

First Hour Exam

By printing your name below, you pledge that

"On my honor, as a University of Colorado at Boulder student,
I have neither given nor received unauthorized assistance on this work."

Name ANDY PHILLIPS

Recitation TA's Name: _____

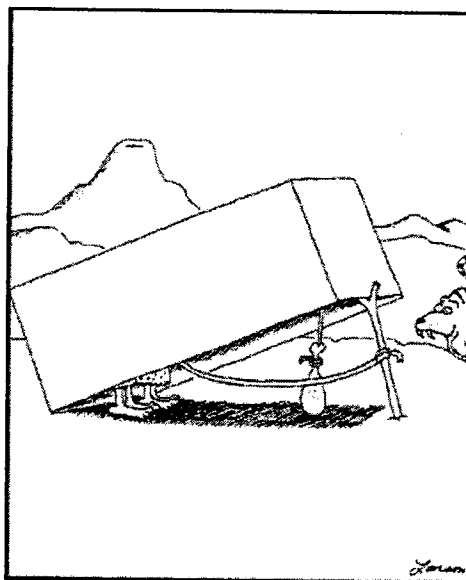
Recitation Day and Time: _____

Points:

Problem #	Max. Points	Your Score
1	20	KEY
2	10	
3	20	
4	20	
5	18	
6	12	
		_____ TOTAL

General Instructions:

- You have 2 hours to complete the exam
- Please write your name on the top of each page
- Use the back of pages for scratch paper
- Don't cheat!



"Shhhh, Zog! ... Here come one now!"

Question # 1

20 pts total

These questions are worth a lot of points so please be careful!

Hint I have not gone out of my way to try and trick you, so don't try and second-guess yourself out of correct answers!

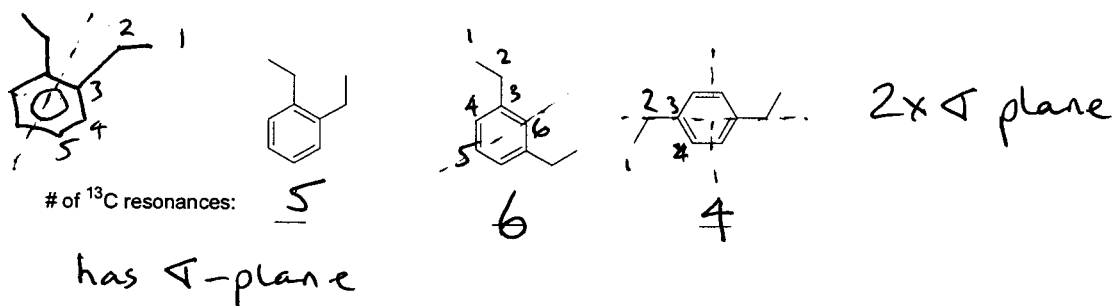
Circle the correct answer (2 pts each):

- a) CH_2Cl_2 will show two doublets, each integrating to 1H in the ^1H NMR spectrum TRUE **FALSE**
- b) CHCl_3 gives a resonance at 7.26 ppm at 300 MHz, and at 14.52 ppm at 600 MHz TRUE **FALSE**
- c) Nuclei that are more shielded have more electron density around them (ignoring anisotropy) **TRUE** FALSE
- d) Integrations for each signal tell you how many adjacent H atoms there are TRUE **FALSE**
- e) In a strong radiofrequency field, a nucleus with spin quantum = $\frac{1}{2}$ will have two different energy states TRUE **FALSE**
- f) In a strong magnetic field, a nucleus with spin quantum = $\frac{1}{2}$ will have two different energy states **TRUE** FALSE
- g) A given ^1H NMR signal will be split into $n + 1$ peaks, where n is the number of equivalent H atoms adjacent **TRUE** FALSE
- h) Chemical shift equivalent protons do not split each other **TRUE** FALSE
- i) The greater the electron density around a nucleus, the further down field the resonance TRUE **FALSE**
- j) ^{13}C NMR is less sensitive than ^1H NMR because of the greater mass of carbon TRUE **FALSE**

