it will not, put N in the box. (2 pts.)

← cannot rotate to syn

[N]



[Y]

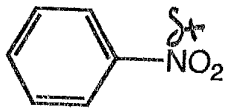
must be syn for reaction

can rotate to syn

4. If a compound below will react with a Grignard reagent, place a Y in the box. If it will not, put N in the box. (2 pts.)

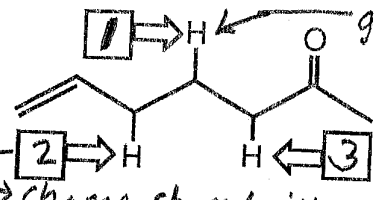
[Y]

acidic



[Y]

5. Place the indicated hydrogen atoms in order of increasing acidity. (1=least, 3=most) (3 pts.)

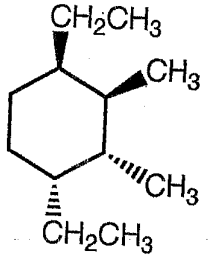


gives anion with no resonance stab.

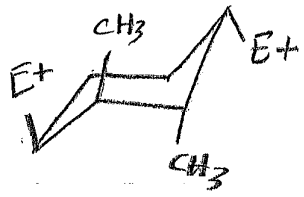
gives res. stabilized anion → charge shared with carbon

gives resonance stabilized anion → ⊖ charge shared with oxygen

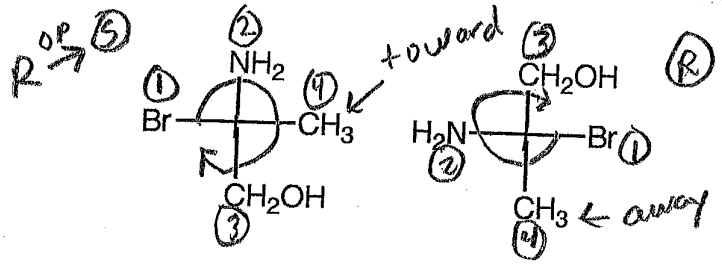
6. Consider the substituted cyclohexane below. In the more stable chair conformation, how many methyl groups are in **equatorial** positions? (2 pts.)



Answer: [0]

