

**LAST NAME:**

**FIRST NAME:**

**UTEID:**

## COVER PAGE

### *Instructions*

This exam will be closed book. No notes, books, calculators, or molecular models will be allowed.

The exam will be comprised of two distinct parts:

**Part I** will consist of a series of multiple choice questions. Your answers to these questions must be submitted on a Scantron “bubble” sheet. The answer sheet will be provided for you, but you will need your own #2 pencil(s). Only answers marked on the bubble sheet will be graded. Answers to Part I questions marked on the exam itself cannot not be graded. No re-grades will be possible on Part I of the exam.

**Part II** consists of questions for which you will need to write out your answers, using structures and/or words. This part of the exam will be hand-graded. Answers for the Part II questions that are written in pencil will not be eligible for re-grades. Answers written in pencil with ink overlay will not be eligible for re-grades. If you use a pen to answer the Part II questions, only blue or black ink is acceptable. Answers written in red ink cannot be graded.

1. You must have your valid UT ID card (or other government-issued ID) with you. You will need to show it to the proctors when you turn in your exam.
2. Chapter 4 of the University’s “General Information” catalog outlines this university’s policies regarding exams, as well as other quizzes administered during the semester. Specifically, students are expected to remain in the exam room until a test is completed. These policies will be strictly enforced, with no exceptions. You may not leave the room for any reason until you are ready to turn in your exam. If you wish to leave the room, you will need to turn in your exam to the proctors, and you will not be allowed to return. Please, plan accordingly by using the rest room before the exam starts.

## CH 318 N EXAM I

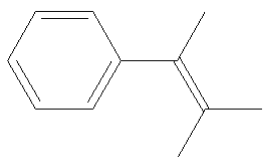
Question	Value	Score
1	20	
2	15	
3	20	
4	20	
Section II	75	
Section I	75	
Raw Total	150	
Grade		

## CH 318-Exam 1

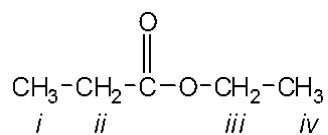
## Objective Section

Identify the choice that best completes the statement or answers the question. Only one choice is correct; be sure to carefully bubble your answer on the scantron sheet. (3 pts ea.; 75 pts this section)

1. What is the x-axis of a mass spectrum?
  - a. mass
  - b. charge
  - c. mass/energy
  - d. mass/charge
2. How many signals appear in the proton-decoupled  $^{13}\text{C}$  NMR spectrum of the following compound?



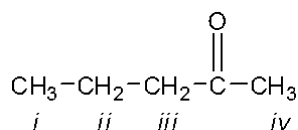
- a. 9
  - b. 8
  - c. 11
  - d. 7
3. Which of the following sets of molecular ions does an alkyl bromide possess?
    - a. two molecular ions in a 3:1 ratio separated by two mass units
    - b. two molecular ions in a 1:1 ratio separated by two mass units
    - c. three molecular ions in a 1:2:1 ratio separated by two mass units
    - d. two molecular ions in a 2:1 ratio separated by two mass units
  4. Which of the protons in the following molecule appear furthest **downfield** in the  $^1\text{H}$  NMR spectrum?



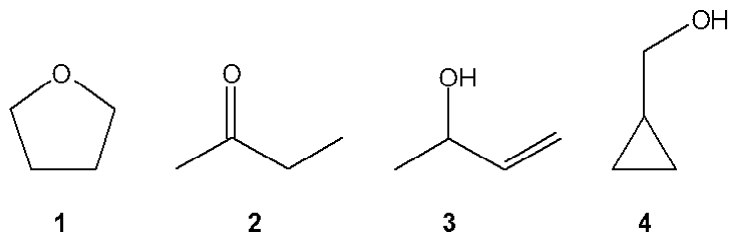
- a. *i*
  - b. *ii*
  - c. *iii*
  - d. *iv*
5. Which of the following functional groups is likely to be present in a molecule that has peaks in the infrared spectrum at  $1630\text{-}1820\text{ cm}^{-1}$  (strong, broad) and  $1000\text{-}1250\text{ cm}^{-1}$ ; but does not have peaks at  $3200\text{-}3650\text{ cm}^{-1}$ ?
    - a. alcohol
    - b. aldehyde or ketone
    - c. ether
    - d. ester

6. What is the splitting of the signal in the  $^1\text{H}$  NMR spectrum for the methyl protons of 1-bromo-2-methylpropane?
- singlet
  - triplet
  - doublet
  - nonet
7. How many sets of equivalent protons are there in hexane?
- 2
  - 7
  - 6
  - 3

8. Which of the protons in the following molecule appear at the highest  $\delta$ -value in the  $^1\text{H}$  NMR spectrum?

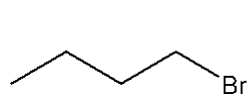


- i*
  - ii*
  - iii*
  - iv*
9. Which of the following is most consistent with a molecule having a molecular ion with  $m/e$  of 77?
- the molecule is a hydrocarbon
  - the molecule is an alcohol
  - the molecule contains nitrogen
  - the molecule contains bromine
10. Which of the following compounds gives an infrared spectrum with a peak in the range of  $1630\text{-}1820\text{ cm}^{-1}$  (strong peak), but **does not have peaks at  $3200\text{-}3650$  or  $1000\text{-}1250\text{ cm}^{-1}$** ?

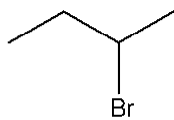


- 1**
- 2**
- 3**
- 4**

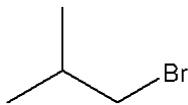
11. Which  $C_4H_9Br$  compound(s) gives a  $^{13}C$  NMR spectrum consisting of four signals?