Question # 2

10 pts total

a) As part of your job at a pharmaceutical company, you are given three bottles of the isomers of diethylbenzene and you are asked to determine which one is which using ^{13}C NMR. How many ^{13}C resonances would you expect for each compound? (3 pts)

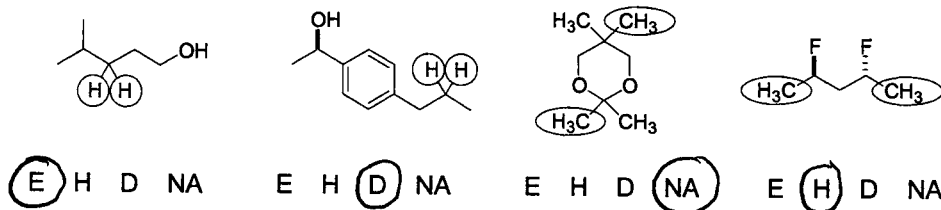


b) How would you use IR to distinguish between these two related compounds: (1 pt)



- IR will show -OH (str) at $\sim 3300\text{ cm}^{-1}$ for the diol; not possible for the diether

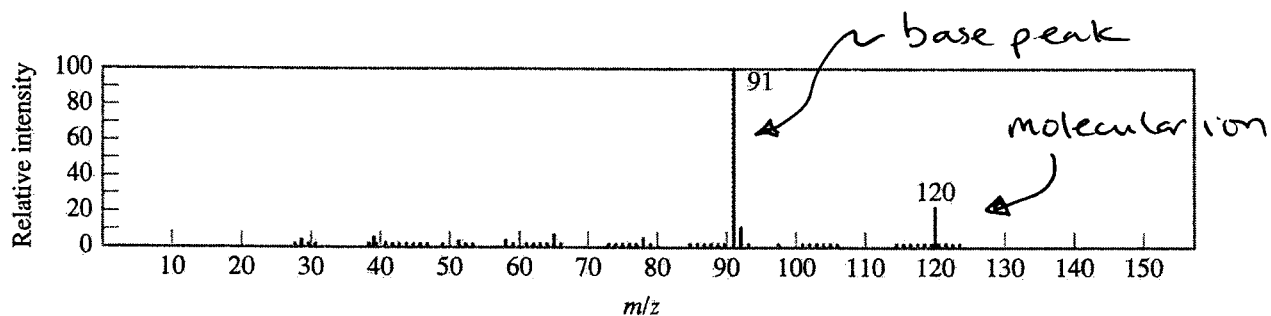
c) For the compounds shown label the circled groups as enantiotopic (E), homotopic (H), diastereotopic (D), or not applicable (NA): (4 pts)



d) On the mass-spectrum shown below, clearly label

i) the peak that corresponds to the molecular ion, and ii) the base peak

(1 pt)



ii) what important piece of information about a compound does the molecular ion gives us? (1 pt)

the molecular mass

Question # 3

20 pts total

What is the structure of the compound that would give the spectroscopic data shown? The molecular formula is $C_6H_{12}O$. Be sure to show all of your work (degrees of unsaturation, fragments, etc) if you want partial credit.

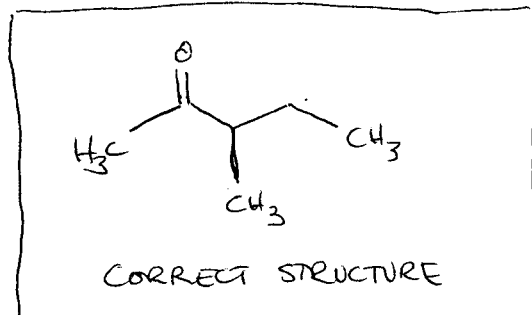
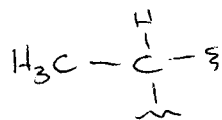
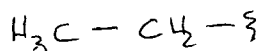
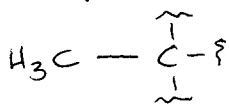
The spectra for this problem are on the next page!