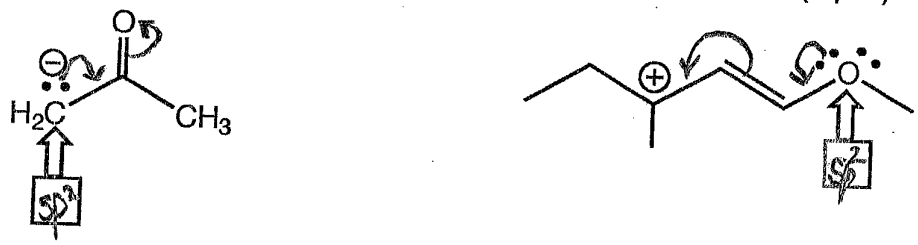


7. Label the following pair as identical, structural isomers, enantiomers or diastereomers. (2 pts.)

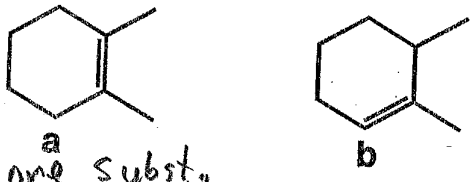


enantiomers

8. In the boxes, provide the hybridization of the indicated atoms. (2 pts.)



9. Which compound has the higher heat of hydrogenation, **a** or **b**? (2 pts.)



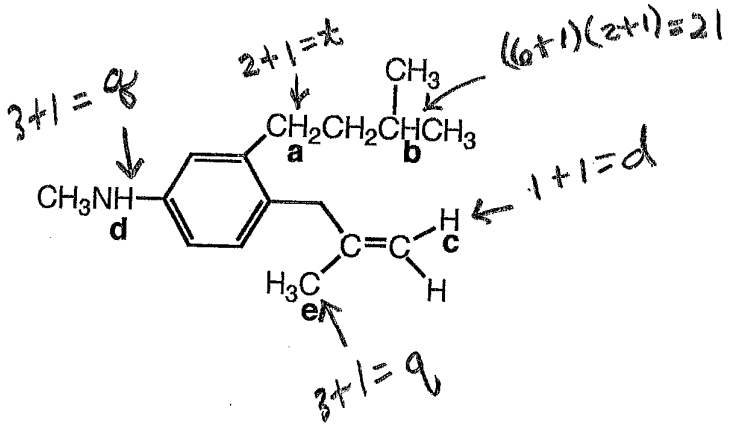
Answer: b

more subst
more stable

10. Which anion is more stable, **a** or **b**? (2 pts.)

Answer: b

11. Answer the following questions for the molecule shown below and place the answers in the appropriate boxes. (i) What are the theoretically predicted multiplicities (splitting patterns) of the signals for the protons labeled **a**, **b**, and **c**? (ii) Under ultrapure conditions, what is the theoretically predicted multiplicity of the signal for the proton labeled **d**? (iii) What is the theoretically predicted multiplicity of the signal for the carbon atom labeled **e** in the proton spin coupled C -13 NMR? (5 pts.)



