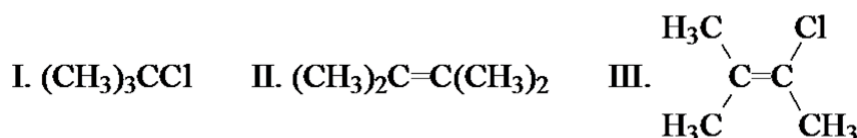


Chapter 13: Spectroscopy

1. Which of the following isomeric dibromopropanes has only a single peak in its proton NMR spectrum?
 A) 1,1-dibromopropane C) 1,2-dibromopropane
 B) 1,3-dibromopropane D) 2,2-dibromopropane
 Ans: D

2. How many different types(sets) of hydrogens are there in 2,2-dimethylpentane?
 A) 2 B) 3 C) 4 D) 5
 Ans: C

3. Which of the following has only a single peak in its proton NMR spectrum?



- A) only I B) only II C) I and II D) I, II, and III
 Ans: C

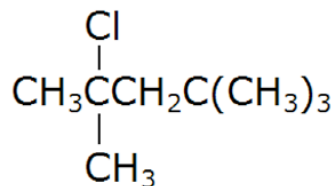
4. A compound is either cyclononane or cyclodecane. Which of the following is the most useful technique in identifying the compound?
 A) IR spectroscopy B) mass spectrometry C) proton NMR D) C-13 NMR
 Ans: B

5. Which of the following gives the furthest downfield shift from TMS in its proton NMR spectrum?
 A) $(\text{CH}_3)_4\text{C}$ B) $(\text{CH}_3)_3\text{N}$ C) $(\text{CH}_3)_2\text{O}$ D) CH_3F
 Ans: D

6. Which of the following gives the furthest downfield shift from TMS in its proton NMR spectrum?
 A) CCl_4 B) CHCl_3 C) CH_2Cl_2 D) CH_3Cl
 Ans: B

7. How many different sets of equivalent protons are there for *para*-xylene (1,4-dimethylbenzene)?
 A) only 1 B) two C) three D) four
 Ans: B

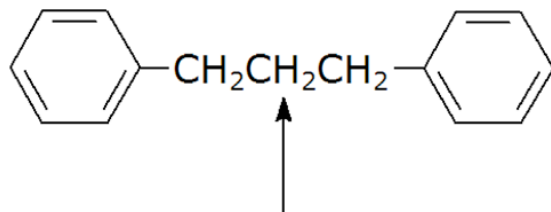
8. How many different sets of equivalent protons are there in the following compound?



- A) three B) four C) five D) six

Ans: A

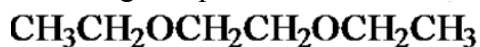
9. What is the multiplicity of the methylene hydrogens indicated in the proton NMR of the following compound?



- A) doublet B) triplet C) quartet D) pentet

Ans: D

10. What is the multiplicity of the methylene hydrogens indicated in the proton NMR of the following compound?



- A) singlet B) doublet C) triplet D) quartet

Ans: A

11. What are the approximate intensities of the four lines in the quartet from the proton NMR of diethyl ether, $(\text{CH}_3\text{CH}_2)_2\text{O}$? (Assume distortion of the quartet is minimal.)

- A) 1:1:1:1 B) 1:2:2:1 C) 2:3:3:2 D) 1:3:3:1

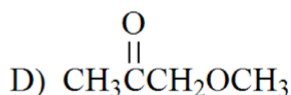
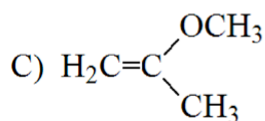
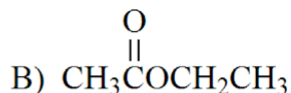
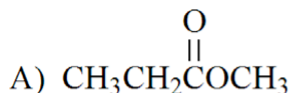
Ans: D

12. Which compound below fits the following proton NMR data?

triplet δ 1.22 (3H)

singlet δ 1.98 (3H)

quartet δ 4.07 (2H)



A) A B) B C) C D) D

Ans: B

13. The proton NMR of 1,1-dibromoethane would appear as a

A) downfield doublet and upfield quartet.

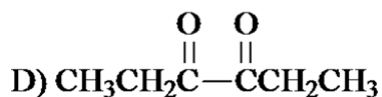
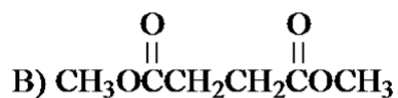
B) downfield quartet and upfield doublet.

C) downfield doublet and upfield triplet.

D) downfield triplet and upfield doublet.

Ans: B

14. The proton NMR spectrum of a compound gives singlets at δ 2.10 and δ 2.56 in a ratio of 3:2, respectively. Which compound below is the best match for the spectrum?

