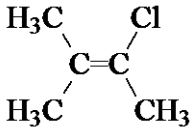
ACS Review Spectroscopy

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

I. $(CH_3)_3CCl$ II. $(CH_3)_2C{=}C(CH_3)_2$ III. 

   A. only I
   B. only II
   C. I and II
   D. I, II, and III

2. 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

3. Which of the following gives the furthest downfield shift from TMS in its proton NMR spectrum?

   A. $(CH_3)_4C$
   B. $(CH_3)_3N$
   C. $(CH_3)_2O$
   D. CH_3F

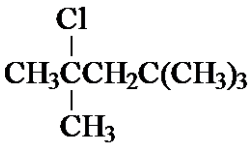
4. Which of the following gives the furthest downfield shift from TMS in its proton NMR spectrum?

   A. CCl_4
   B. $CHCl_3$
   C. CH_2Cl_2
   D. CH_3Cl

5. How many different sets of equivalent protons are there for *para*-xylene (1,4-dimethylbenzene)?

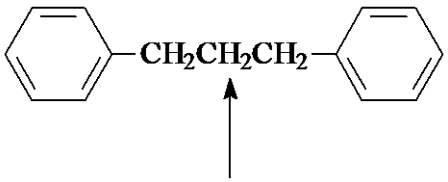
   A. only 1
   B. two
   C. three
   D. four

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



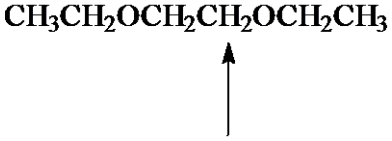
   A. three
   B. four
   C. five
   D. six

7. 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

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



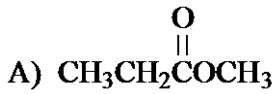
A. singlet
B. doublet
C. triplet
D. quartet

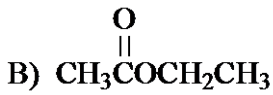
9. What are the approximate intensities of the four lines in the quartet from the proton NMR of diethyl ether, $(CH_3CH_2)_2O$? (Assume distortion of the quartet is minimal.)

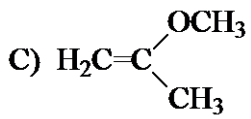
A. 1:1:1:1
B. 1:2:2:1
C. 2:3:3:2
D. 1:4:4:1

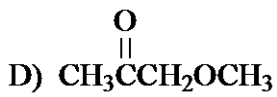
10. Which compound below fits the following proton NMR data?

triplet δ 1.22 (3H)
singlet δ 1.98 (3H)
quartet δ 4.07 (2H)

A) 

B) 

C) 

D) 

A. A
B. B
C. C
D. D

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

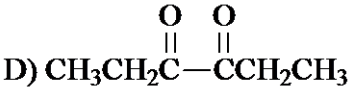
A. downfield doublet and upfield quartet
B. downfield quartet and upfield doublet
C. downfield doublet and upfield triplet
D. downfield triplet and upfield doublet

12. The proton NMR spectrum of a compound gives a singlet 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) $CH_3OCH_2CH_2OCH_3$

B) 

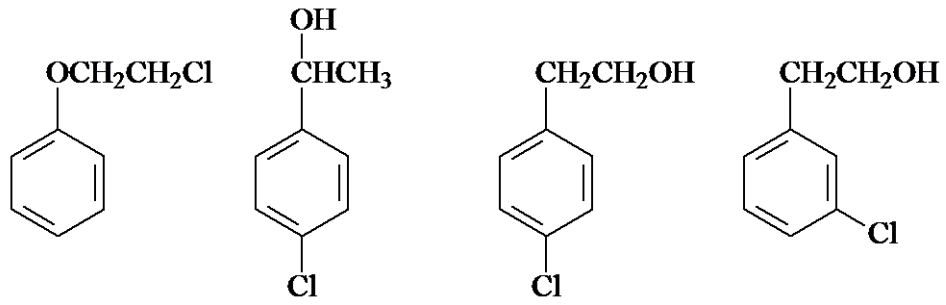
C) 

D) 

A. A
B. B
C. C
D. D

13. 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 2.75 (2H)
triplet	δ 3.69 (2H)
doublet	δ 7.02 (2H)
doublet	δ 7.50 (2H)



I II III IV

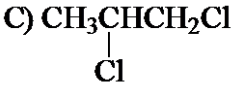
A. I

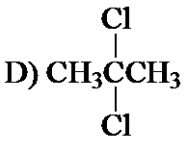
B. II
C. III
D. IV

14. 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) $CH_3CH_2CHCl_2$

B) $ClCH_2CH_2CH_2Cl$

C) 

D) 