(i) multiplicity of H_a t or 3

multiplicity of H_b 21

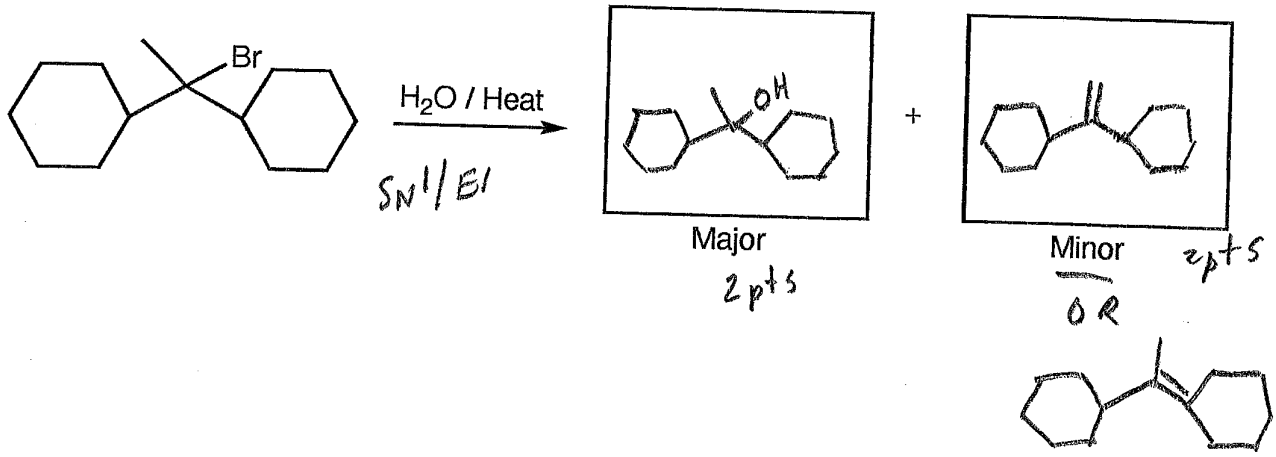
multiplicity of H_c d or 2

(ii) multiplicity of H_d q or 4

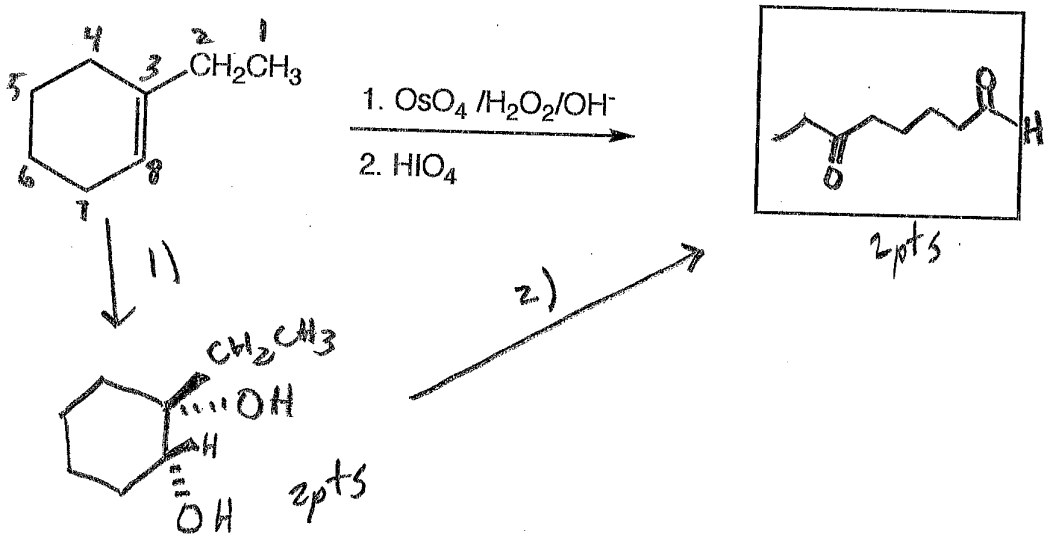
(iii) multiplicity of C_e q or 4

C. Reactions: Total = 36 points, 4 points each
Please provide the major product in the answer box unless otherwise indicated. Indicate **stereochemistry** if applicable. **Full credit is awarded only when the product of each step in a multi-step reaction is shown below the reaction.**

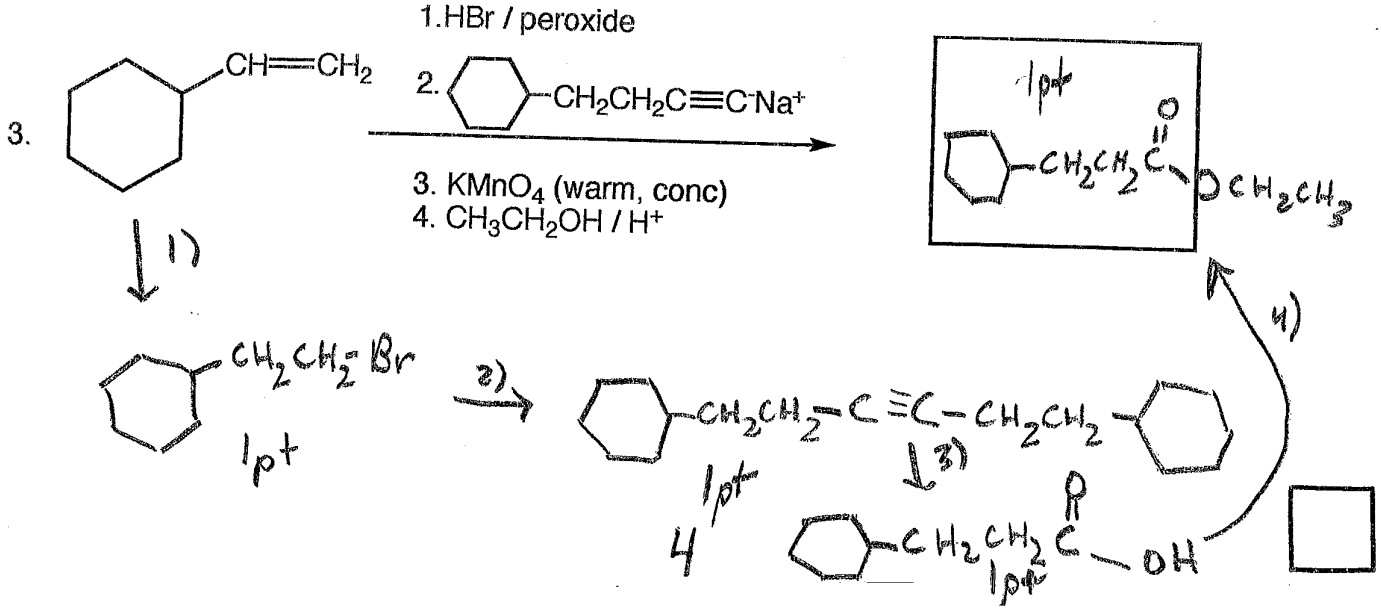
1.