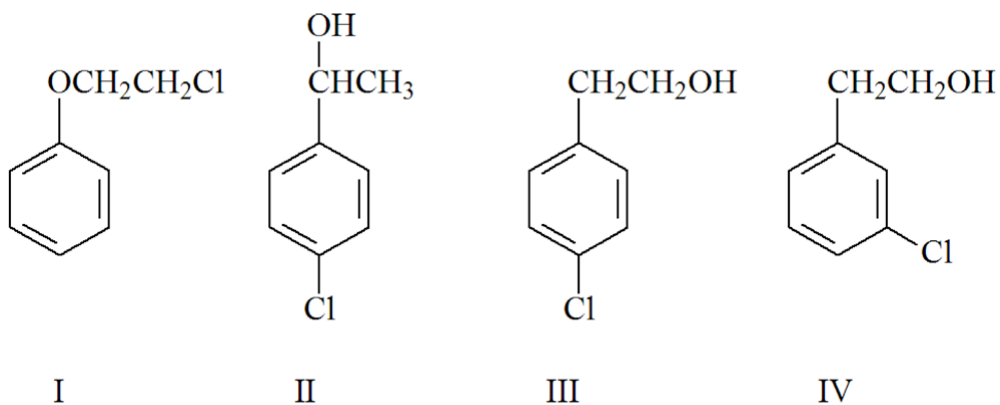


A) A B) B C) C D) D

Ans: C

15. The proton NMR of a compound, C_8H_9ClO , has the following peaks. Which compound below best fits the data?

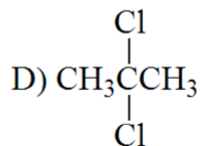
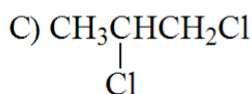
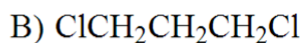
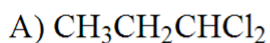
broad singlet	δ 2.41 (1H)
triplet	δ 2.41 (2H)
triplet	δ 3.69 (2H)
doublet	δ 7.02 (2H)
doublet	δ 7.50 (2H)



- A) I B) II C) III D) IV

Ans: C

16. The proton NMR spectrum of a compound, $C_3H_6Cl_2$, has a pentet at δ 2.19 and a triplet at δ 3.72 in a 1:2 ratio, respectively. Which compound below best matches the data?



- A) A B) B C) C D) D

Ans: B

17. A large doublet and a small septet pattern in 1H NMR is usually indicative of a(n)

- A) ethyl group. B) propyl group. C) isopropyl group. D) phenyl group.

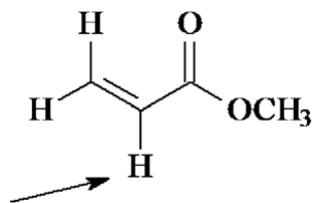
Ans: C

18. A triplet and quartet pattern in 1H NMR often indicates the presence of a(n)

- A) ethyl group. B) propyl group. C) isopropyl group. D) phenyl group.

Ans: A

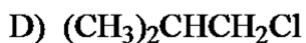
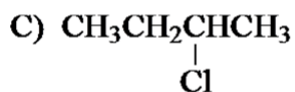
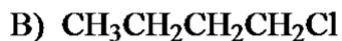
19. Which of the following describes the spin-spin splitting of the indicated H in the ^1H NMR of the compound shown below?



- A) singlet B) doublet of doublets C) triplet D) doublet of triplets
 Ans: B

20. Identify the $\text{C}_4\text{H}_9\text{Cl}$ isomer given the following proton NMR data:

doublet δ 1.04 (6H)
 multiplet δ 1.95 (1H)
 doublet δ 3.35 (2H)



