

Panther ID: _____

NAME: _____

FLORIDA INTERNATIONAL UNIVERSITY
Department of Chemistry

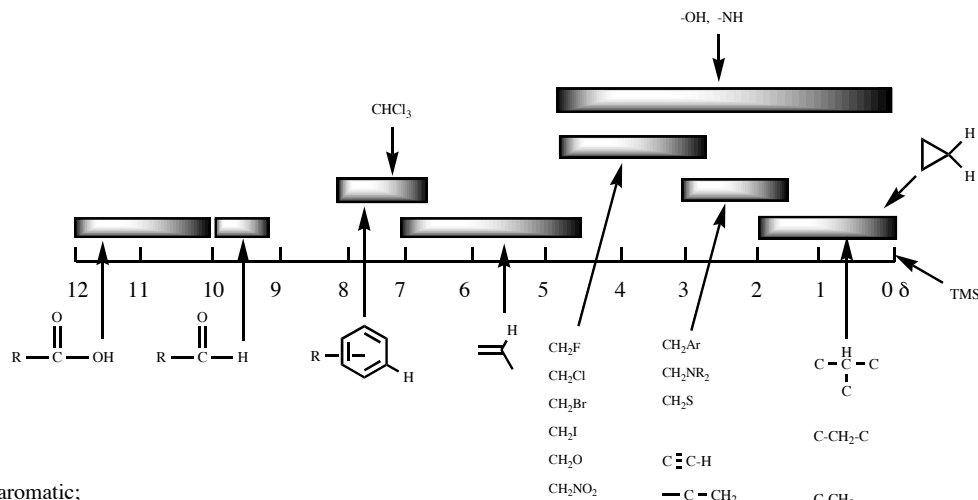
CHM 2211-U02- ORGANIC CHEMISTRY II

PRACTICE EXAM I

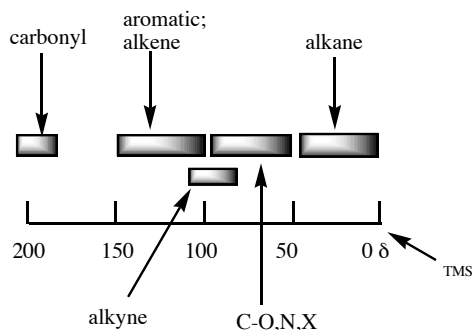
**CHARACTERISTIC
 INFRARED
 FREQUENCIES**

Type of Vibration			Frequency (cm ⁻¹)	Intensity
C-H	Alkanes	(stretch)	3000-2850	s
	-CH ₃	(bend)	1450 and 1375	m
	-CH ₂ -	(bend)	1465	m
	Alkenes	(stretch)	3100-3000	m
		(bend)	1700-1000	s
	Aromatic	(stretch)	3150-3050	s
		(out-of-plane bend)	1000-700	s
Alkyne	(stretch)	ca. 3300	m	
	Aldehyde		2900-2800 2800-2700	w w
C=C	Alkene	(stretch)	1680-1600	m-w
	Aromatic	(stretch)	1600-1400	m-w
C≡C	Alkyne	(stretch)	2250-2100	m-w
C=O	Aldehyde	(stretch)	1740-1720	s
	Ketone (acyclic)		1725-1705	s
	Carboxylic Acid		1725-1700	s
	Ester		1750-1730	s
	Amide		1700-1640	s
	Anhydride		1810 and 1760	s
C-O	Alcohols, ethers, esters carboxylic acids		1300-1000	s
O-H	Alcohols, phenols			
	Free		3650-3600	m
	H-bonded		3400-3200	m
	Carboxylic acids		3300-2500	m
NH	Primary and secondary amines		ca. 3500	m
C≡N	Nitriles		2260-2240	m
N=O	Nitro		1600-1500 and 1400-1300	s

**¹H-NMR
 CHEMICAL
 SHIFTS**

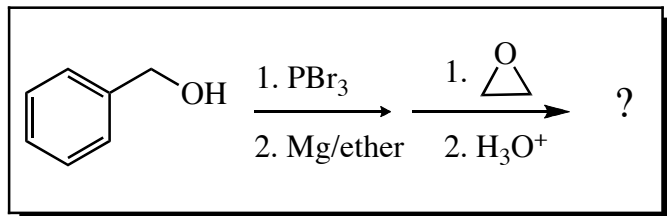


**¹³C-NMR
 CHEMICAL SHIFTS**



MULTIPLE CHOICE QUESTIONS: Answer each of the following questions by bubbling in the correct response on the Scantron answer sheet.