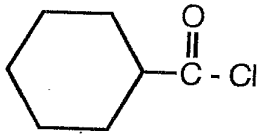


2.

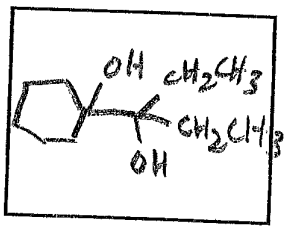


3.



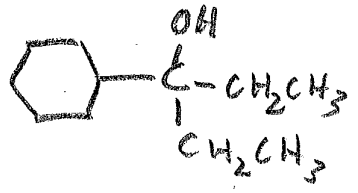
4. 

1. CH_3CH_2MgBr (2 eq) then H_3O^+
2. H_2SO_4 / Heat
3. $CH_3C(=O)-OOH$ / H_3O^+



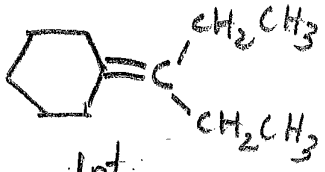
2pts

1)



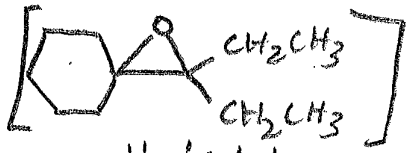
1pt

2)



1pt

3)



can't isolate

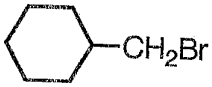
ring opens in H_3O^+

5. $CH_3-CH=CH_2$

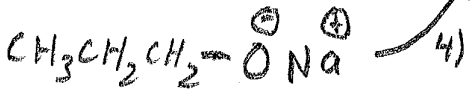
1)
2)

$CH_3CH_2CH_2-OH$

1pt

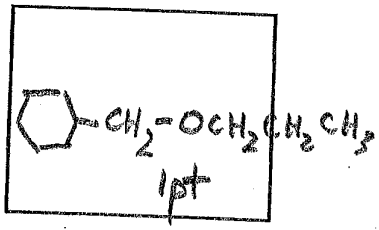
1. BH_3 - THF
2. H_2O_2 / OH-
3. Na°
4. 

3)

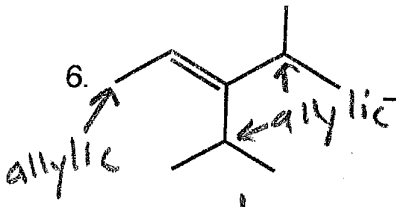


2pts

4)



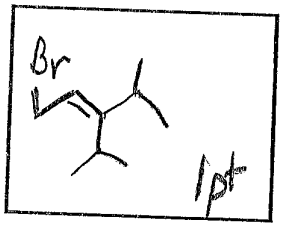
1pt

6. 

allylic

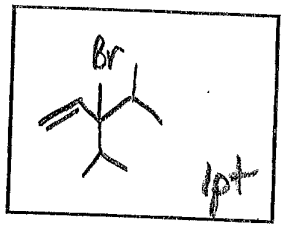
allylic

NBS / Light



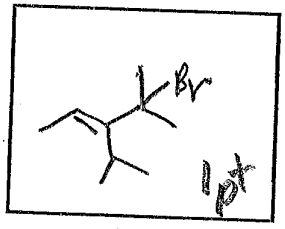
1pt

+



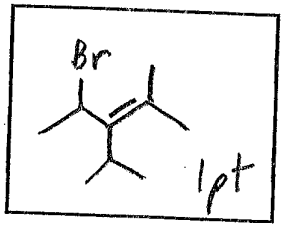
1pt

+



1pt

+



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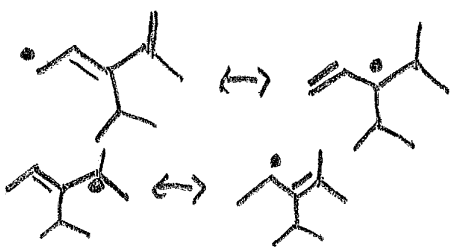
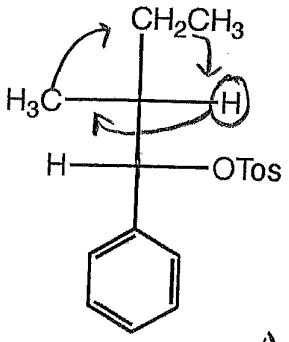
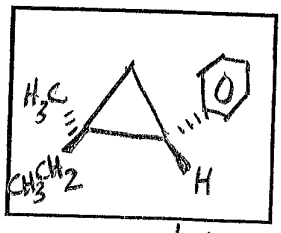


7.



