

# 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 \_\_\_\_\_

Recitation TA's Name: \_\_\_\_\_

Recitation Day and Time: \_\_\_\_\_

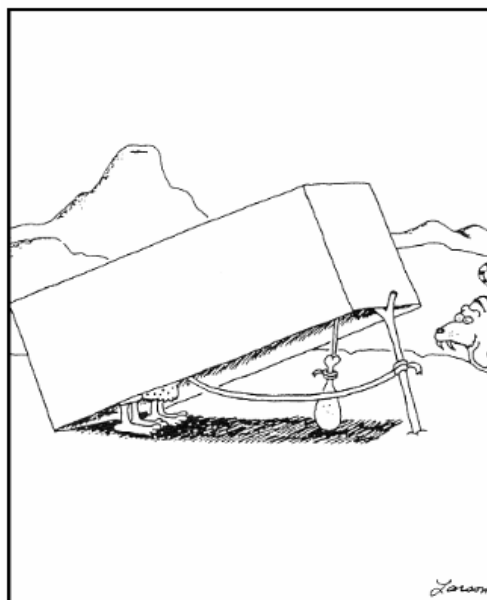
Points:

Problem #	Max. Points	Your Score
1	20	
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!

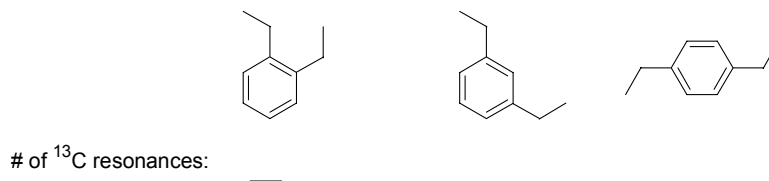
*Hint* I have not gone out of my way to try and trick you, so don't try and second-guess yourself out of correct answers!

Circle the correct answer (2 pts each):

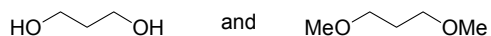
- a)  $\text{CH}_2\text{Cl}_2$  will show two doublets, each integrating to 1H in the  $^1\text{H}$  NMR spectrum TRUE FALSE
- b)  $\text{CHCl}_3$  gives a resonance at 7.26 ppm at 300 MHz, and at 14.52 ppm at 600 MHz TRUE FALSE
- c) Nuclei that are more shielded have more electron density around them (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  $^1\text{H}$  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)  $^{13}\text{C}$  NMR is less sensitive than  $^1\text{H}$  NMR because of the greater mass of carbon TRUE FALSE

**Question # 2****10 pts total**

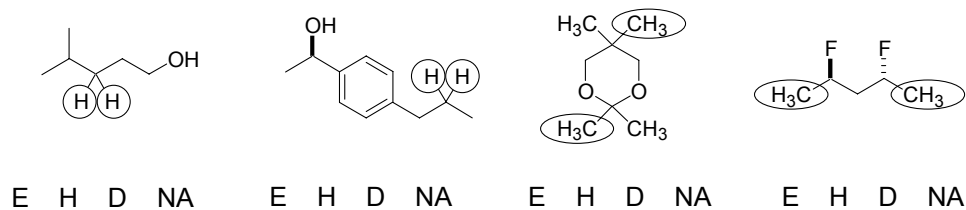
a) As part of your job at a pharmaceutical company, you are given three bottles of the isomers of diethylbenzene and you are asked to determine which one is which using  $^{13}\text{C}$  NMR. How many  $^{13}\text{C}$  resonances would you expect for each compound? (3 pts)