MF = $C_6H_{12}O$; 6 x C from ^{13}C \rightarrow no symmetry

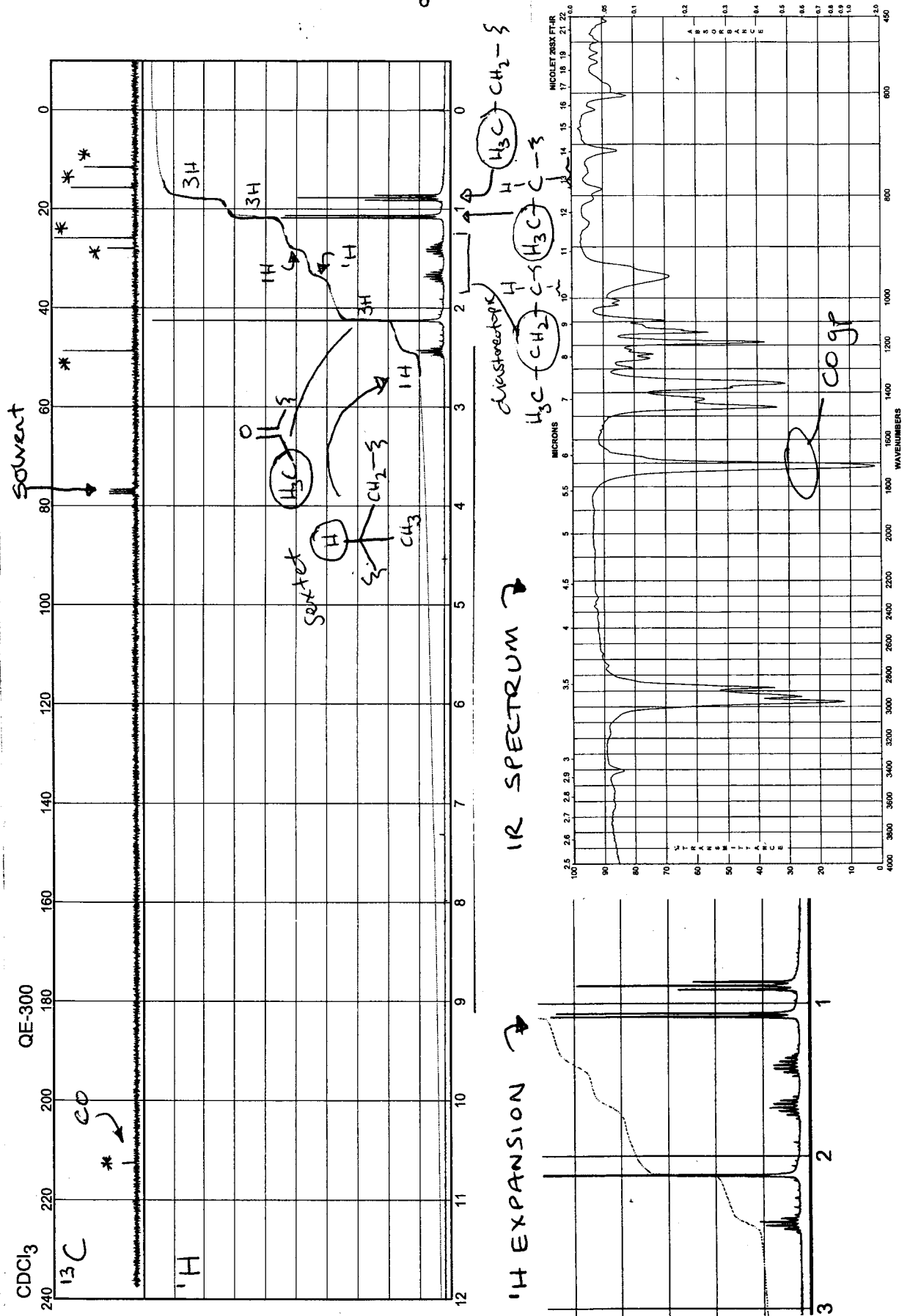
Degrees of unsat. = 1

CO group (IR $\approx 1720\text{cm}^{-1}$ or ^{13}C δ 215)

From 1H :



Spectra for Question # 3



Question # 4

20 pts total

What is the structure of the compound that would give the spectroscopic data shown? The molecular formula is $C_4H_{10}O$. Be sure to show all your working if you want partial credit.