- A) A B) B C) C D) D

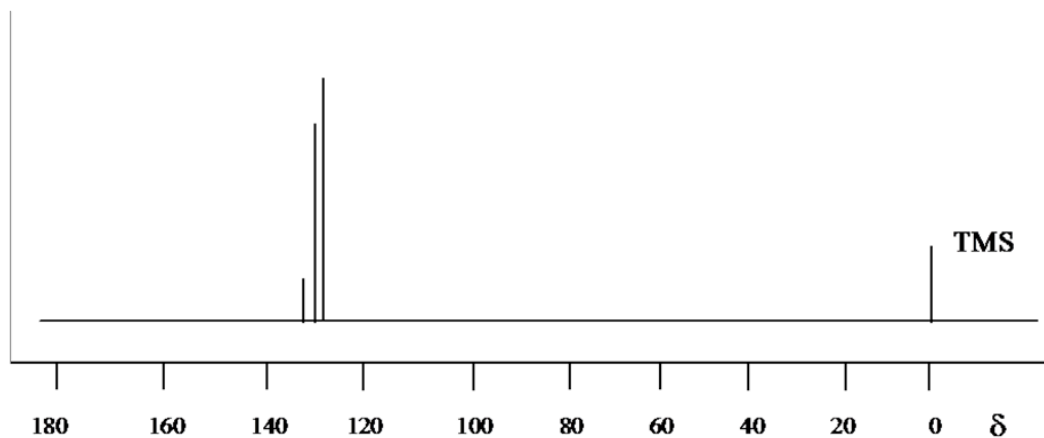
Ans: D

21. What region of the electromagnetic spectrum is used in nuclear magnetic resonance spectroscopy?

- A) radio wave B) X-ray C) ultraviolet D) microwave

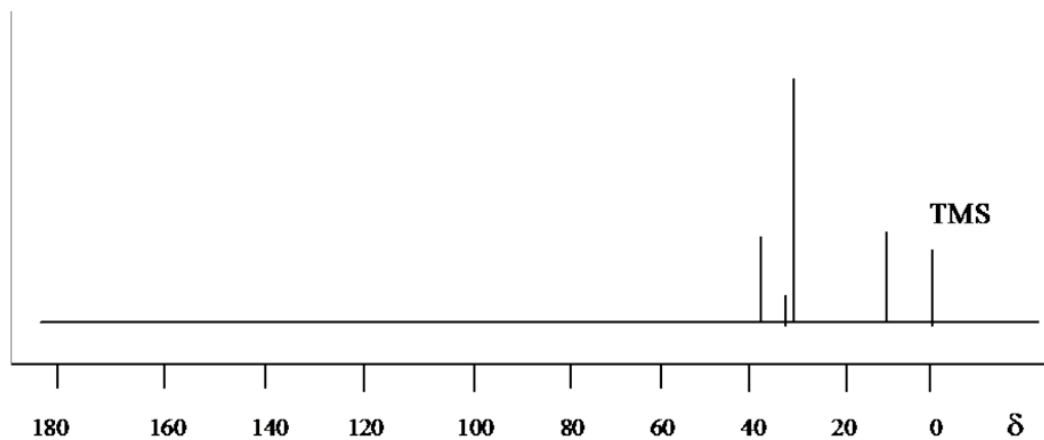
Ans: A

22. Which of the compounds below fit the following C-13 NMR?



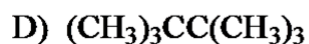
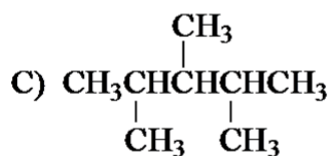
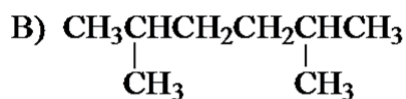
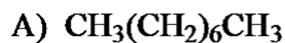
- A) *para*-dichlorobenzene
 B) *meta*-dichlorobenzene
 C) *ortho*-dichlorobenzene
 D) chlorobenzene
- Ans: C

23. Identify which one of the following isomers of C₆H₁₄ has the C-13 NMR below.



- A) CH₃CH₂CH₂CH₂CH₂CH₃
 B) CH₃CH₂CH₂CH(CH₃)₂
 C) (CH₃)₂CHCH(CH₃)₂
 D) CH₃CH₂C(CH₃)₃
- Ans: D

24. Which one of the following isomers of C_8H_{18} has only two peaks in its ^{13}C NMR?



A) A B) B C) C D) D

Ans: D

25. In infrared spectroscopy, absorption of electromagnetic radiation results in transitions between _____ energy levels.

A) vibrational B) electronic C) rotational D) nuclear

Ans: A

26. In proton NMR, 1H - 1H spin-spin splitting is common. Why is there no comparable ^{13}C - ^{13}C spin-spin splitting in C-13 NMR?

A) C-13 has a nuclear spin of zero.

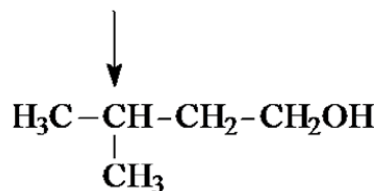
B) The probability of two C-13 nuclei being next to each other in a compound is very low.

C) The coupling constant is very small—too small to be observed.

D) There is ^{13}C - ^{13}C spin-spin splitting but because of the complex splitting patterns decoupling techniques are used to suppress it.

Ans: B

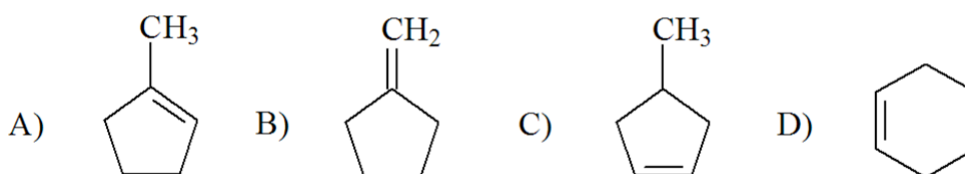
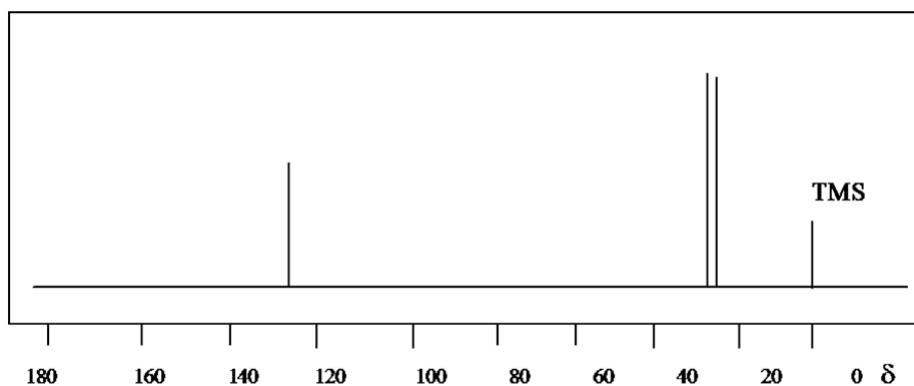
27. What is the multiplicity of the indicated carbon in an off-resonance decoupled C-13 NMR spectrum? (In off-resonance decoupled spectra, direct ^{13}C - 1H coupling is observed.)