A. A
B. B
C. C
D. D

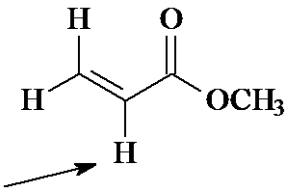
15. A large doublet and a small septet pattern in ^1H NMR is usually indicative of a(an):

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

16. A triplet and quartet pattern in ^1H NMR often indicates the presence of a(an):

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

17. 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

18. Identify the C_4H_9Cl isomer given the following proton NMR data:

doublet δ 1.04 (6H)

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

A) $(CH_3)_3CCl$

B) $CH_3CH_2CH_2CH_2Cl$

C) $CH_3CH_2\underset{\displaystyle Cl}{\underset{|}{C}}HCH_3$

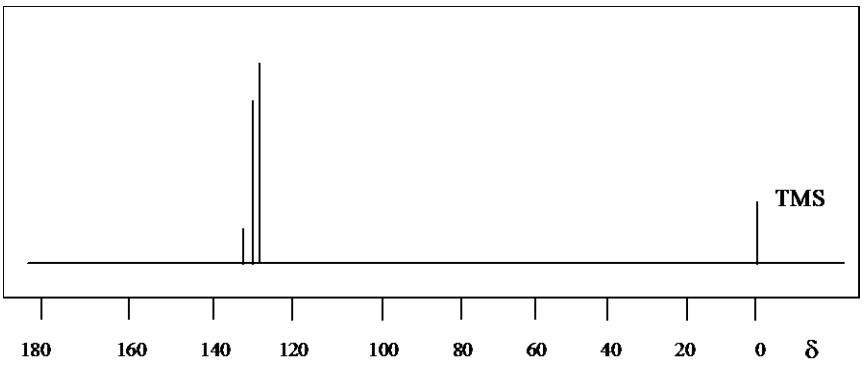
D) $(CH_3)_2CHCH_2Cl$

A. A
B. B
C. C
D. D

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

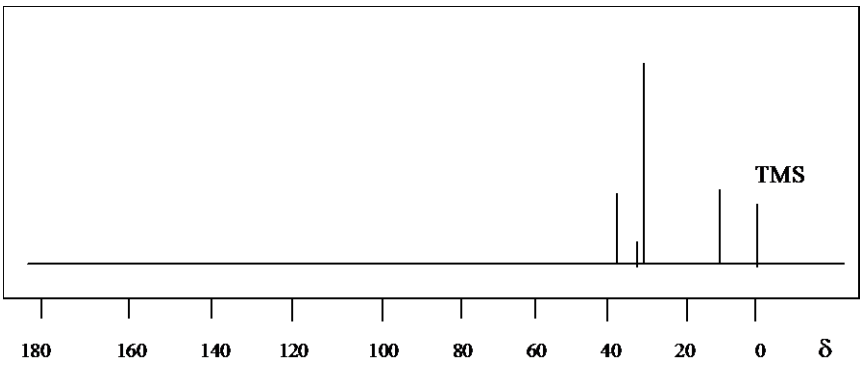
A. radio wave
B. X-ray
C. ultraviolet
D. microwave

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



A. *para*-dichlorobenzene
B. *meta*-dichlorobenzene
C. *ortho*-dichlorobenzene
D. chlorobenzene

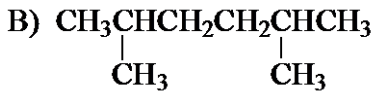
21. Identify which one of the following isomers of C_6H_{14} has the C-13 NMR below.

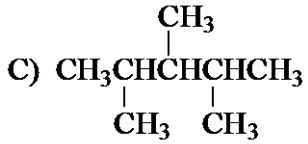


A. $CH_3CH_2CH_2CH_2CH_2CH_3$
B. $CH_3CH_2CH_2CH(CH_3)_2$
C. $(CH_3)_2CHCH(CH_3)_2$
D. $CH_3CH_2C(CH_3)_3$

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

A) $CH_3(CH_2)_6CH_3$

B) 

C) 

D) $(CH_3)_3CC(CH_3)_3$

A. A
B. B
C. C
D. D

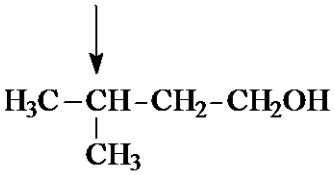
23. In infrared spectroscopy, absorption of electromagnetic radiation results in transitions between _____ energy levels.

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

24. 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?