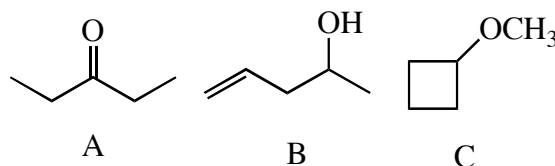
1. What would be the final product in the following reaction sequence?



- a.
- b.
- c.
- d.
- e.

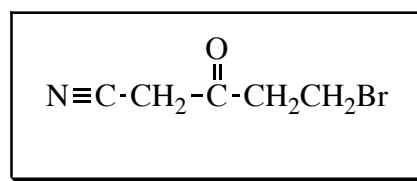
2. Why is the infrared absorption for the stretching of the carbon-carbon triple bond of internal alkynes rarely observed?
- They do not form cations.
 - They are too strong.
 - Observable bonds cannot be too symmetric.
 - They don't have hydrogens attached to them.
3. Which of the reagents/techniques listed below would serve as the basis for a simple chemical test to distinguish between $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_2\text{CHO}$ and $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_2\text{CH}_2\text{OH}$?
- KMnO_4
 - Br_2 in CCl_4
 - IR spectroscopy
 - PCC
 - Both c and d

4. Which of the following statements is (are) accurate about the IR spectra of compounds A, B, and C?



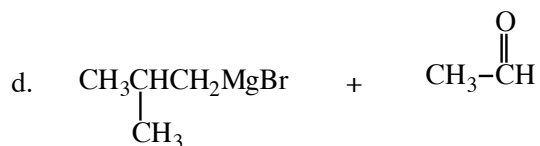
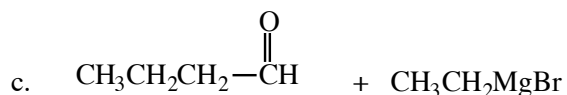
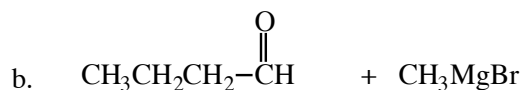
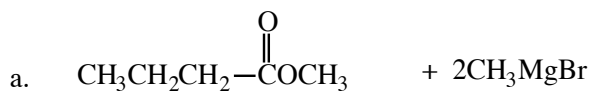
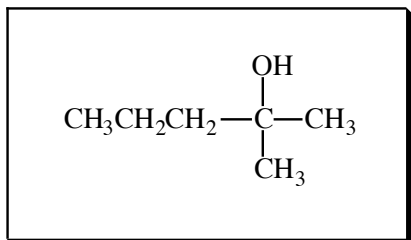
- Compound A shows absorptions at 3000 and 1700 cm^{-1} .
- Compound B shows absorptions at 3200-3600 and 1650 cm^{-1} .
- Compound C shows absorptions at 3200-3600 and 3000 cm^{-1} .
- Both a and b are true.
- Answers a, b, and c are all true.

5. Which of the following statements is (are) true about the infrared spectrum of the compound shown below?

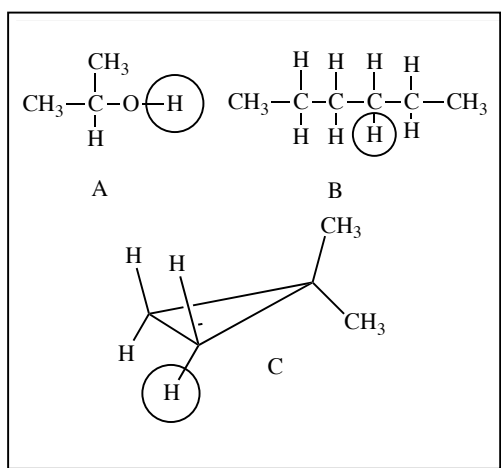


- It shows absorptions at 3000-3150 cm^{-1} and 1720 cm^{-1} .
- It shows absorptions at 3000-2850 cm^{-1} and 2250 cm^{-1} .
- It shows absorptions at 2250 cm^{-1} and 1650 cm^{-1} .
- It shows absorptions at 2250 cm^{-1} and 1720 cm^{-1} .
- Both b and d are true.