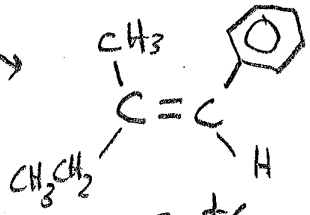
1. $NaNH_2$ ← strong base, E2 → anti

2. CH_2N_2 / Heat → $:CH_2$



2pts

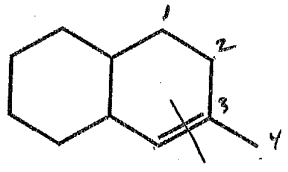
1)



2pts

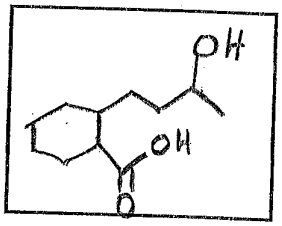
2)

8.



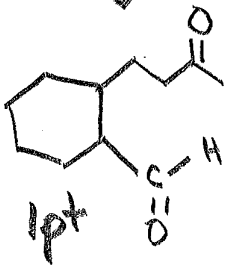
1. O_3

2. $(CH_3)_2S$
3. $Na_2Cr_2O_7$ / H_2SO_4 / H_2O
4. $NaBH_4$ / CH_3CH_2OH



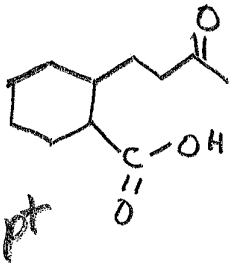
2pts

1)
2)



1pt

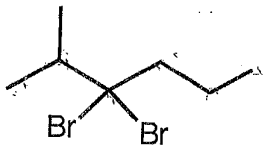
3)



1pt

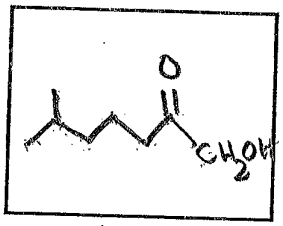
4)

9.



1. $NaNH_2$ / 150°C

2. H-C(=O)-H then H_3O^+
3. $HgSO_4$ / H_2SO_4 / H_2O



1pt

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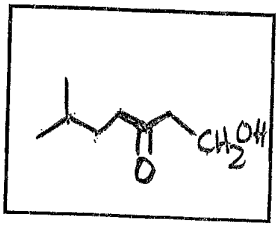
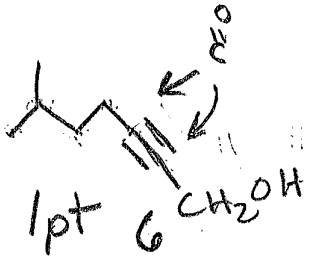


1pt

1)

1pt

2)