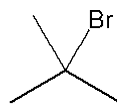
1



2



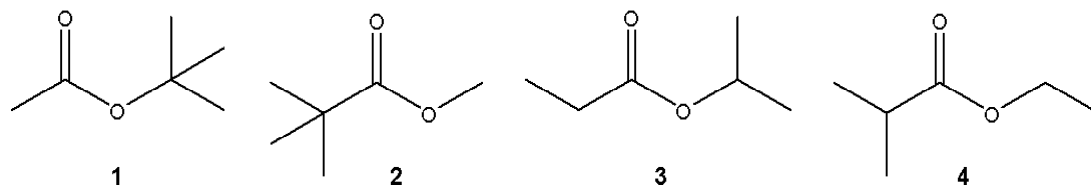
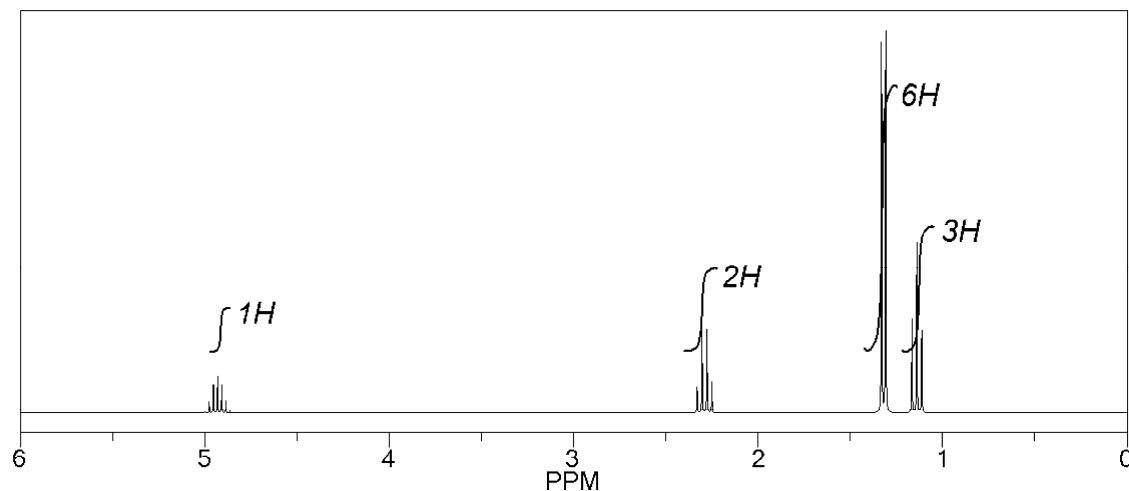
3



4

- only 1
  - only 1 and 2
  - only 2 and 3
  - 1, 2, 3 and 4
12. Which of the following functional groups is likely to be present in a molecule that has peaks in the infrared spectrum at  $1630-1820\text{ cm}^{-1}$  (strong, broad), but does not have peaks at  $3200-3650$  or  $1000-1250\text{ cm}^{-1}$
- alcohol
  - ether
  - ester
  - aldehyde or ketone
13. Which feature in the  $^1H$  NMR spectrum provides information about the **electronic environment** of the protons in a compound?
- integral
  - splitting
  - chemical shift
  - number of signals
14. How many signals appear in the proton-decoupled  $^{13}C$  NMR spectrum of 3-bromotoluene?
- 7
  - 5
  - 3
  - 4

15. Which  $C_6H_{12}O_2$  compound gives the following  $^1H$  NMR spectrum?



- 1
- 2
- 3
- 4

16. What is required for a bond to give an infrared absorption?

- a change in bond length during vibration
- a change in bond dipole during vibration
- a change in bond angle during vibration
- a change in reduced mass during vibration

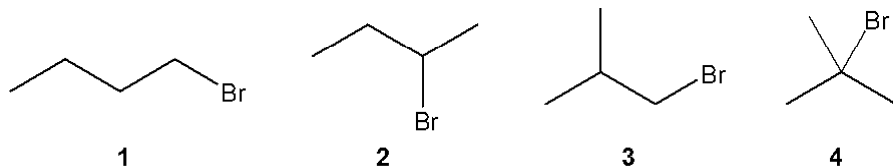
17. Which of the following corresponds to the molecular ion in EI mass spectrometry?

- the ion formed by removal of an electron from the molecule
- the ion with the smallest  $m/e$
- the most abundant ion
- any ion formed by fragmentation of the molecule

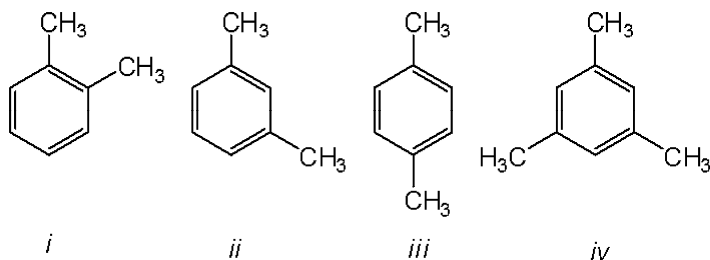
18. How many sets of equivalent protons are there in 3-methylhexane?

- 7
- 6
- 3
- 2

19. Which of the following gives rise to a prominent  $M - 18$  peak in the mass spectrum?
- hexane
  - 1-chloropentane
  - 3-methylpentane
  - 1-pentanol
20. Which  $C_4H_9Br$  compound gives a triplet at approximately 3.5 ppm in the  $^1H$  NMR spectrum?

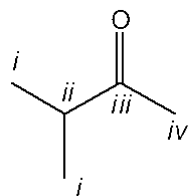


- 1
  - 2
  - 3
  - 4
21. Which of the following relationships is *not* valid as applied to infrared spectroscopy?
- $\Delta E = B_0$
  - $\nu = 4.12 \sqrt{K/\mu}$
  - $\Delta E = h \nu$
  - wavenumber =  $1/\lambda$  (in cm)
22. Which of the following compounds would give a  $^1H$  NMR spectrum consisting of two singlets and a  $^{13}C$  NMR consisting of consisting of three signals?