6. Which Grignard reaction could be used to synthesize :

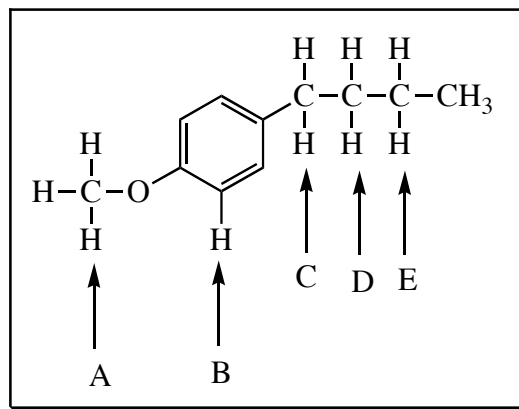


7. How many peaks would be seen for each of the circled protons in the compounds below?



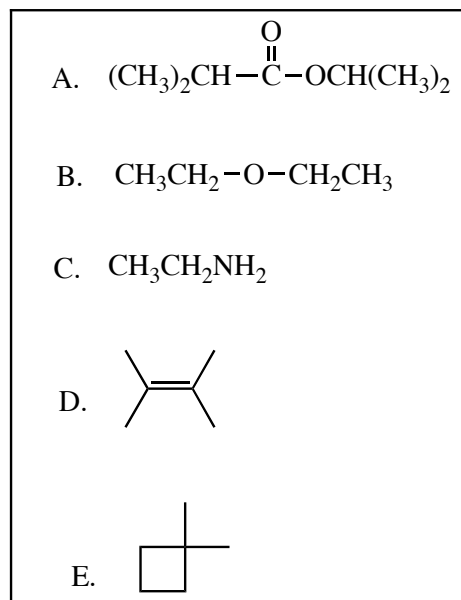
- a. A: 1; B: 5; C: 2
b. A: 2; B: 5; C: 1
c. A: 1; B: 5; C: 1
d. A: 2; B: 5; C: 2
e. A: 1; B: 3; C: 1

8. Which of the labeled hydrogens absorbs furthest *upfield* in the NMR?



- a. A b. B c. C d. D e. E

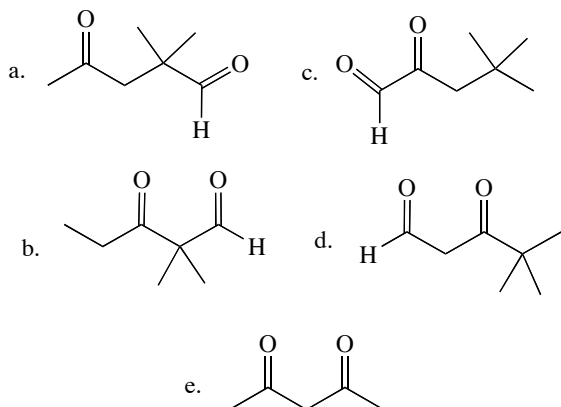
9. How many different kinds of protons are present in each of the following molecules?



- a. A: 4; B: 2; C: 1; D: 4; E: 3
b. A: 3; B: 2; C: 3; D: 1; E: 3
c. A: 4; B: 3; C: 3; D: 7; E: 4
d. A: 4; B: 2; C: 3; D: 1; E: 3

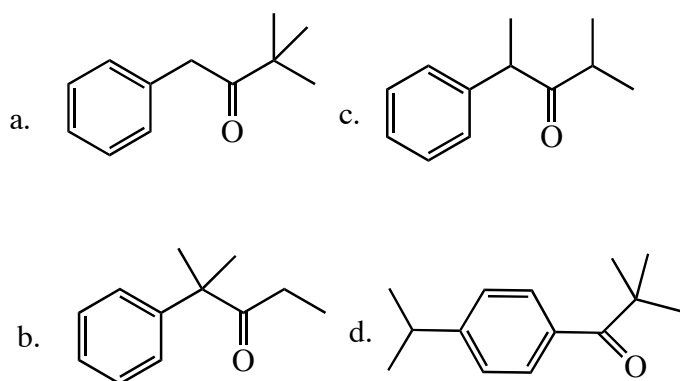
e. A: 4; B: 2; C: 3; D: 1; E: 4

10. The $^1\text{H-NMR}$ spectrum of which of the compounds below would consist of a singlet, a doublet, and a triplet only?