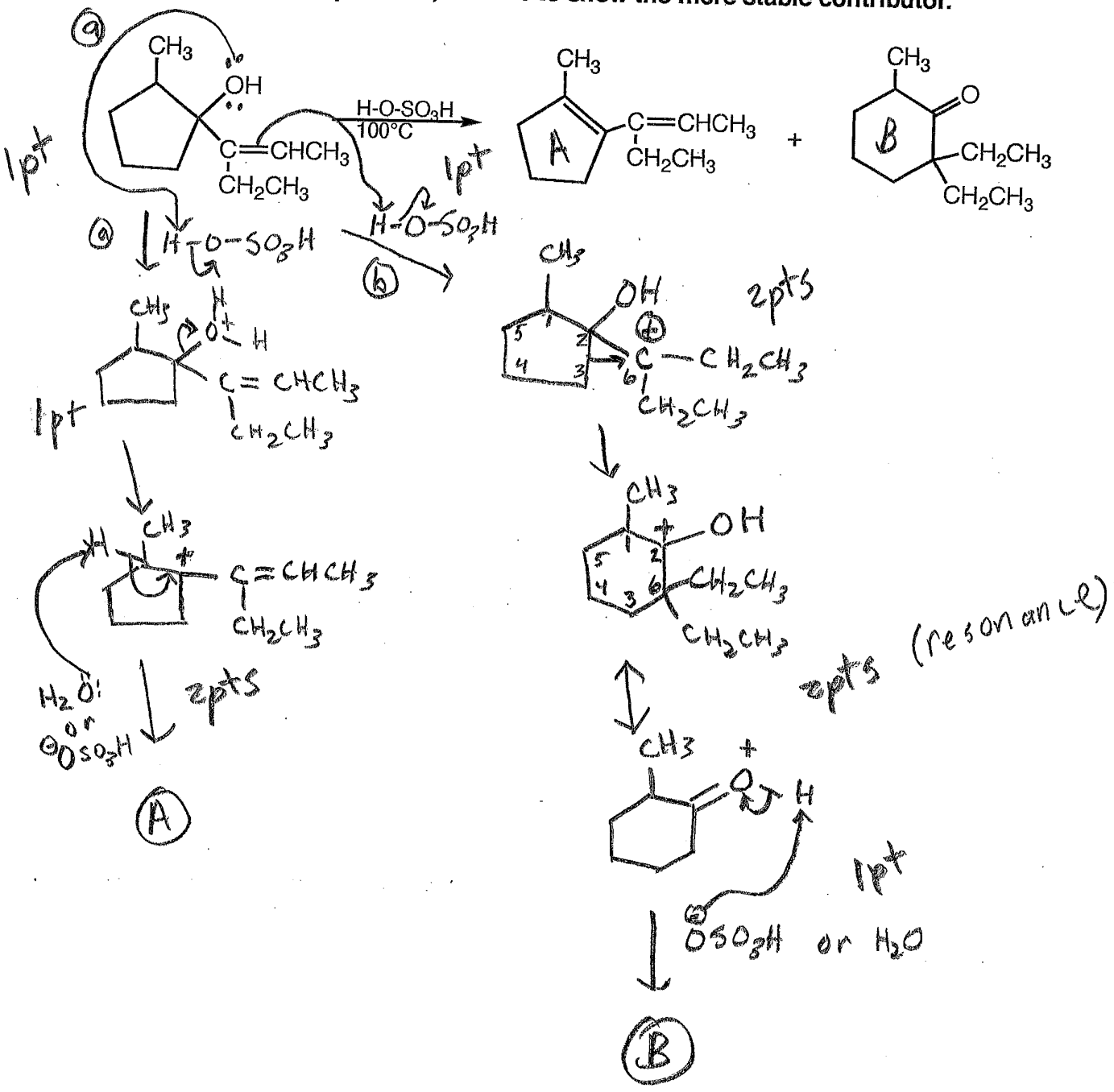
1pt

3)

