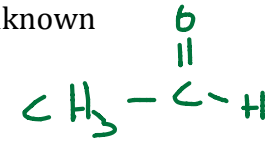
Name: Answer Key Section _____

CHEM 226: Elementary Organic Chemistry
Spring 2013 Quiz 2:
Chapter 12-Spectroscopy Dr. Odago

1. An IR spectrum of an unknown organic molecule having the formula C_2H_4O reveals a strong absorption at 1715–1725 cm^{-1}. To what class of compounds does the unknown belong?

C

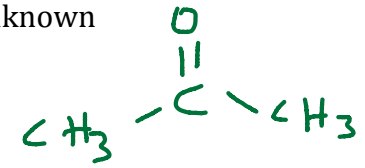
A) alcohol
B) amine
C) aldehyde
D) alkyne
E) ether



2. An IR spectrum of an unknown organic molecule having the formula C_3H_6O reveals a strong absorption at 1725 cm^{-1}. To what class of compounds does the unknown belong?

C

A) acid chloride
B) alkene
C) ketone
D) alkyne
E) phenol

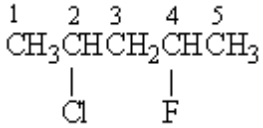


3. How many peak(s) would you expect to see in the ^1H NMR spectrum of 1-bromobutane?

D

A) 1
B) 2
C) 3
D) 4
E) more than 4

4. In the ^1H NMR spectrum of the following molecule, the protons on which carbon will have the most downfield chemical shift?

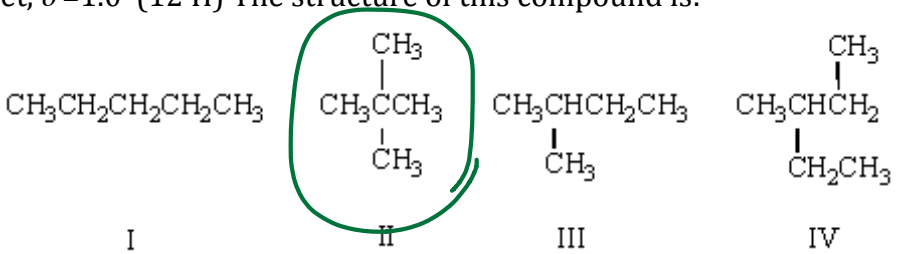


most electronegative F, deshields, hence more downfield

D

A) 1
B) 2
C) 3
D) 4
E) 5

5. A compound with the molecular formula C_5H_{12} gave the following ^1H NMR spectrum singlet, δ =1.0 (12 H) The structure of this compound is:



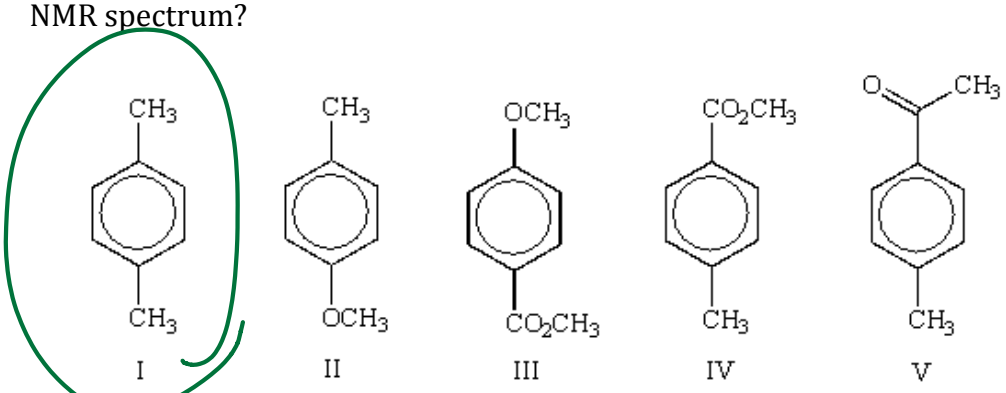
I II III IV

B

A) I
B) II
C) III
D) IV
E) all are possible

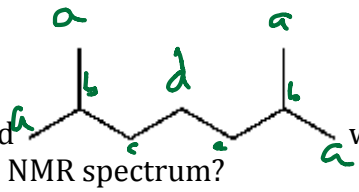
all H equivalent

6. Which of the following molecules will show two peaks with an area ratio of 6:4 in its ^1H NMR spectrum?



A

A) I
B) II
C) III
D) IV
E) V

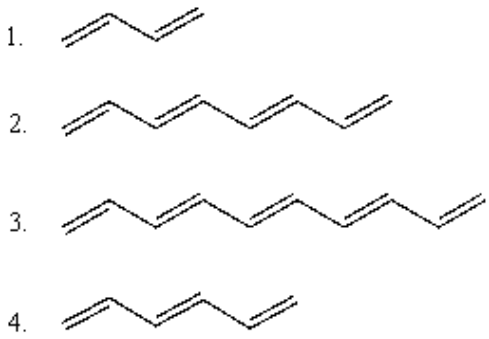
7. The compound  will show what number of peaks in its ^1H decoupled ^{13}C NMR spectrum?