11. An unknown compound Z has the molecular formula $\text{C}_{12}\text{H}_{16}\text{O}$. Z absorbs strongly in the IR at 1700 cm^{-1} . The NMR spectral data for Z are given below. What is the structure of Z?

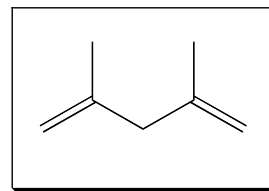
1.0 δ , 6H, s; 1.2 δ , 3H, t; 2.2 δ , 2H, qt;
7.0 δ , 5H, broad singlet



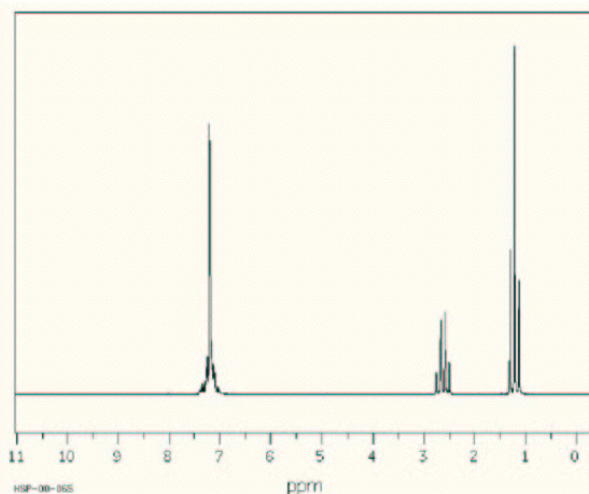
12. Reaction of an aldehyde with NaBH_4 yields:

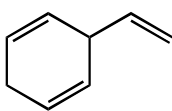
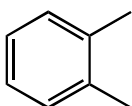
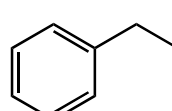
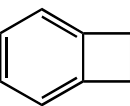
- a. primary alcohol
b. secondary alcohol
c. tertiary alcohol
d. ketone
e. ester

13. Consider the expected $^1\text{H-NMR}$ spectrum of 2,4-dimethyl-1,4-pentadiene. Which of the following is likely to be observed?



- a. 7 signals: all singlets
b. 4 signals: all singlets
c. 3 signals: all singlets
d. 3 signals: one singlet, 2 doublets
e. 4 signals: two singlets, 2 doublets
14. A compound with the molecular formula C_8H_{10} gives the following $^1\text{H-NMR}$ spectrum. What is its structure?



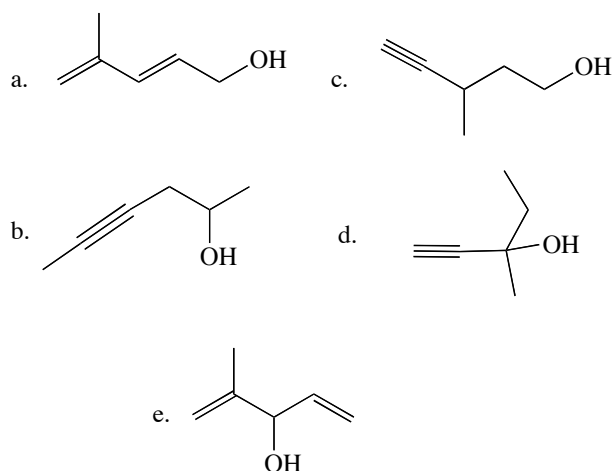
- a. 
- b. 
- c. 
- d. 
- e. Can't tell just from the NMR spectrum