6

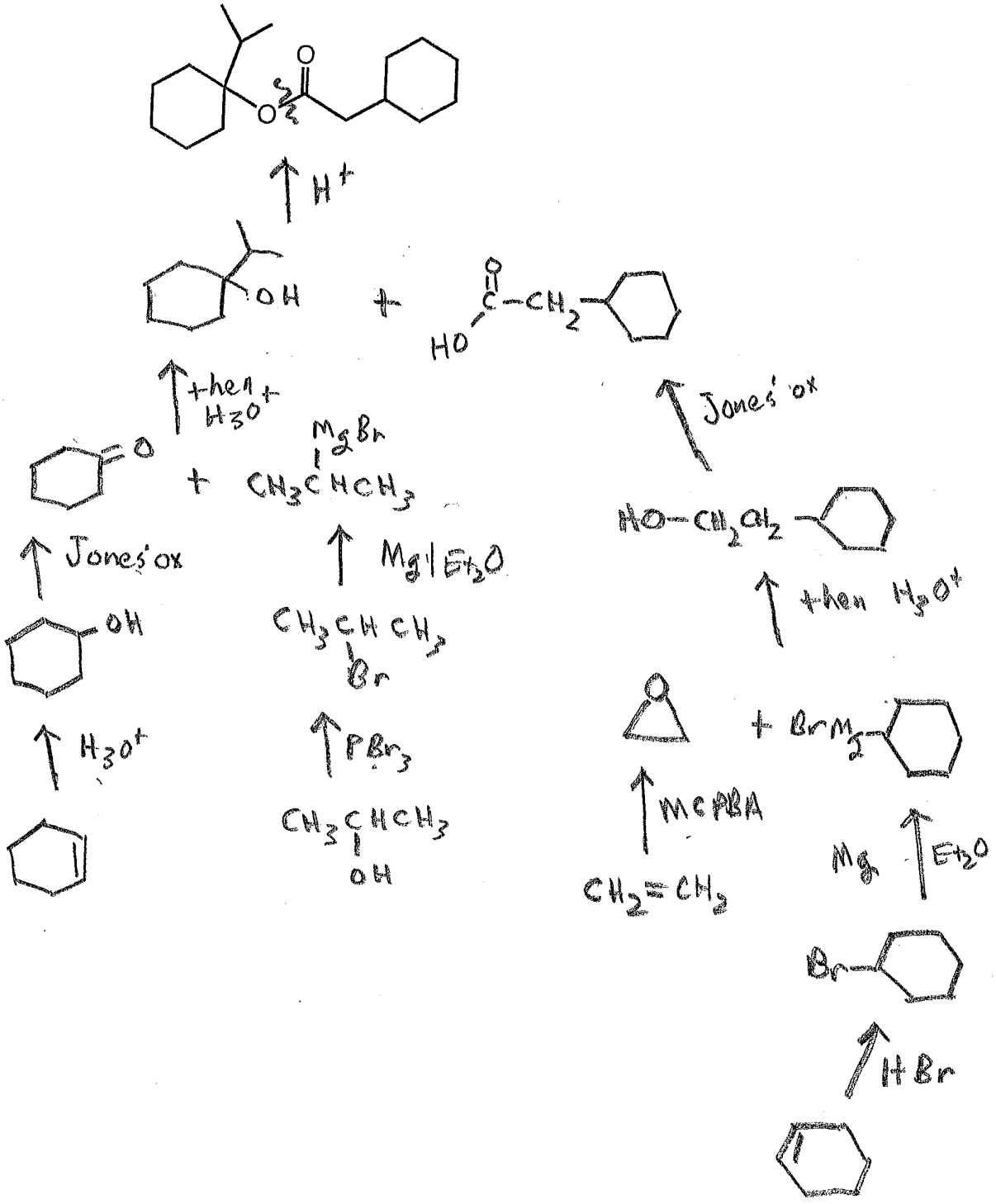
D. Mechanisms: (10 points)

The reaction below produces a mixture of products. Provide a clear mechanism to explain the formation of the products shown. Use curved arrows to indicate "electron flow". Remember to show only one step at a time. Show all intermediates and all formal charges. **If more than one resonance contributor is possible, be sure to show the more stable contributor.**