- only *i*
  - only *iii*
  - only *i* and *iii*
  - iii* and *iv*
23. Which of the following gives rise to a prominent peak in the mass spectrum with  $m/z$  of  $M - 31$ ?
- methyl hexanoate
  - hexanoic acid
  - 2-methylhexanoic acid
  - ethyl hexanoate

24. Which feature in the  $^1\text{H}$  NMR spectrum provides information about the number of types of different protons in a compound?
- splitting
  - integral
  - chemical shift
  - number of signals
25. Which of the **carbon atoms** in the following molecule appears furthest downfield in the  $^{13}\text{C}$  NMR spectrum?



- i*
- ii*
- iii*
- iv*

**CH 318-Exam 1**  
**Answer Section**

**MULTIPLE CHOICE**

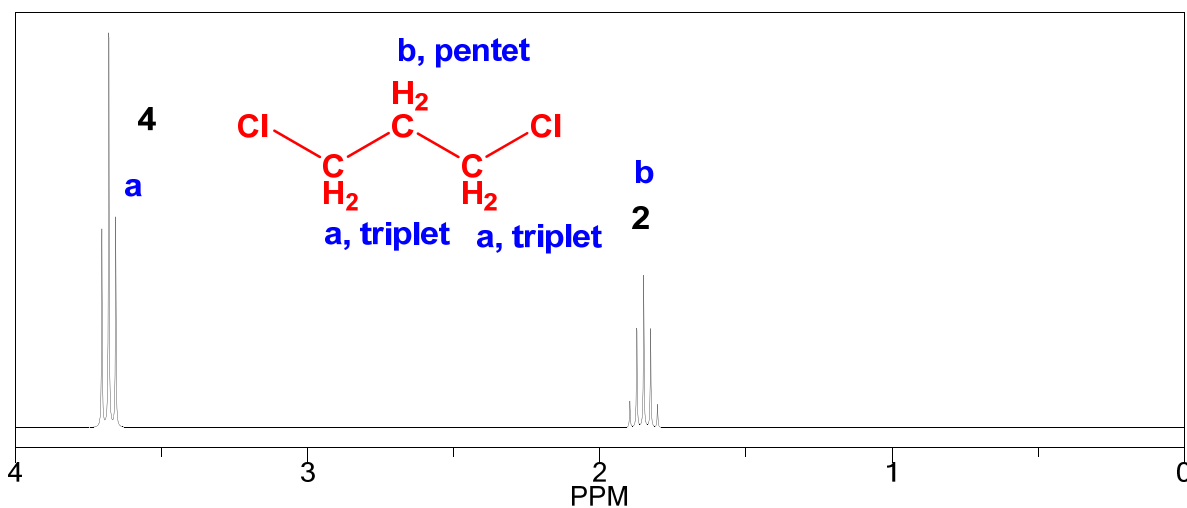
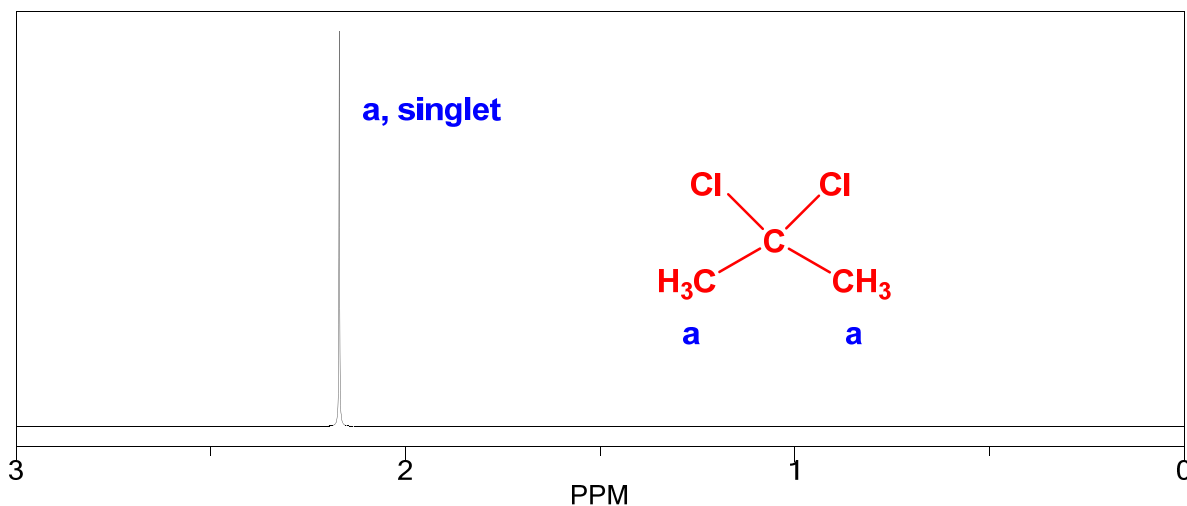
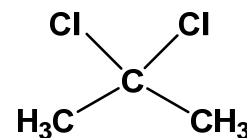
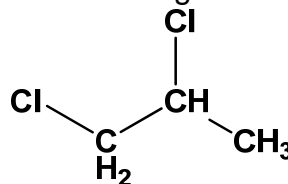
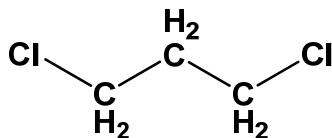
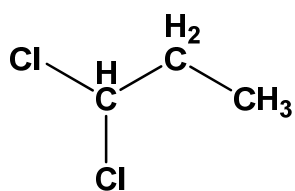
- |            |        |
|------------|--------|
| 1. ANS: D  | PTS: 3 |
| 2. ANS: A  | PTS: 3 |
| 3. ANS: B  | PTS: 3 |
| 4. ANS: C  | PTS: 3 |
| 5. ANS: D  | PTS: 3 |
| 6. ANS: C  | PTS: 3 |
| 7. ANS: D  | PTS: 3 |
| 8. ANS: C  | PTS: 3 |
| 9. ANS: C  | PTS: 3 |
| 10. ANS: B | PTS: 3 |
| 11. ANS: B | PTS: 3 |
| 12. ANS: D | PTS: 3 |
| 13. ANS: C | PTS: 3 |
| 14. ANS: A | PTS: 3 |
| 15. ANS: C | PTS: 3 |
| 16. ANS: B | PTS: 3 |
| 17. ANS: A | PTS: 3 |
| 18. ANS: A | PTS: 3 |
| 19. ANS: D | PTS: 3 |
| 20. ANS: A | PTS: 3 |
| 21. ANS: A | PTS: 3 |
| 22. ANS: D | PTS: 3 |
| 23. ANS: A | PTS: 3 |
| 24. ANS: D | PTS: 3 |
| 25. ANS: C | PTS: 3 |