15. Which of these transformations cannot be classified as a reduction?

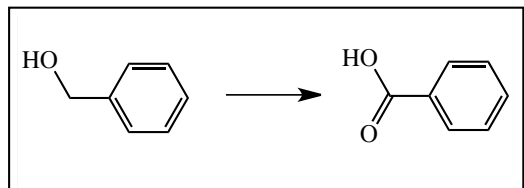
- $\text{RCH}_2\text{Cl} \longrightarrow \text{RCH}_3$
- $\text{RCH}=\text{CH}_2 \longrightarrow \text{RCH}_2\text{CH}_3$
- $\text{RCOOH} \longrightarrow \text{RCH}_2\text{OH}$
- $\text{RCOR} \xrightarrow{\text{O}} \text{RCH}_2\text{OH} + \text{ROH}$
- All of these are reductions.

16. Determine the likely structure for a compound A ($\text{C}_6\text{H}_{10}\text{O}$) which is found to decolorize bromine at room temperature. Its spectral data are as follows:

$^1\text{H-NMR}$	IR
triplet, 1.0 δ ;	2200 cm^{-1} (sharp)
singlet 1.4 δ ;	3300 cm^{-1} (strong)
quartet 1.6 δ	3500 cm^{-1} (broad)



17. Which of the following reagents would NOT carry out the following reaction?

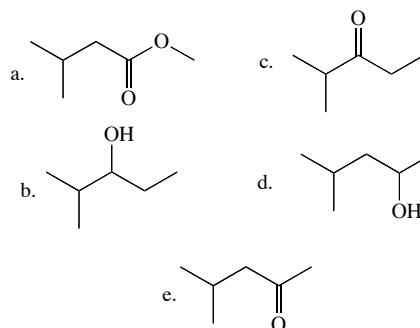
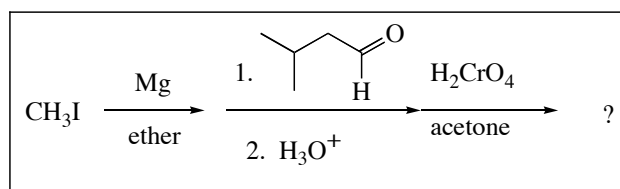


- PCC
- KMnO_4
- $\text{Na}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4$
- All of the above will work.

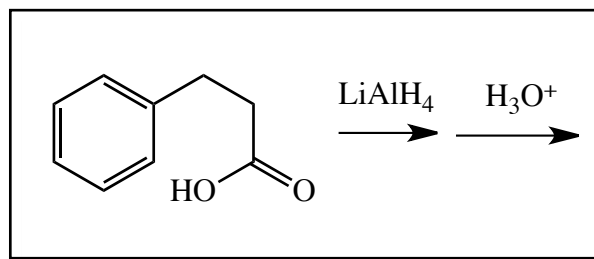
18. The $^1\text{H-nmr}$ spectrum of $\text{ClCH}_2\text{CH}_2\text{CH}_2\text{Cl}$ consists of:

- a triplet and a quartet.
- a doublet and a quartet.
- a triplet and a doublet.
- a triplet and a quintet.

19. What is the final product of the following reaction sequence?

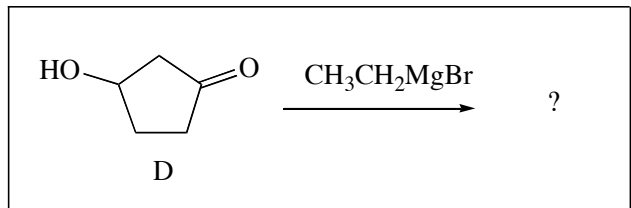


20. The major product of the following reaction is:



- No reaction
-
-
-

21. What is the principal product formed when 1 mole of ethylmagnesium bromide reacts with 1 mole of 3-hydroxycyclopentanone (D)?

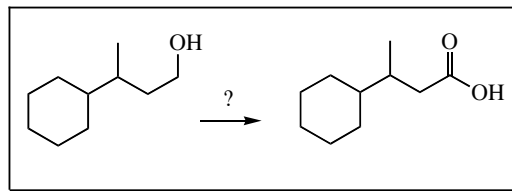


- a.
- b.
- c.
- d.
- e.