A) singlet B) doublet C) quartet D) multiplet

Ans: B

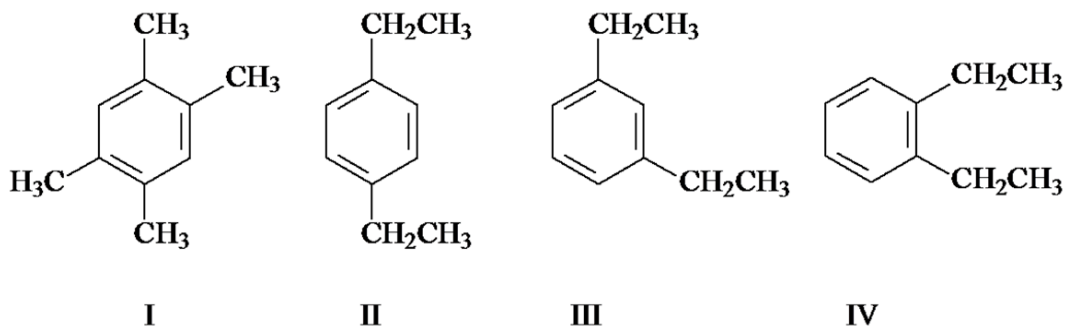
28. Which one of the following compounds fits the C-13 NMR spectrum shown below?



A) A B) B C) C D) D

Ans: D

29. A C-13 NMR spectrum of a compound, $C_{10}H_{14}$, has five peaks. Two peaks are in the 10-30 ppm region and the other three are in the 120-140 ppm area. Which of the following compounds fits the data?



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

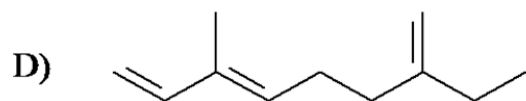
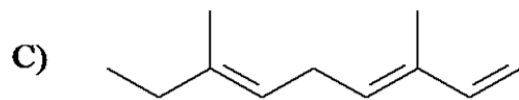
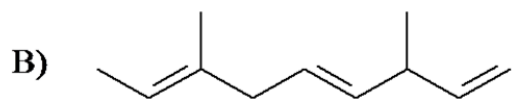
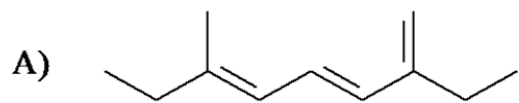
Ans: D

30. Which one of the following isomeric C_8H_{18} compounds has five peaks in its ^{13}C NMR spectrum?

A) octane B) 2-methylheptane C) 3-methylheptane D) 4-methylheptane

Ans: D

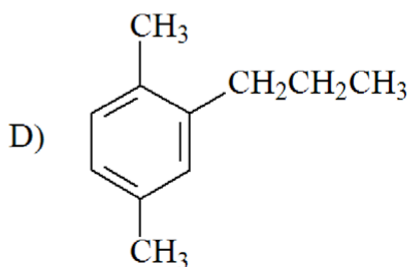
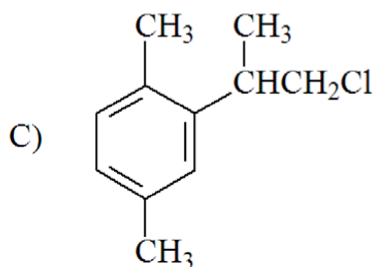
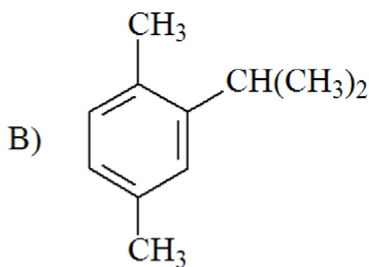
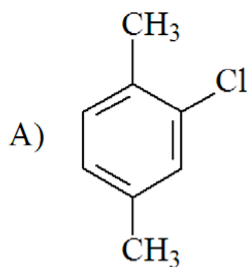
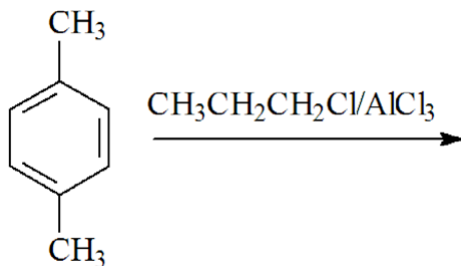
31. Which one of the following has a λ_{max} in its UV-visible spectrum with the longest wavelength?