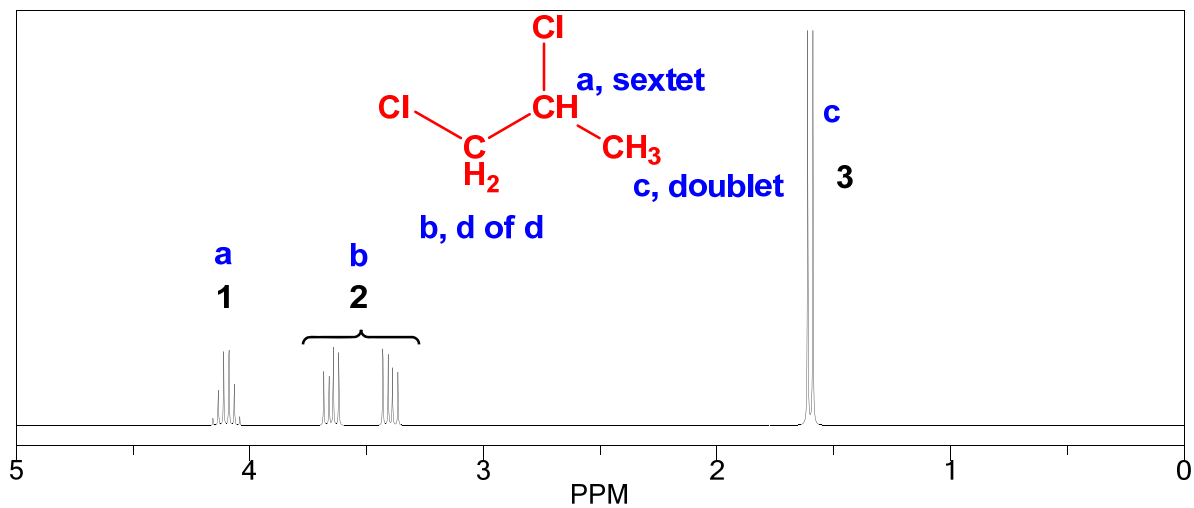
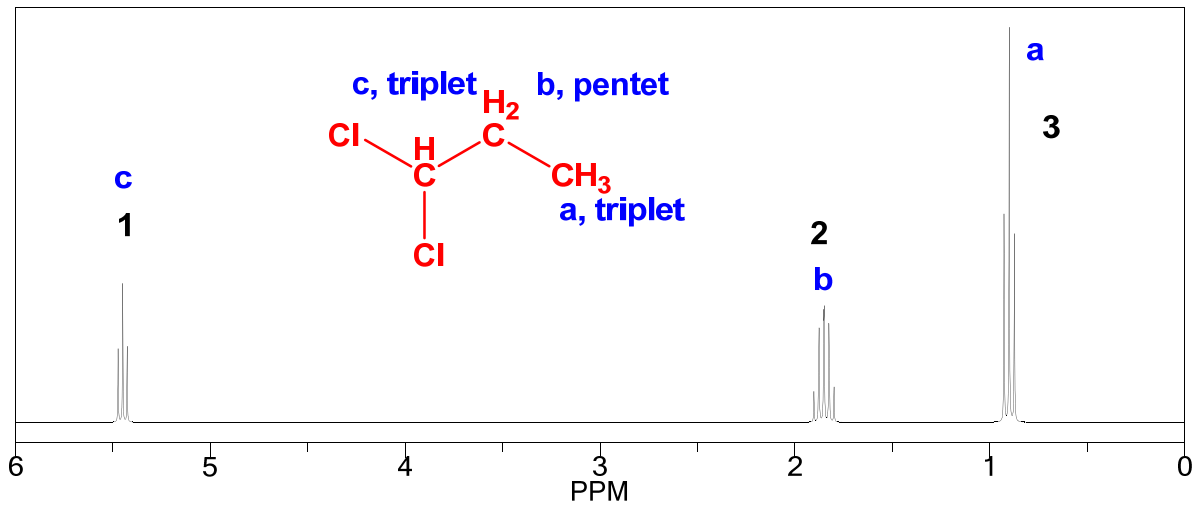
# CH 318 N EXAM #1

UTEID **KEY**

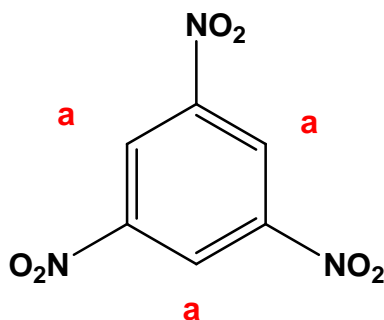
PART 2: Free Style Answer Format (75 pts in this section)

1) The NMRs of four isomers of dichloropropane are shown below. Match each compound with its NMR and provide an interpretation of each spectrum. (i.e. draw the structure on the NMR and label protons, with their splitting.) (5pts each NMR-with assignments)