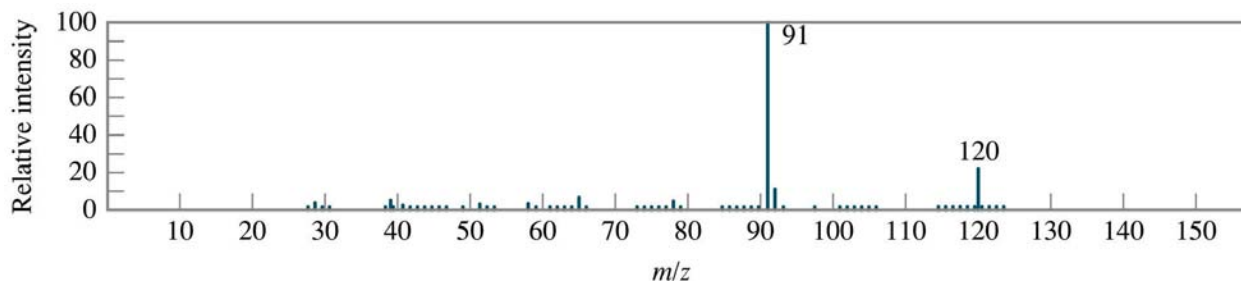
b) How would you use IR to distinguish between these two related compounds: (1 pt)



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)



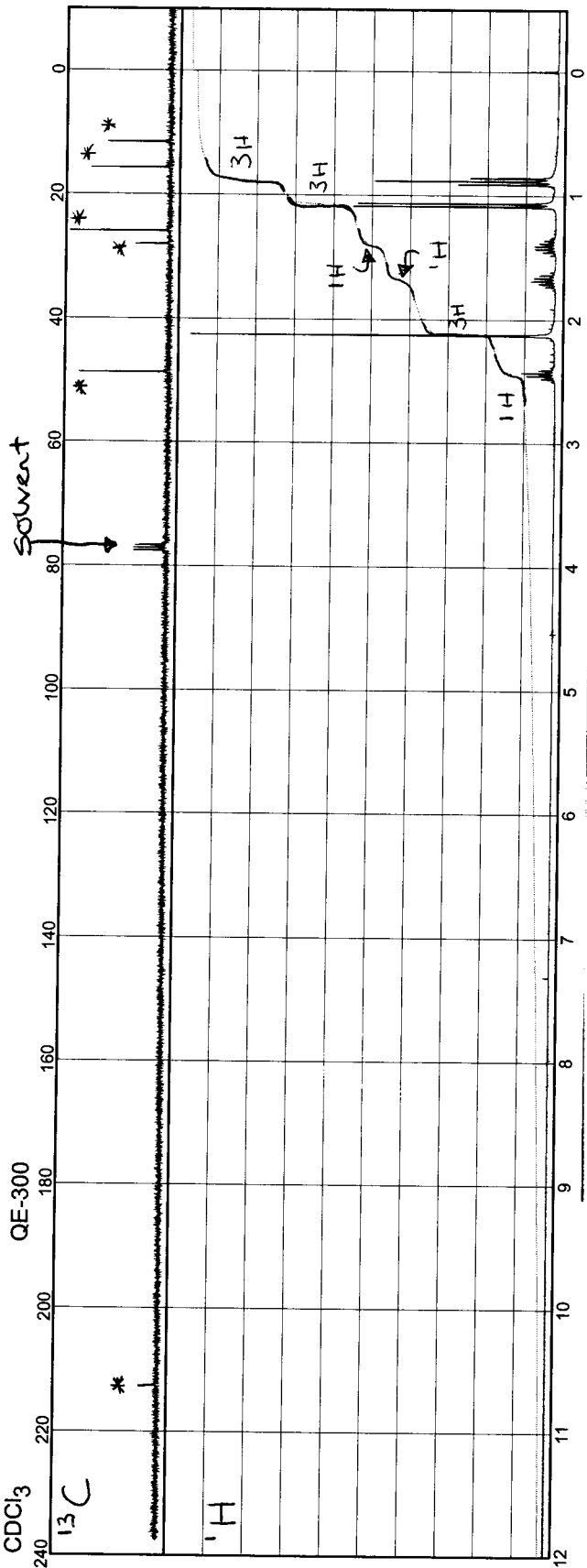
- ii) what important piece of information about a compound does the molecular ion gives us? (1 pt)