A) A B) B C) C D) D

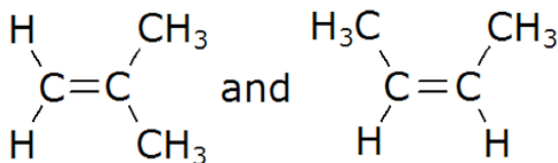
Ans: A

32. The reaction shown below gave two products in a ratio of approximately 1:2. The mass spectrum of the major product has a base peak at m/z 119. The minor product gave a base peak at m/z 133. Based on the reaction given and the information on the mass spectra, which of the following is the major product?



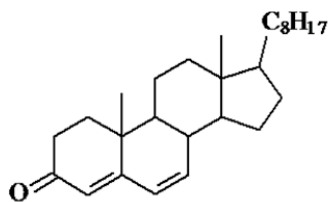
- A) A B) B C) C D) D
Ans: D

33. Which of the methods below would be most useful in distinguishing between the following two compounds?

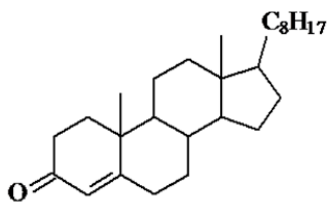


- A) UV spectroscopy
B) C-13 NMR
C) IR spectroscopy
D) mass spectrometry
Ans: B

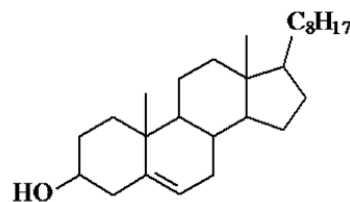
34. Match each steroid below with its λ_{max} in its UV-visible spectrum.



I



II



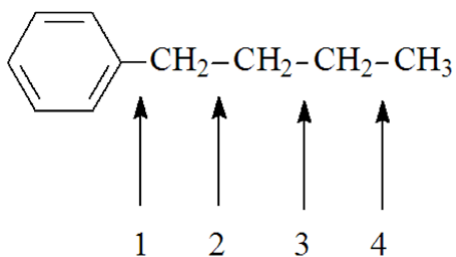
III

- | | I | II | III |
|----|--------|--------|--------|
| A) | 209 nm | 241 nm | 284 nm |
| B) | 241 nm | 284 nm | 206 nm |
| C) | 284 nm | 241 nm | 206 nm |
| D) | 284 nm | 206 nm | 241 nm |

A) A B) B C) C D) D

Ans: C

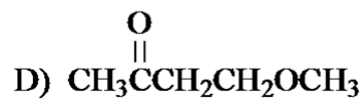
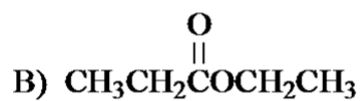
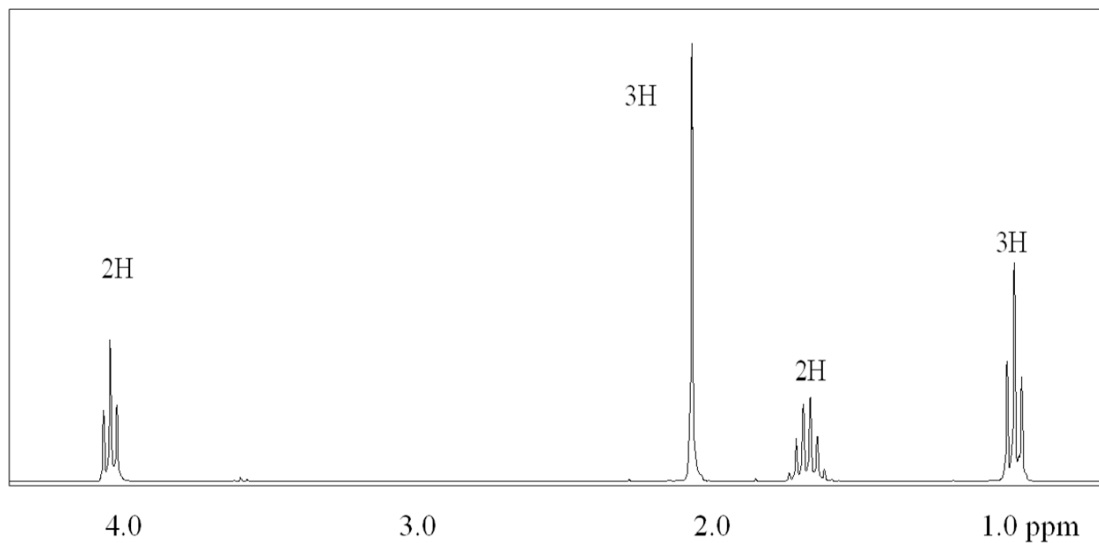
35. Which C-C bond would most likely break and give fragments in the mass spectrum of butyl benzene?