22. Which of the following compounds could *not* be easily distinguished using IR spectroscopy?

- a. and
- b. $\text{CH}_3\text{CH}_2\text{OH}$ and CH_3OCH_3
- c. and
- d. $\text{CH}_3\text{CH}_2\text{C}(=\text{O})\text{OH}$ and $\text{CH}_3\text{C}(=\text{O})\text{OCH}_3$
- e. $(\text{CH}_3\text{CH}_2)_2\text{NH}$ and $(\text{CH}_3\text{CH}_2)_3\text{N}$

23. Which reagent will effect the following conversion?

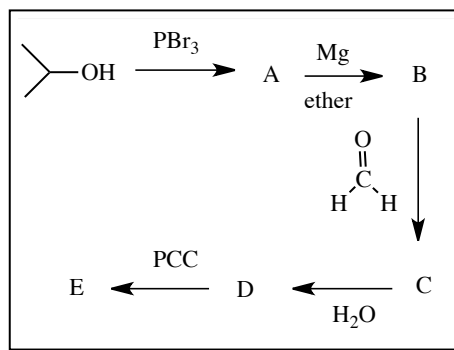


- a. NaBH_4
- b. PCC
- c. $\text{Na}_2\text{Cr}_2\text{O}_7$
- d. peracetic acid
- e. O_3 followed by $\text{Zn}/\text{H}_2\text{O}$

24. Which of the following does NOT react with sodium borohydride?

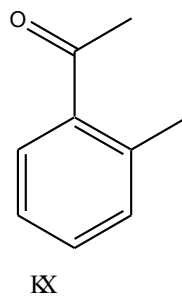
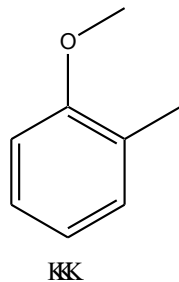
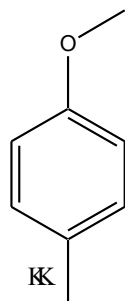
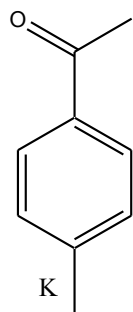
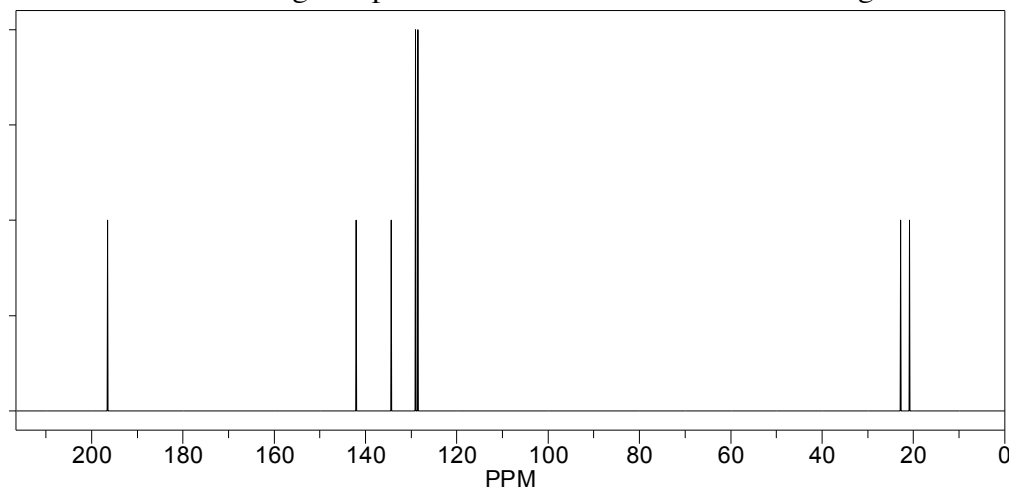
- a.
- b.
- c.
- d.