**Question # 3****20 pts total**

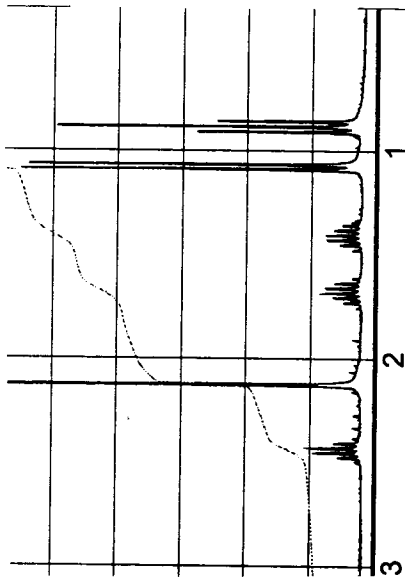
What is the structure of the compound that would give the spectroscopic data shown? The molecular formula is  $C_6H_{12}O$ . Be sure to show all of your work (degrees of unsaturation, fragments, etc) if you want partial credit.

*The spectra for this problem are on the next page!*

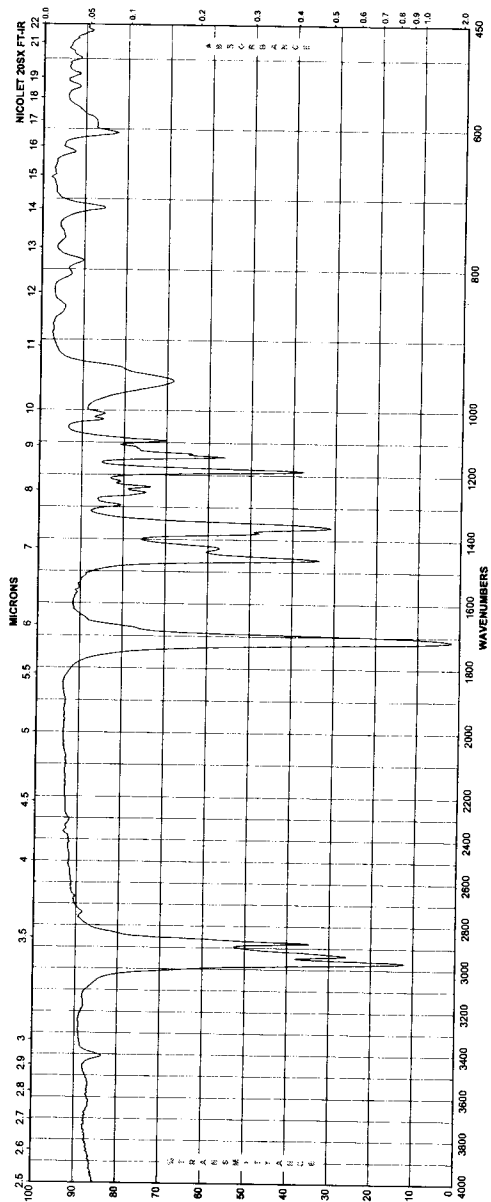