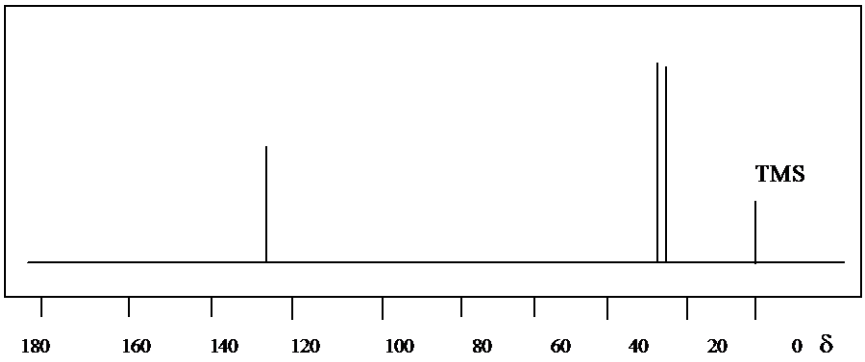
A. C-13 has a nuclear spin of zero.
B. The probability of two C-13 nuclei being next to each other in a compound is very low.
C. The coupling constant is very small-too small to be observed.
D. There is ^{13}C-^{13}C spin-spin splitting but because of the complex splitting patterns decoupling techniques are used to suppress it.

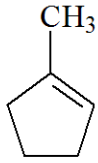
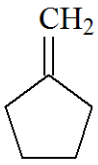
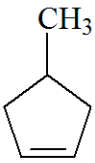
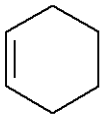
25. What is the multiplicity of the indicated carbon in an off-resonance decoupled C-13 NMR spectrum? (In off-resonance decoupled spectra, direct ^{13}C-^1H coupling is observed.)



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

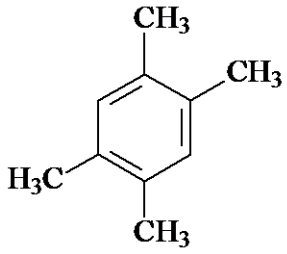
26. Which one of the following compounds fits the C-13 NMR spectrum shown below?



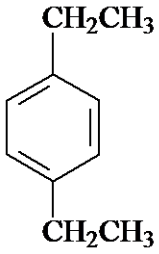
A)  B)  C)  D) 

A. A
B. B
C. C
D. D

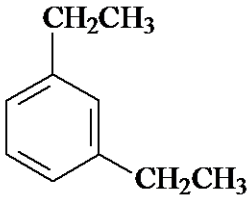
27. A C-13 NMR spectrum of a compound, $C_{10}H_{14}$, has five peaks. Two peaks are in the 10-30 ppm region and the other three are in the 120-140 ppm area. Which of the following compounds fits the data?



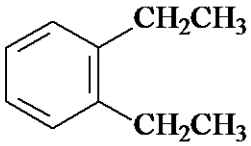
I



II



III



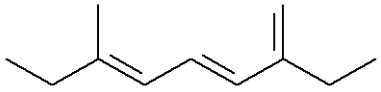
IV

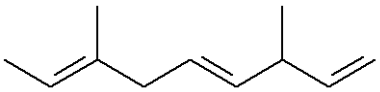
A. I
B. II
C. III
D. IV

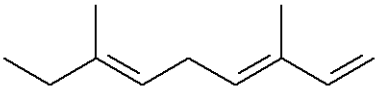
28. Which one of the following isomeric C_8H_{18} compounds has five peaks in its ^{13}C NMR spectrum?

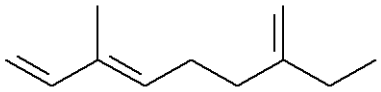
A. octane
B. 2-methylheptane
C. 3-methylheptane
D. 4-methylheptane

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

A) 

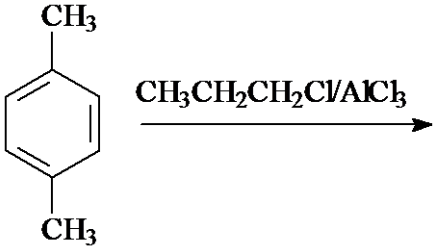
B) 

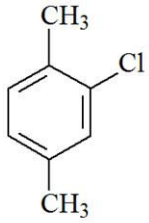
C) 

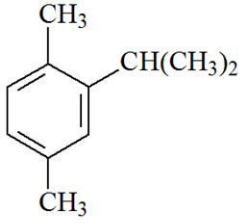
D) 

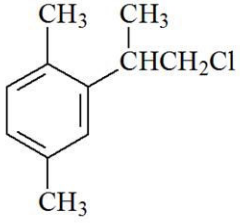
A. A
B. B
C. C
D. D

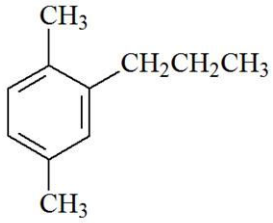
30. The reaction shown below gave two products in a ratio of approximately 1:2. The mass spectrum of the major product has a base peak at *m/z* 119. The minor product gave a base peak at *m/z* 133. Based on the reaction given and the information on the mass spectra, which of the following is the major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