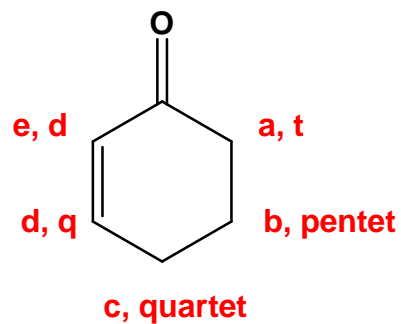
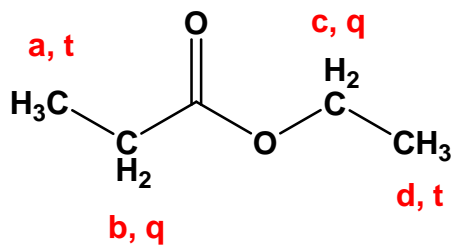




2) Label the protons of the following compounds using the "a,b,c," labeling system **AND** indicate the splitting patterns for each. (Use s=singlet; d=doublet; t=triplet; q=quartet etc. If there are more than 7 peaks, simply use m=multiplet.) (5 pts per structure)



**All equivalent: 1 singlet**



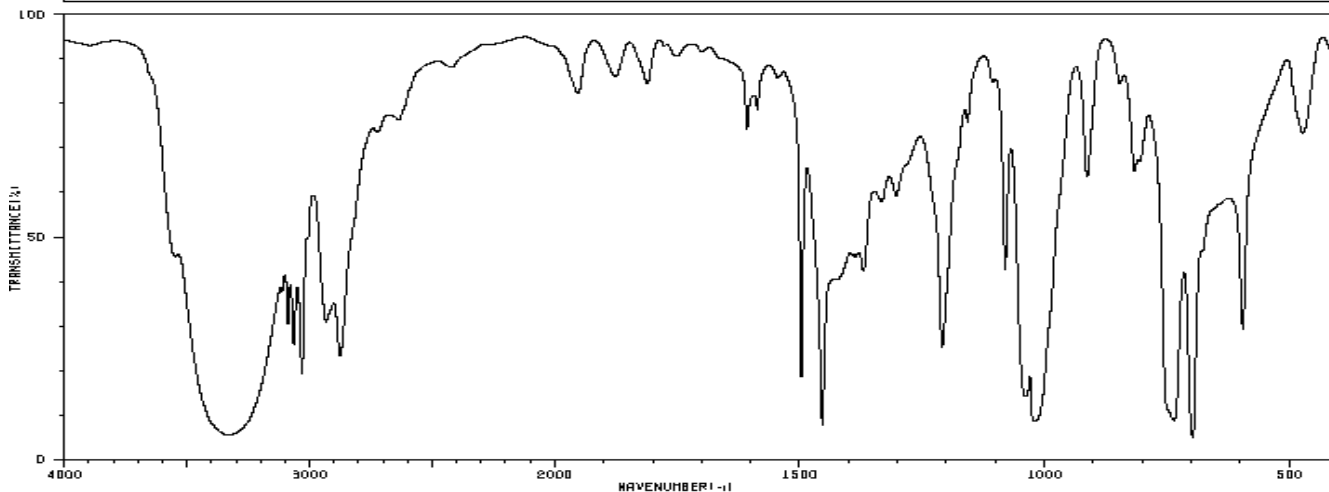
3) The spectra of an unknown compound are shown below. Interpret & summarize the key features of each spectrum (in the space provided) and propose a structure. (20 pts for unknown & interpretation)

**Unknown 1**

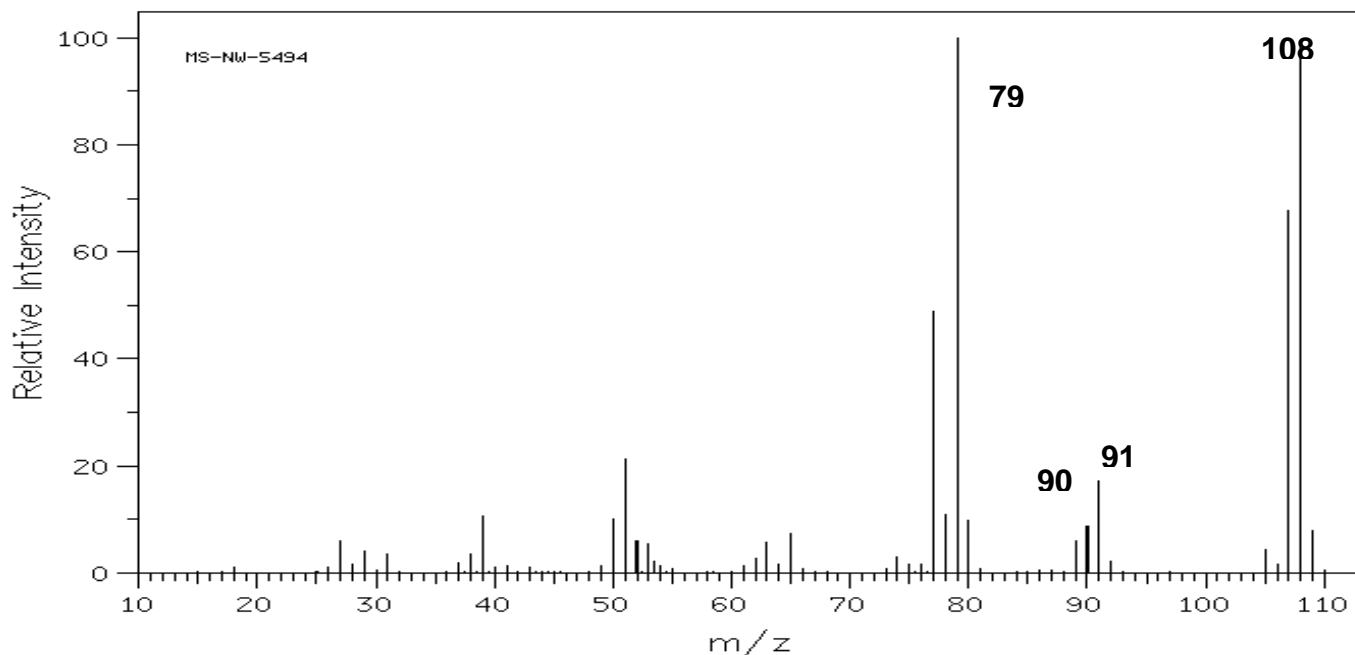
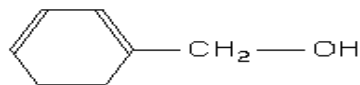
$C_7H_8O$