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

Ans: B

36. Which of the following compounds fits the proton NMR shown below?

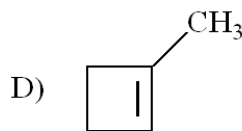
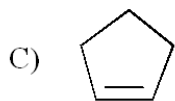
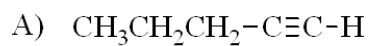
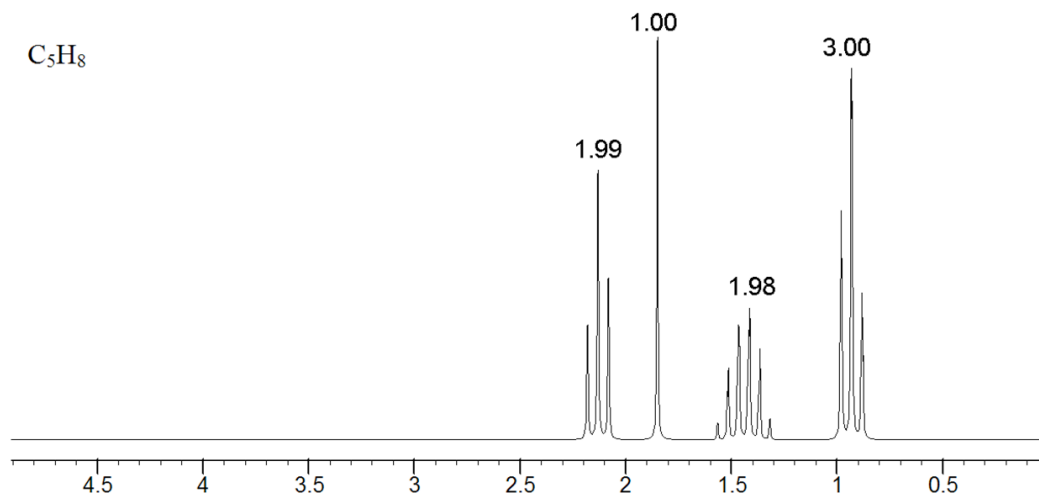


A) A B) B C) C D) D

Ans: C

37. Which of the following C_5H_8 compounds best fits the proton NMR spectrum shown below?

(The numbers above the peaks are integration values.)

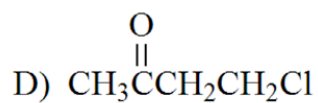
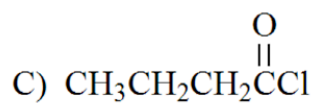
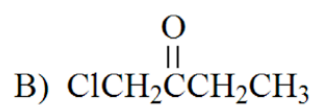
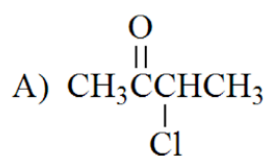
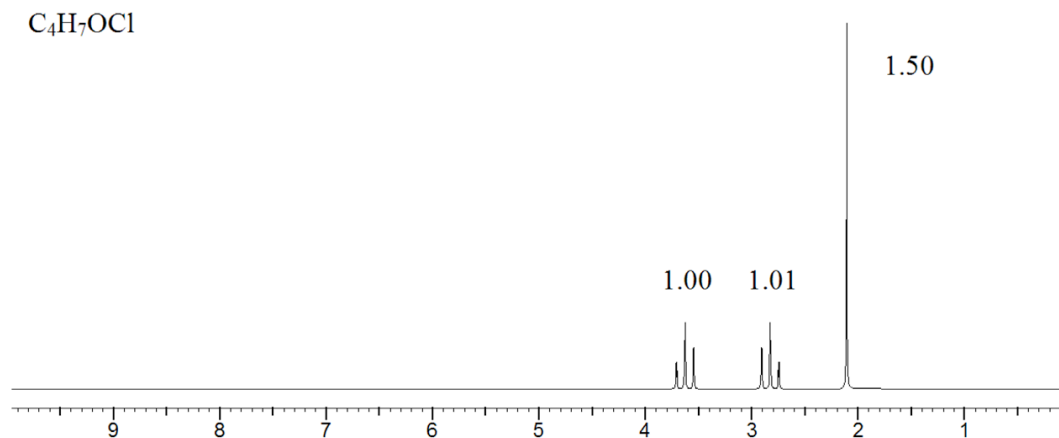


A) A B) B C) C D) D

Ans: A

38. Which of the following C_4H_7OCl compounds best fits the proton NMR spectrum shown below?

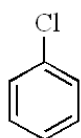
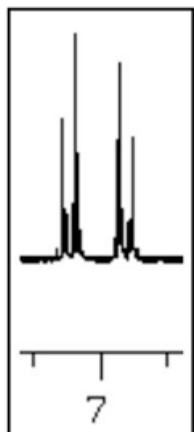
(The numbers above the peaks are integration values.)