A) 

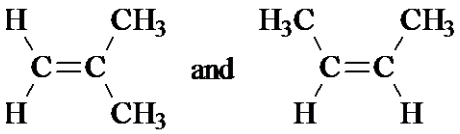
B) 

C) 

D) 

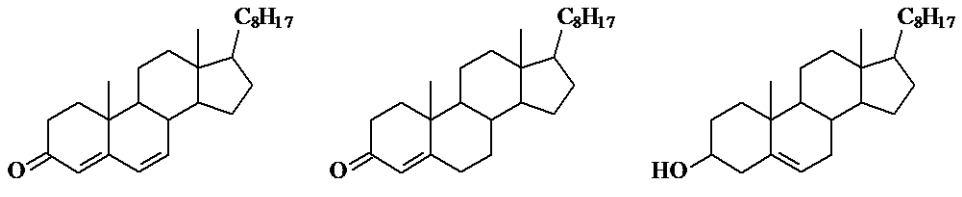
A. A
B. B
C. C
D. D

31. 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

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

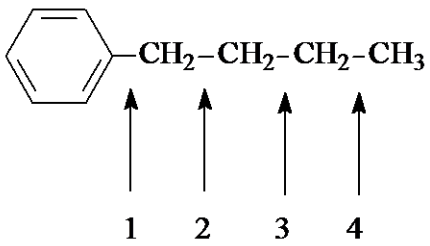


I **II** **III**

	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

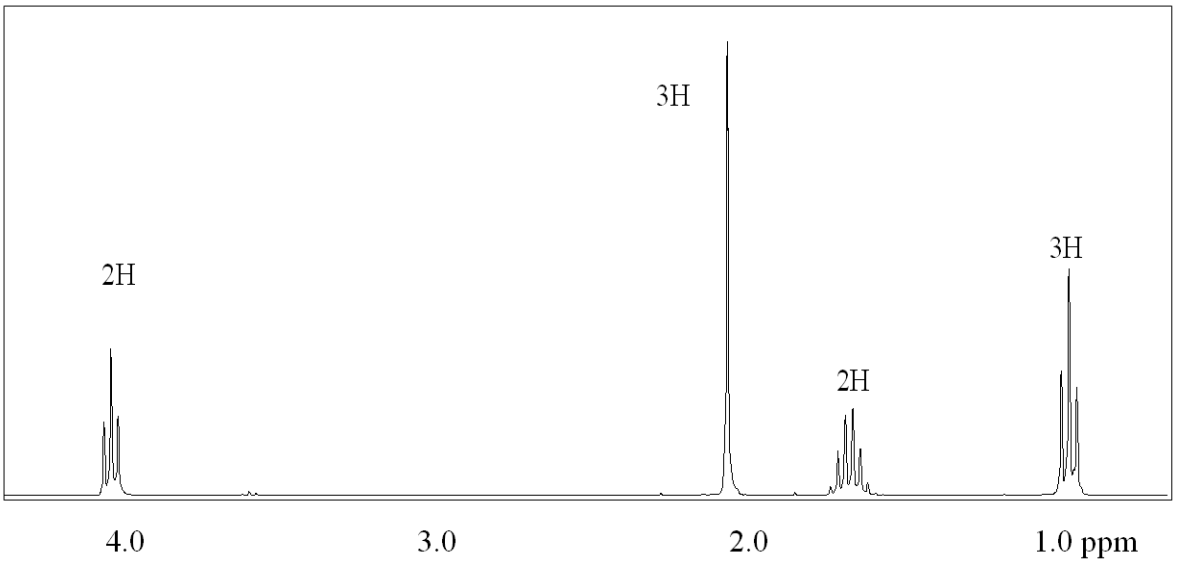
A. A
B. B
C. C
D. D

33. 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

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



A) $CH_3CH_2CH_2\overset{\overset{O}{\|}}{C}OCH_3$

B) $CH_3CH_2\overset{\overset{O}{\|}}{C}OCH_2CH_3$

C) $CH_3\overset{\overset{O}{\|}}{C}OCH_2CH_2CH_3$

D) $CH_3\overset{\overset{O}{\|}}{C}CH_2CH_2OCH_3$

A. A
B. B
C. C
D. D

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1. C
2. B
3. D
4. B
5. B
6. A
7. D
8. A
9. D
10. B
11. B
12. C
13. C
14. B
15. C
16. A
17. B
18. D
19. A
20. C
21. D
22. D
23. A
24. B
25. B
26. D
27. D
28. D
29. A
30. D
31. B
32. C
33. B
34. C