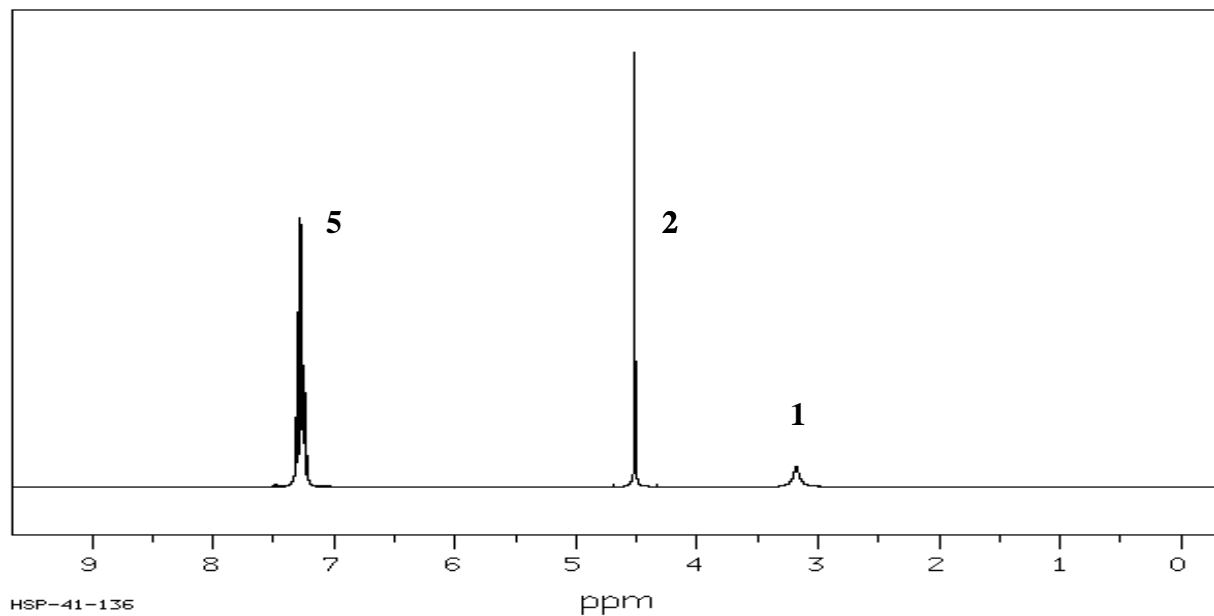
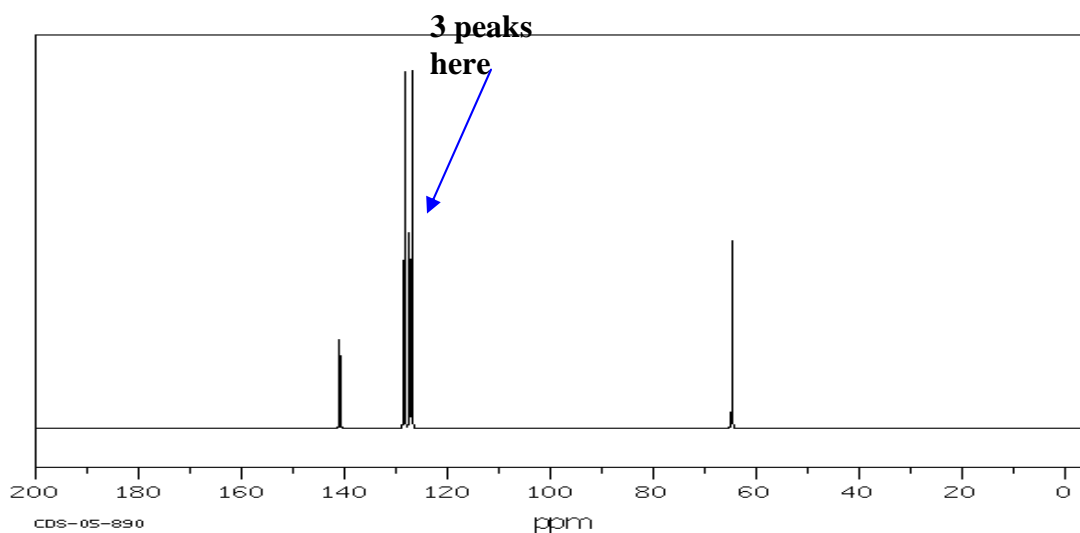
108

HIT-NO=1125	SCORE= ( )	SDBS-NO=685	IR-NIDA-05226 : LIQUID FILM
BENZYL ALCOHOL			
$C_7H_8O$			



3325	6	1962	79	1497	18	1080	41	806	54
3088	29	1876	84	1454	7	1039	13	736	8
3065	24	1611	81	1370	41	1018	8	696	4
3031	18	1607	72	1332	55	913	60	595	27
2932	29	1593	79	1305	57	846	81	473	70
2875	22	1587	77	1209	23	817	62		
2419	84	1544	81	1157	72	812	64		



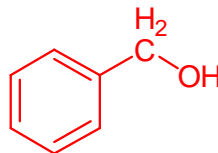
<sup>1</sup>H NMR- (Integers indicate relative integration of protons)<sup>13</sup>C NMR:MS: M=108; 91: is tropyllium ion; 90: M-18 loss H<sub>2</sub>O; 79 is M-29, loss CH<sub>2</sub>OH

IR: 3400-3200, s indicates O—H; C—H stretches &gt;3000 indicate aromatic &amp; &lt;3000 aliphatic