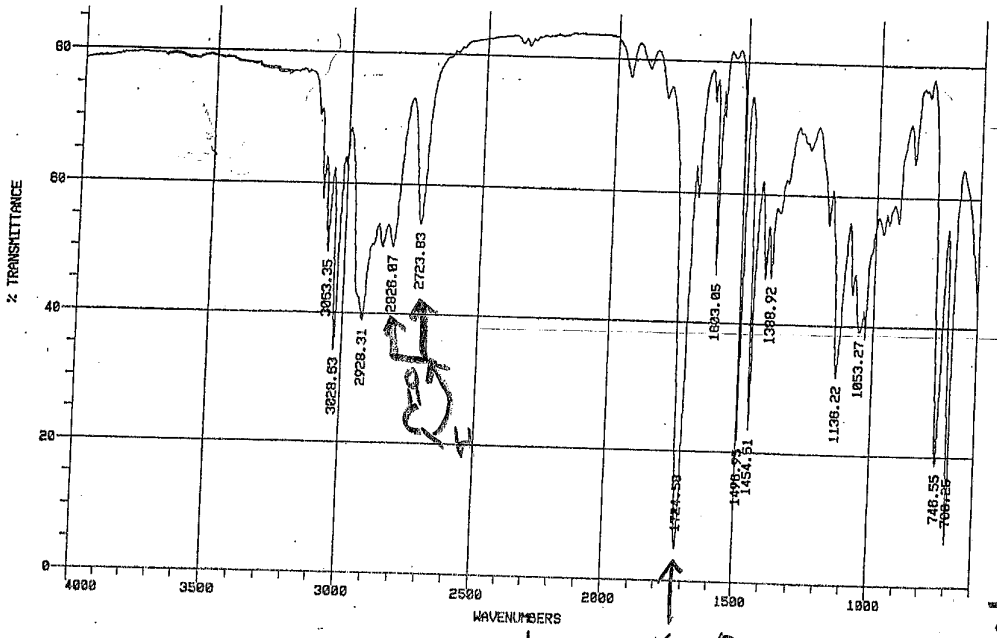
E. Synthesis: 10 Points

Synthesize the molecule below using any of the following reagents: cyclohexene, **alcohols** or **alkenes** of **three carbons or less**, any inorganic reagents, and any oxidizing or reducing agents.

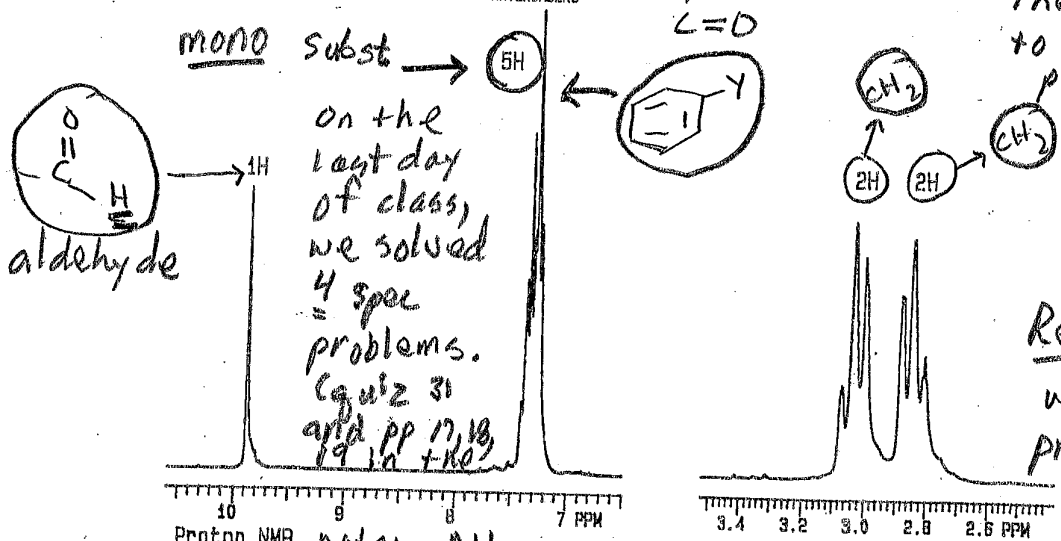


F. Spectroscopy: 8 Points

A compound with the formula $C_9H_{10}O$ exhibits the IR, ^1H NMR, and proton-spin decoupled ^{13}C NMR spectra shown below. Please identify this compound and draw the structure in the box provided below.



The key to this puzzle is the peak at 7.3δ. This clearly indicates a mono substituted benzene ring. The only way to put the pieces together is the structure in the box.



on the last day of class, we solved 4 spec problems. (quiz 31 and pp 17,18, 19 in the notes. All of them were monosubstited benzene rings.

Remember, we can predict a signal's multiplicity, but in this case the coupling constant (J) is very small for the aldehyde H.