25. Provide the structure for the final product, (E), in the following reaction sequence:



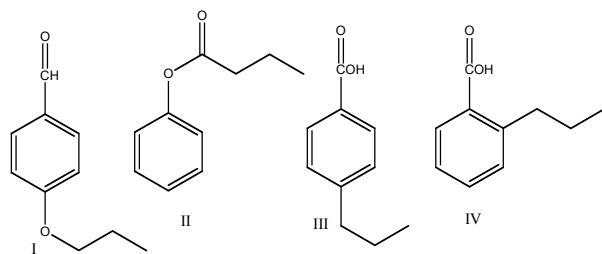
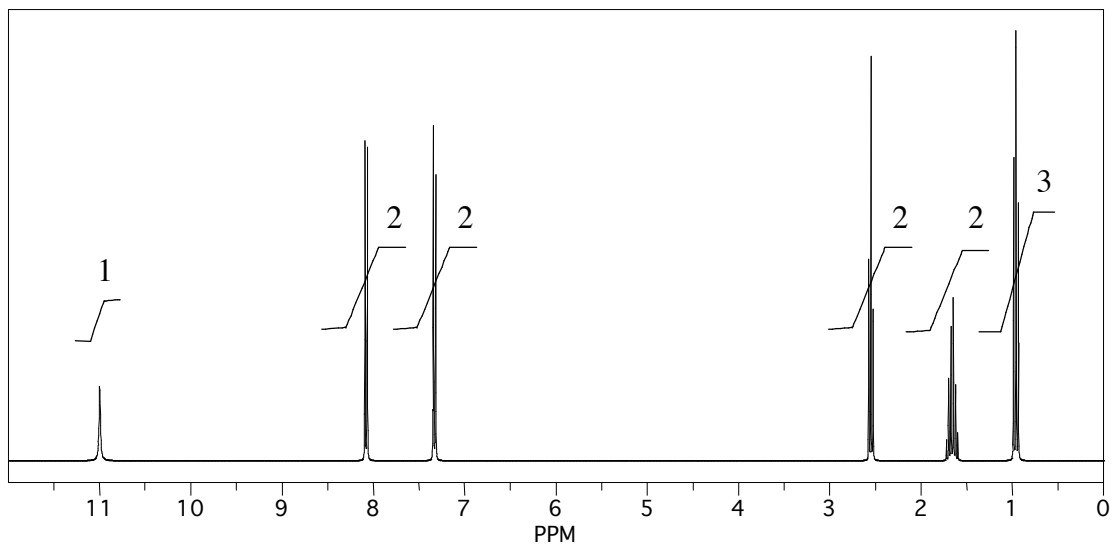
- a.
- b.
- c.
- d.
- e.

26. Which of the following compounds is consistent with the following ^{13}C NMR spectrum?



- A) I
- B) II
- C) III
- D) IV
- E) none of these

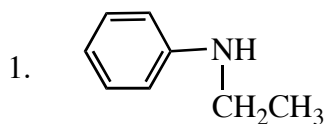
27. A compound with a molecular formula $C_{10}H_{12}O_2$ has the following HNMR spectrum. Which of the following structures is consistent with this spectrum?



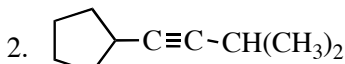
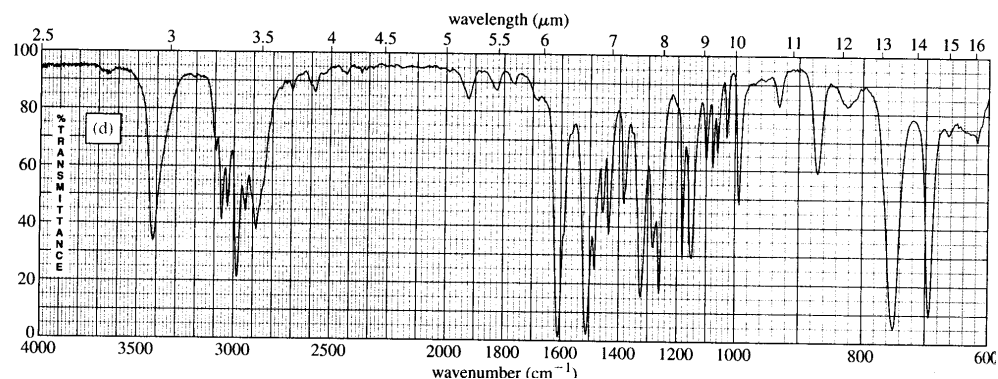
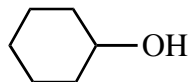
- A) I
B) II
C) III
D) IV
E) none of these