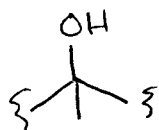
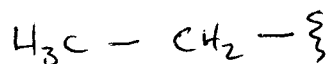
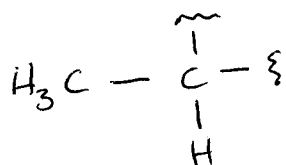
The spectra for this problem are on the next page!

MF = $C_4H_{10}O$; 4xC from ^{13}C \rightarrow no symmetry

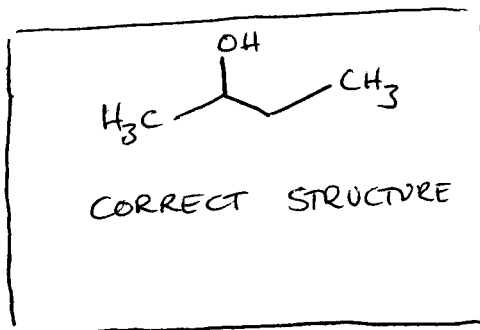
Degrees of unsat. = 0

-OH group (from IR $\sim 3300cm^{-1}$ or 1H 2.10 ppm)

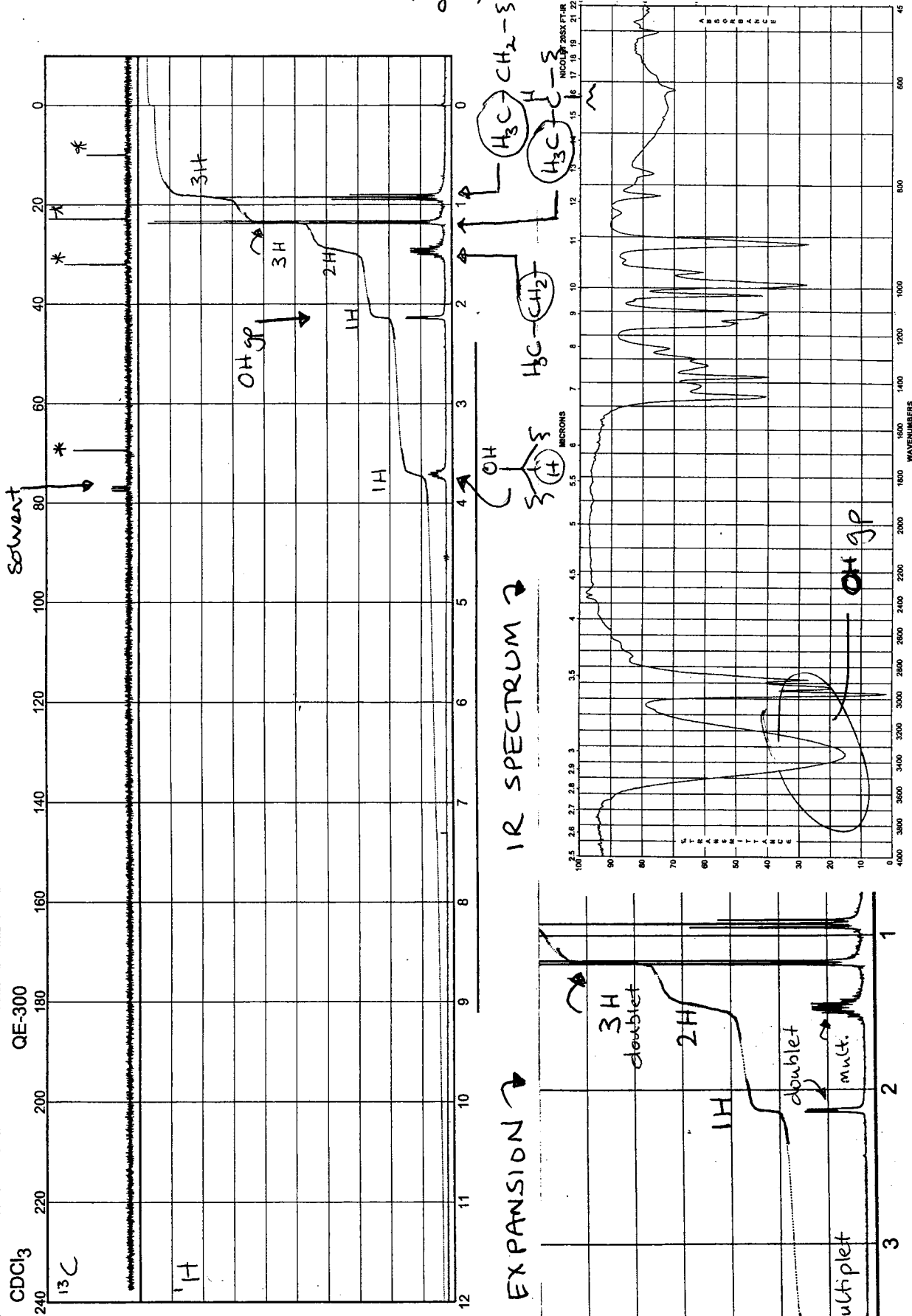
From 1H :