Spectra for Question # 3



$^1\text{H}$  EXPANSION  $\rightarrow$



IR SPECTRUM  $\rightarrow$



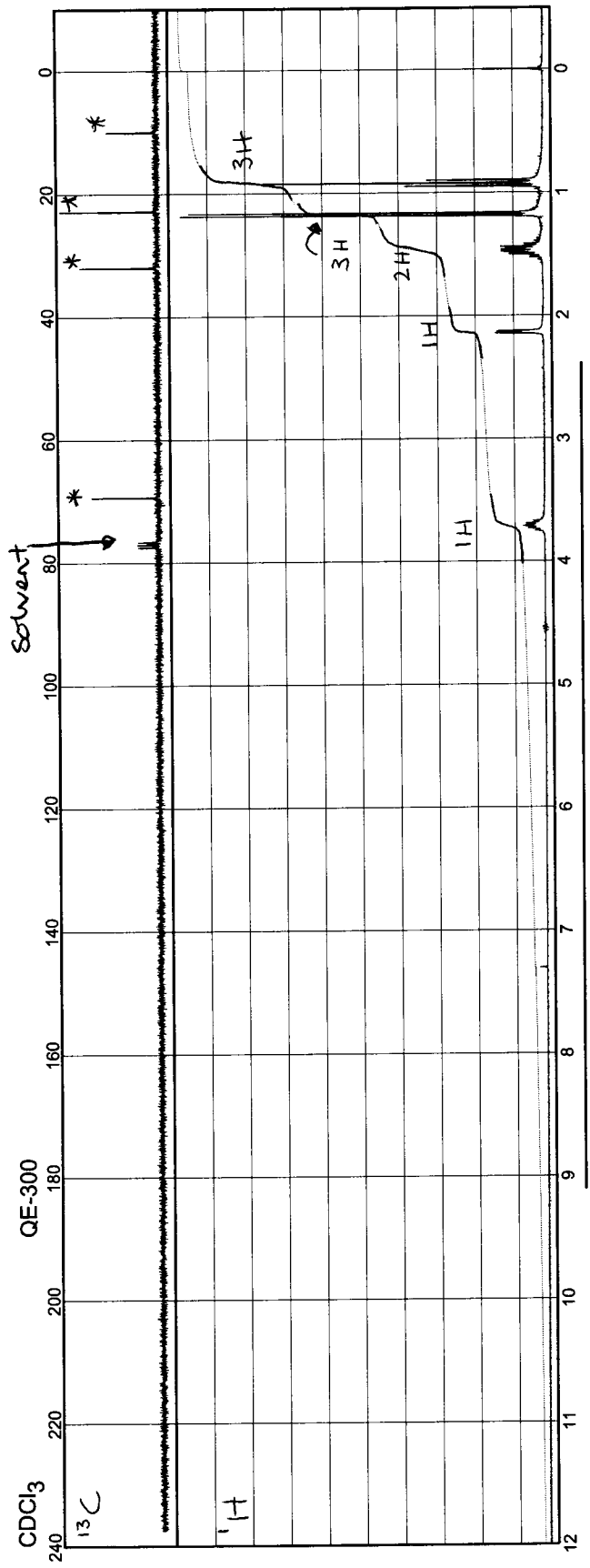
**Question # 4**

**20 pts total**

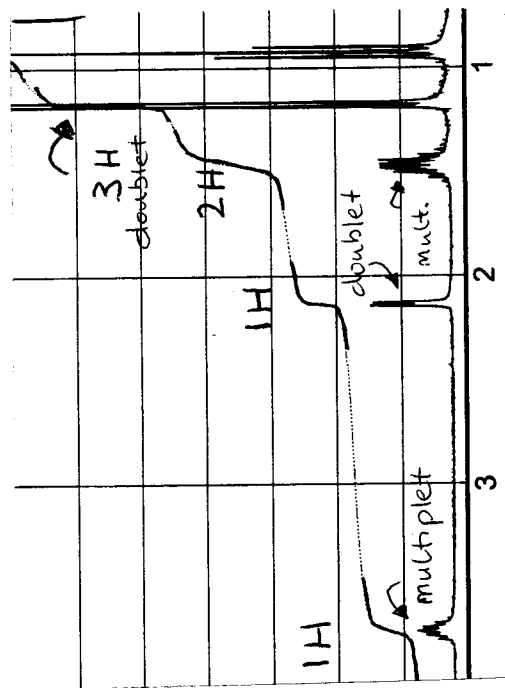
What is the structure of the compound that would give the spectroscopic data shown? The molecular formula is  $C_4H_{10}O$ . Be sure to show all your working if you want partial credit.