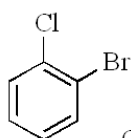
A) A B) B C) C D) D

Ans: D

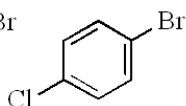
39. Which compound would you expect to give the ^1H NMR pattern shown?



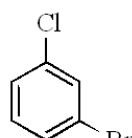
A



B



C

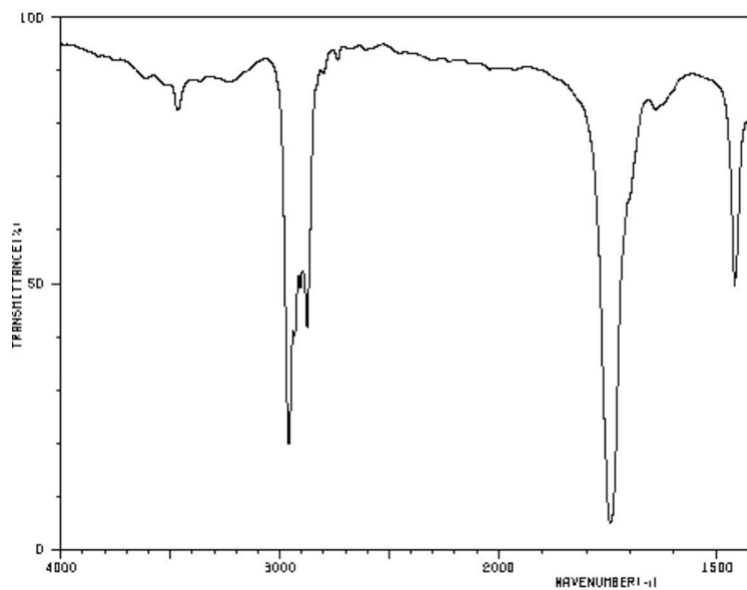


D

A) A B) B C) C D) D

Ans: C

40. The IR spectrum below reveals what functional group, if any?



C=C

O—H

C=O

A

B

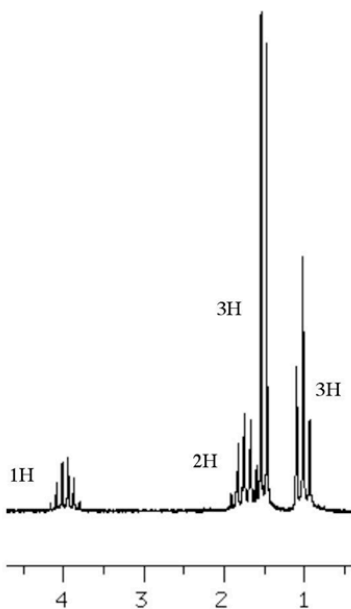
C

D: none of these

A) A B) B C) C D) D

Ans: C

41. Which compound C_4H_9Cl would give the 1H NMR shown below?



A) 1-chlorobutane

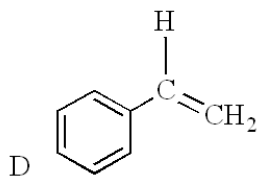
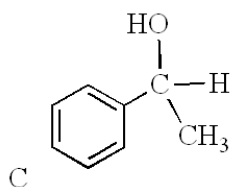
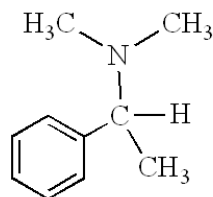
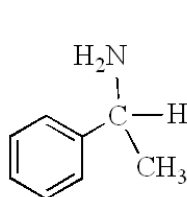
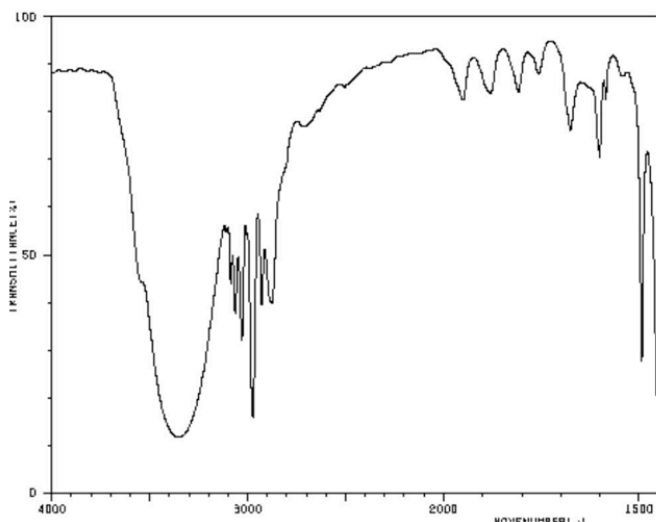
B) 1-chloro-2-methylpropane