$\{ - C - \{ \rightarrow$ mult. @ ~ 3.75 ppm



Spectra for Question # 4



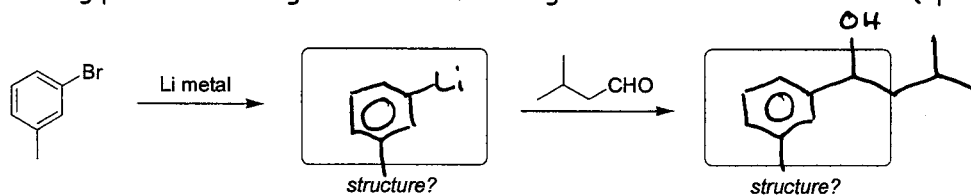
Question # 5

18 pts total

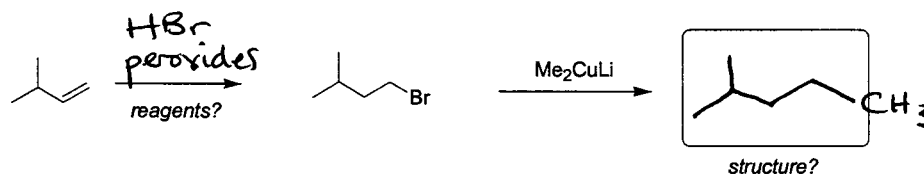
A. Fill in the missing products or reagents for the following reactions:

(2pts each)

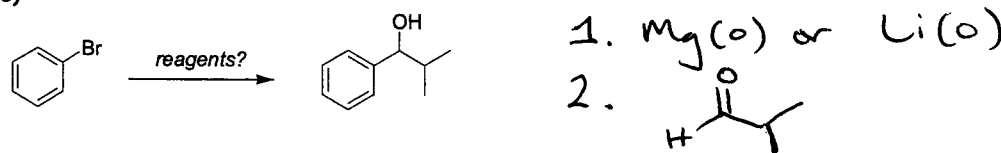
a)



b)

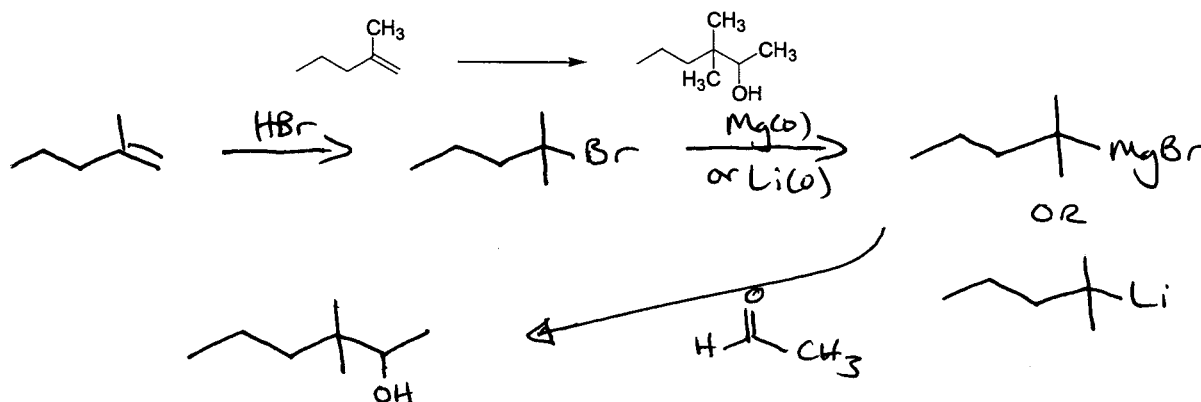


c)