NMR: 3 types of protons 7.2, 5H, multiplet (aromatic); 4.5, s, 2H (benzylic); 3.2, br s, 1H (ROH)

CNMR: 5 peaks; 4 aromatic; 1 C—O

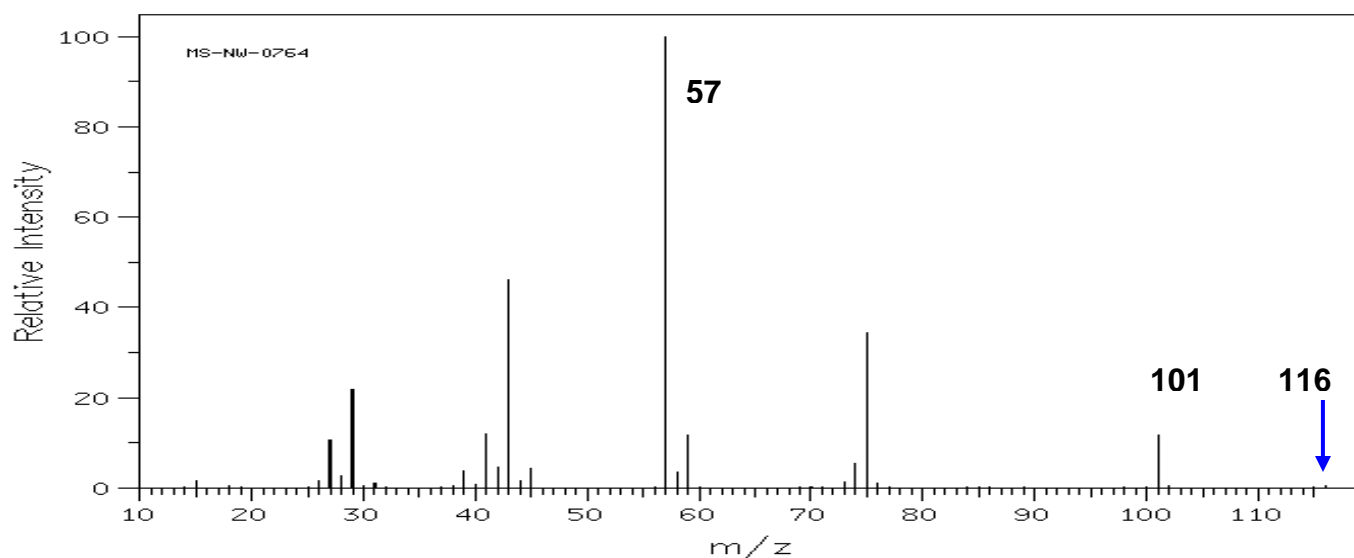
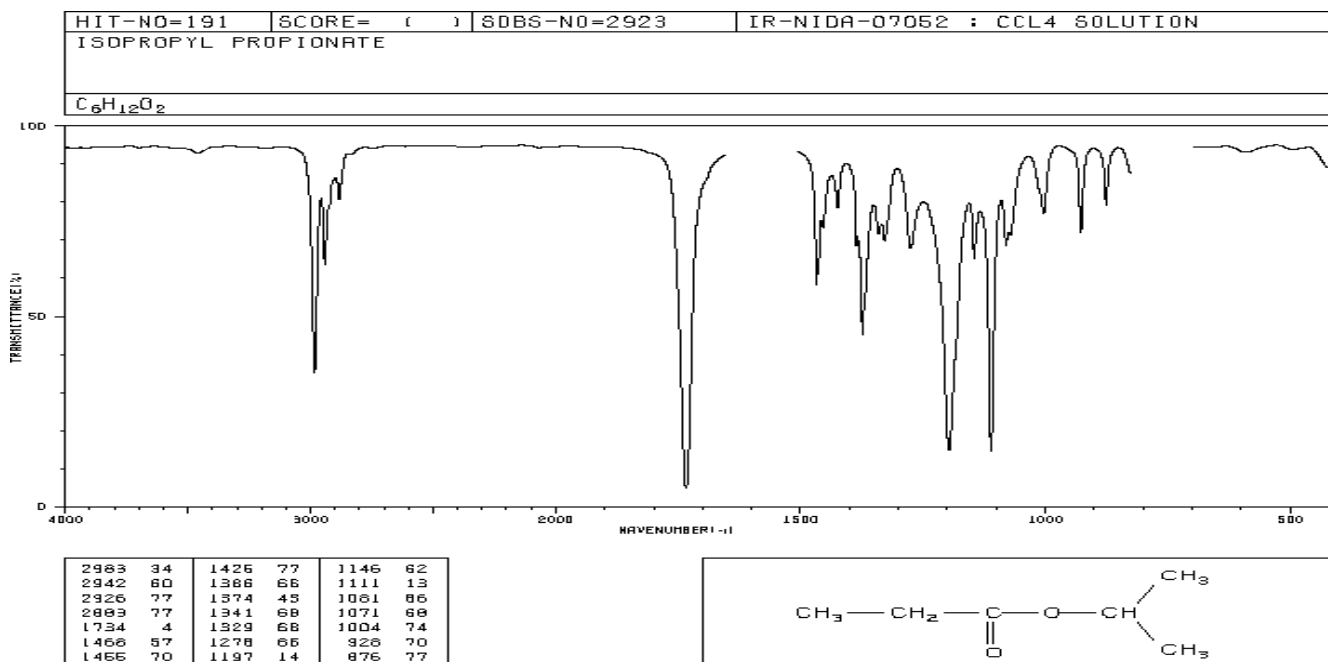
Proposed Structure:



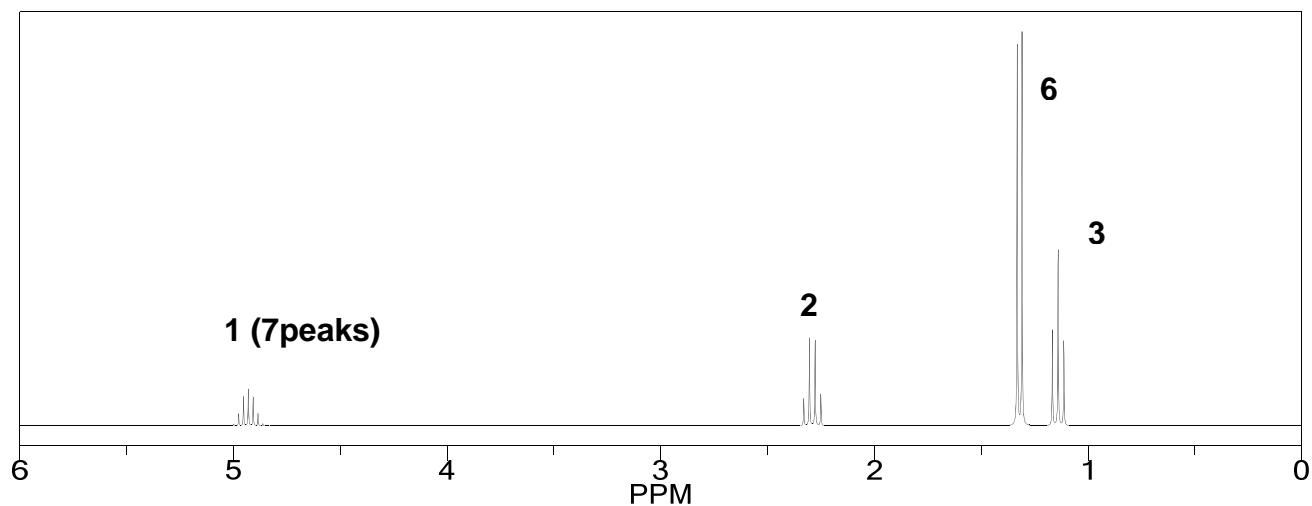
4) The spectra of an unknown compound are shown below. Interpret & summarize the key features of each spectrum (in the space provided) and propose a structure. (20 pts for unknown & interpretation)

**Unknown 2** $C_6H_{12}O_2$ 

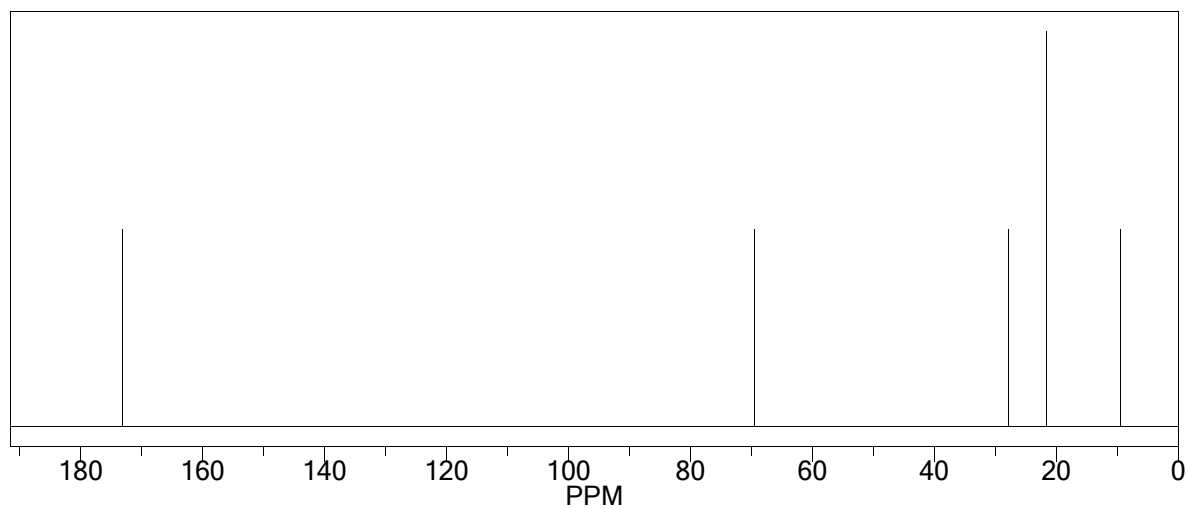
MW 116



$^1\text{H}$  NMR- (Integers indicate relative integration of protons)



$^{13}\text{C}$  NMR:



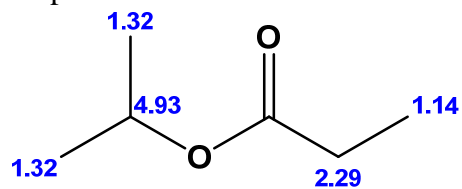
MS:  $M=116$ ; 101, loss of  $\text{CH}_3$ ; 57, loss of  $\text{CH}_3\text{CH}_2\text{C}=\text{O}$

IR: 3000 aliphatic; 1730,  $\text{C}=\text{O}$ ; 1100  $\text{C}-\text{O}$

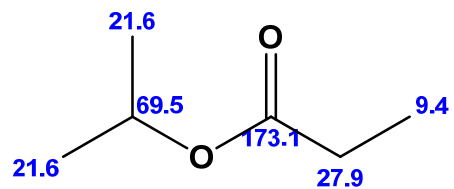
NMR: 4 types of protons 4.93, m (or heptet), 1H; 2.29, q, 2H; 1.32, d, 6H; 1.14, t, 3H

CNMR: 5 peaks; 173,  $\text{C}=\text{O}$ , 70,  $\text{C}-\text{O}$ ; 28,  $\text{C}$   $\alpha$  to  $\text{C}=\text{O}$ ; 22, two methyl groups; 9 last methyl group

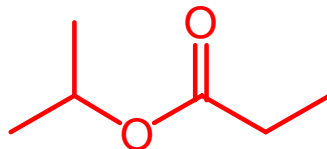
Proposed Structure:



Proton Assignments



Carbon Assignments

**END OF EXAM SECTION**