C) 2-chlorobutane

D) 2-chloro-2-methylpropane

Ans: C

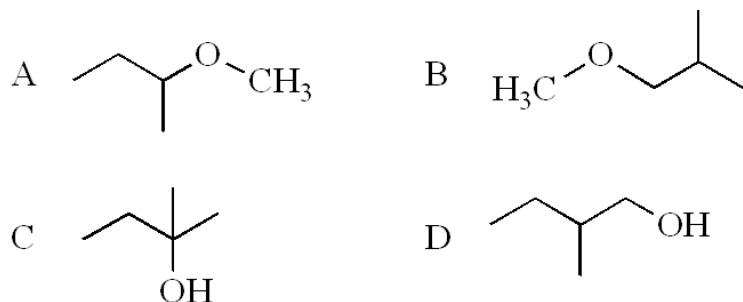
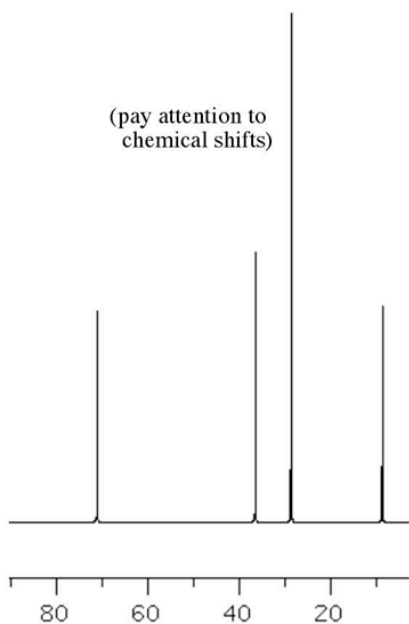
42. The IR spectrum shown below is most consistent with which structure?



A) A B) B C) C D) D

Ans: C

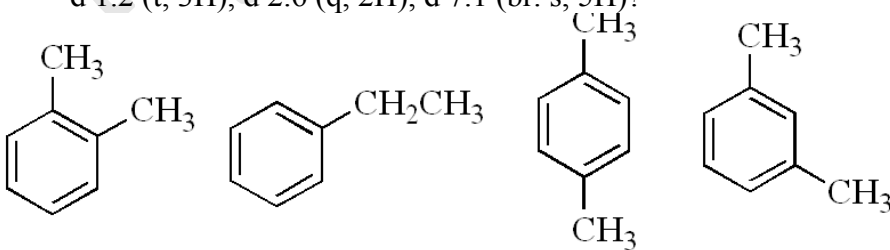
43. Which structure is most consistent with the ^{13}C NMR shown?



A) A B) B C) C D) D

Ans: C

44. What compound of formula C_8H_{10} would exhibit the following ^1H NMR:
d 1.2 (t, 3H), d 2.6 (q, 2H), d 7.1 (br. s, 5H)?



A

B

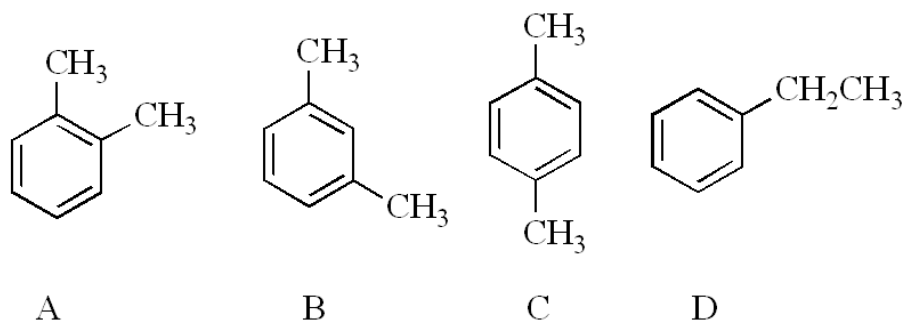
C

D

A) A B) B C) C D) D

Ans: B

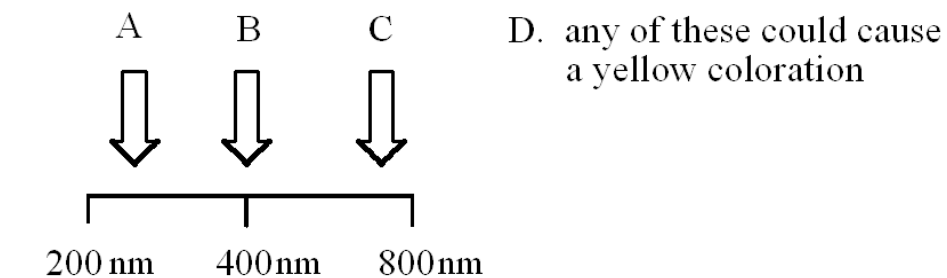
45. Which of the compounds below would exhibit the FEWEST peaks in the ^{13}C NMR spectrum?



A) A B) B C) C D) D

Ans: C

46. A compound's UV-vis absorption peak where would likely cause a yellow coloration?



A) A B) B C) C D) D

Ans: B