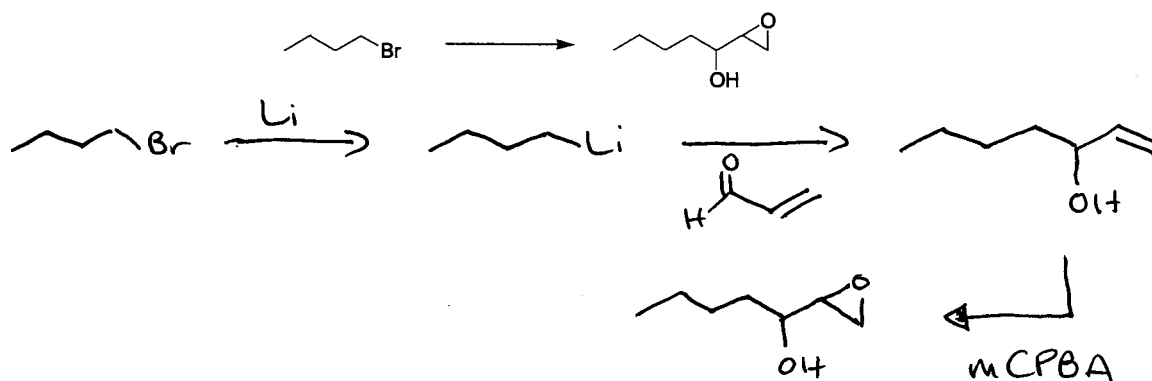


B. Complete the following syntheses, using any reagents required. If your synthesis requires more than 1 step then you must write the reagents, and draw the products for each step. (4 pts each)

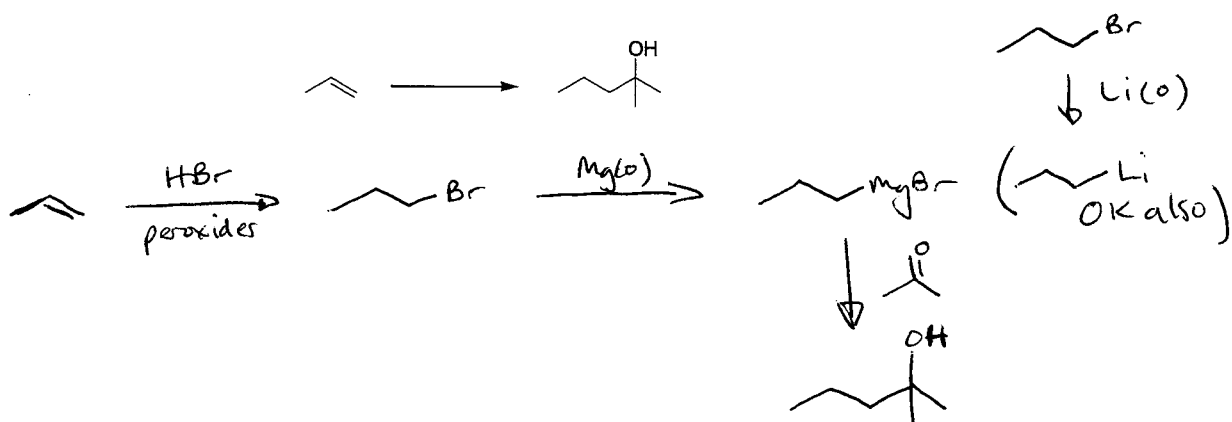
a)



b)



c)

**Question # 6****12 pts total**

Draw the product (4 pts) and write a mechanism (8 pts) for the following reaction. *Be sure to show all the intermediates and all the arrows required for each step [including aqueous workup!]*