(4)

B

A) 3
B) 4
C) 5
D) 6
E) 9

8. The following compounds in order of increasing wavelength of maximum UV-VIS absorption are



B

A) 1 < 2 < 3 < 4
B) 1 < 4 < 2 < 3
C) 3 < 2 < 4 < 1
D) 4 < 3 < 2 < 1
E) 1 < 2 < 4 < 3

9. A bromoalkane shows two parent ion peaks *m/z* 122 and 124. What is the molecular formula?

B

A) C_4H_9Br
B) C_3H_7Br
C) C_2H_5Br
D) CH_3Br
E) $C_2H_{19}Br$

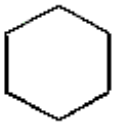
$C_nH_{2n+1}Br = 124$

$12n + 2n + 1 + 81 = 124$ ∴ C_3H_7Br

$14n = 42$

$n = 3$

10. Which of the following compounds will have one peak in its ^1H NMR and two peaks in its ^{13}C NMR spectrum?

A) 

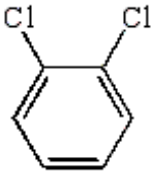
1 ^1H NMR peak
1 ^{13}C peak

B) 

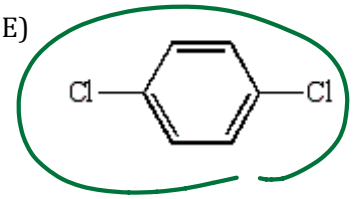
1 peak in both

C) $H_3C—CH_3$

1 peak in both

D) 

2 ^1H NMR peaks
3 ^{13}C NMR peaks

E) 

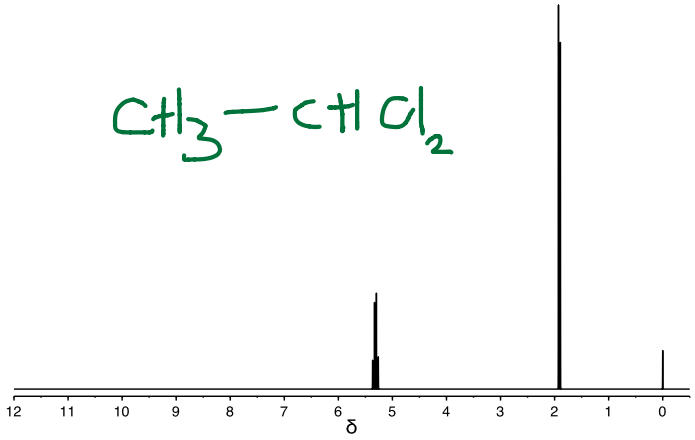
1 ^1H peak
2 ^{13}C NMR peaks

E

Bonus Question

11. The ^1H NMR spectrum of two isomeric compounds with the molecular formula $C_2H_4Cl_2$ are shown. Predict the structures and match each with the correct spectrum based on the number of peaks, the chemical shift and/or the splitting pattern. (The peak at δ=0 is due to TMS)

$CH_3—CHCl_2$



$Cl—CH_2—CH_2—Cl$

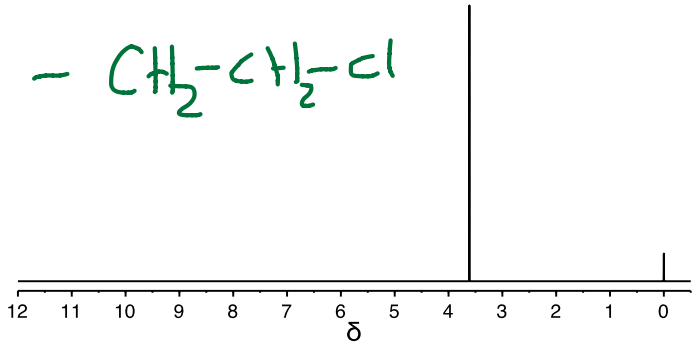


Table 12.2 Typical ^1H Chemical Shifts (Relative to Tetramethylsilane)

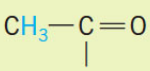
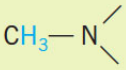
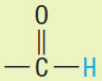
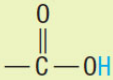
Type of ^1H	δ (ppm)	Type of ^1H	δ (ppm)
C—CH_3	0.85–0.95	—CH_2—F	4.3–4.4
C—CH_2—C	1.20–1.35	—CH_2—Br	3.4–3.6
		—CH_2—I	3.1–3.3
	1.40–1.65	CH_2=C	4.6–5.0
CH_3—C≡C	1.6–1.9	—CH=C	5.2–5.7
CH_3—Ar	2.2–2.5	Ar—H	6.6–8.0
	2.1–2.6	—C≡C—H	2.4–2.7
	2.1–3.0		9.5–9.7
CH_3—O—	3.5–3.8		10–13
—CH_2—Cl	3.6–3.8	R—OH	0.5–5.5
—$CHCl_2$	5.8–5.9	Ar—OH	4–8

Table 12.4 Infrared Stretching Frequencies of Some Typical Bonds

Bond type	Group	Class of compound	Frequency range (cm^{-1})
single bonds to hydrogen	C—H	alkanes	2850–3000
	=C—H	alkenes and aromatic compounds	3030–3140
	≡C—H	alkynes	3300
	O—H	alcohols and phenols	3500–3700 (free) 3200–3500 (hydrogen-bonded)
	O—H	carboxylic acids	2500–3000
	N—H	amines	3200–3600
	S—H	thiols	2550–2600
double bonds	C=C	alkenes	1600–1680
	C=N	imines, oximes	1500–1650
	C=O	aldehydes, ketones, esters, acids	1650–1780
triple bonds	C≡C	alkynes	2100–2260
	C≡N	nitriles	2200–2400