II. SPECTROSCOPY PROBLEMS

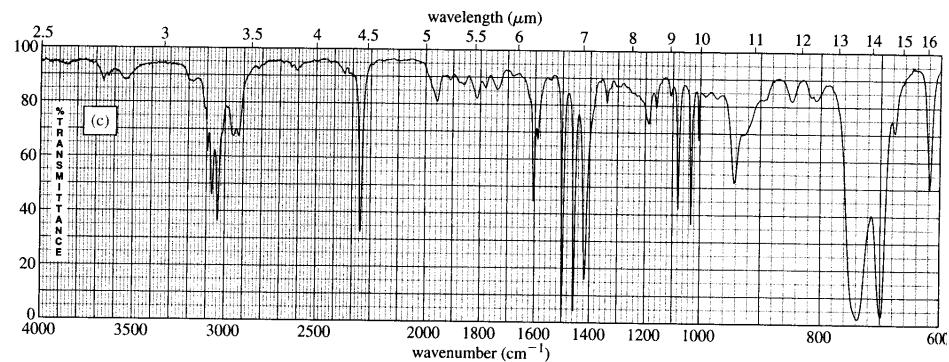
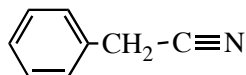
- A. For EACH of the following infrared spectra, indicate which of the two given compounds is responsible for the spectrum, AND give your reasoning (i.e, briefly explain why the structure you chose better fits the spectrum). [4 points each]



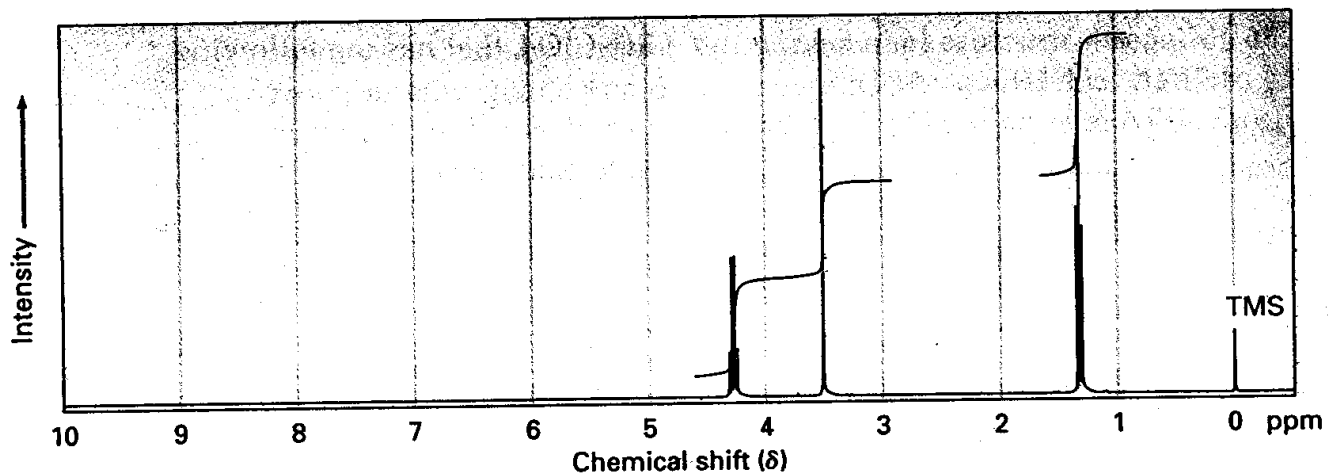
or



or



- B. This compound has the molecular formula $C_5H_7NO_2$. Its infrared spectrum shows a sharp peak of medium intensity at 2250 cm^{-1} , a very strong peak at 1735 cm^{-1} , and no absorptions above 3000 cm^{-1} . It has the following $^1\text{H-NMR}$ spectrum



C. A compound with the molecular formula C_4H_7BrO has the following 1H -NMR spectrum:

1.7 δ (3H, d); 2.2 (3H, s); 4.68 (1H, qt)

What is the structure of this compound? For partial credit, you must show your reasoning. The more correct information you give, the more partial credit you will receive.