*The spectra for this problem are on the next page!*

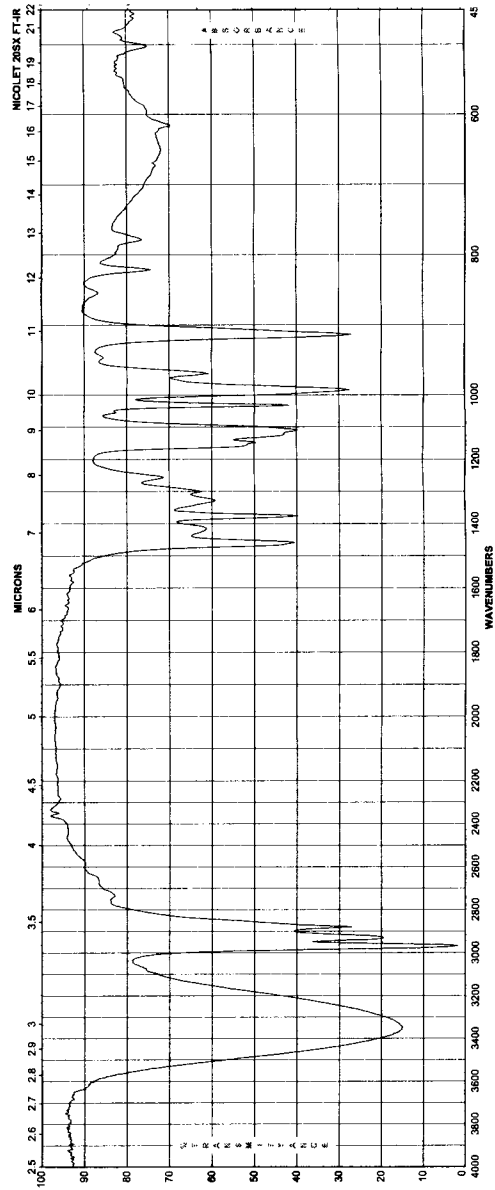
Spectra for Question # 4



$^1\text{H}$  EXPANSION  $\rightarrow$



IR SPECTRUM  $\rightarrow$

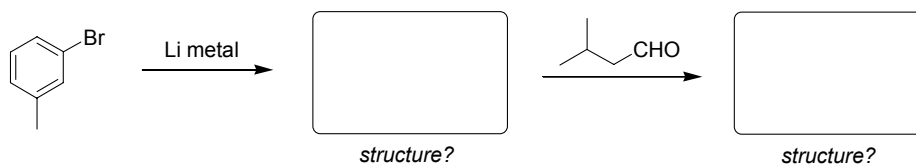


**Question # 5****18 pts total**

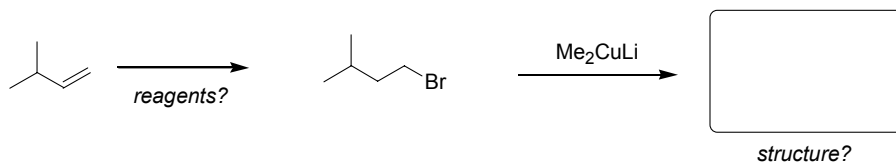
A. Fill in the missing products or reagents for the following reactions:

(2pts each)

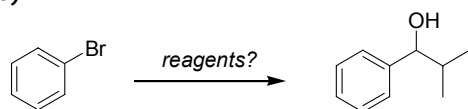
a)



b)

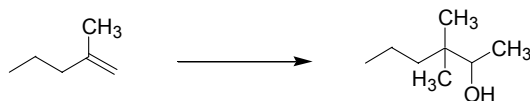


c)

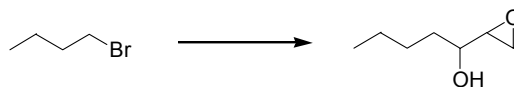


B. Complete the following syntheses, using any reagents required. If your synthesis requires more than 1 step then you must write the reagents, and draw the products for each step. (4 pts each)

a)

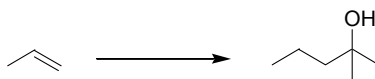


b)





c)

**Question # 5****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!]*

