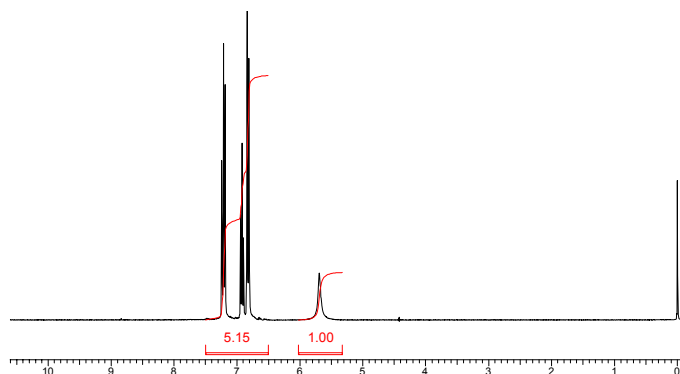
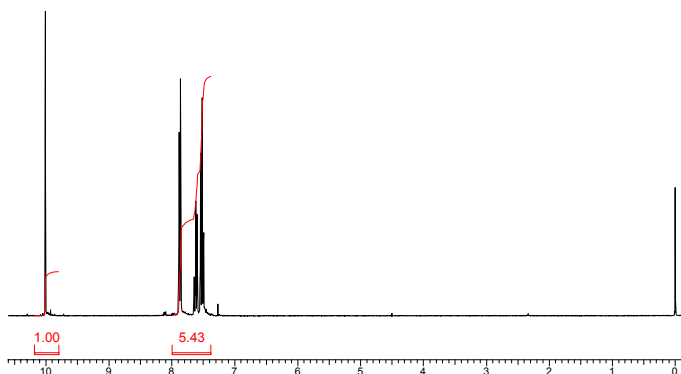
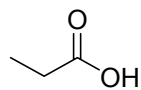
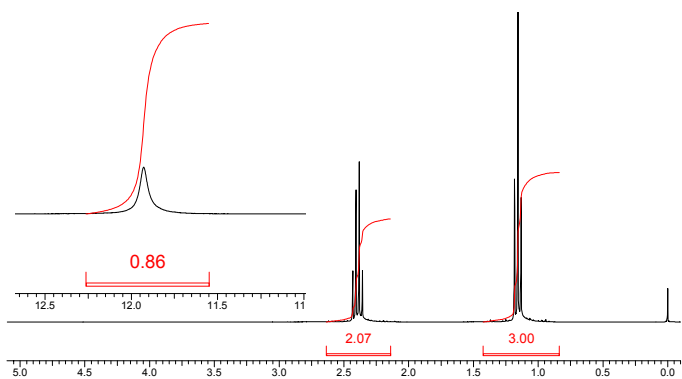


## NMR Practice Problems

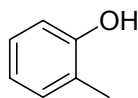
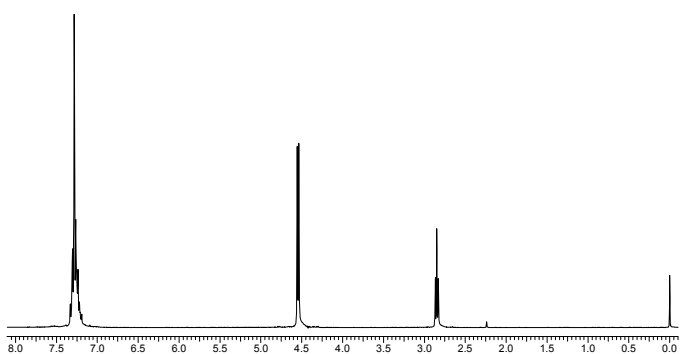
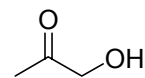
- Tell precisely how you would use the proton NMR spectra to distinguish between the following pairs of compounds:
  - 1-bromopropane and 2-bromopropane
  - propanal and propanone
  - ethyl acetate (MeCO<sub>2</sub>Et) and methyl propanoate (EtCO<sub>2</sub>Me)
  - 1-butyne and 2-butyne
- Each of the following compounds exhibits a single <sup>1</sup>H NMR peak. Approximately where would you expect each compound to absorb?
  - cyclohexane
  - acetone
  - benzene
  - glyoxal (ethandial)
  - dichloromethane
  - trimethylamine ((CH<sub>3</sub>)<sub>3</sub>N)
- Draw structures for compounds that meet these descriptions:
  - C<sub>2</sub>H<sub>6</sub>O; one singlet
  - C<sub>3</sub>H<sub>7</sub>Cl; one doublet and one septet
  - C<sub>4</sub>H<sub>8</sub>Cl<sub>2</sub>O; two triplets
  - C<sub>4</sub>H<sub>8</sub>O<sub>2</sub>; one singlet, one triplet, and one quartet
- The two spectra below are of phenol and benzaldehyde. Assign them.



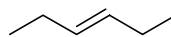
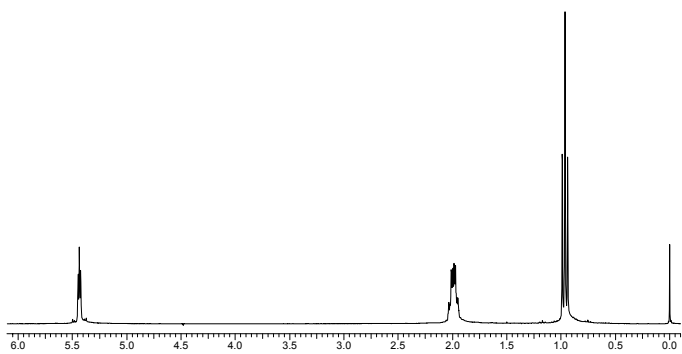
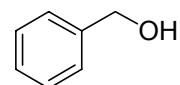
5) For each spectrum below, chose between the alternative compounds. Give your reasons.



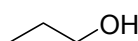
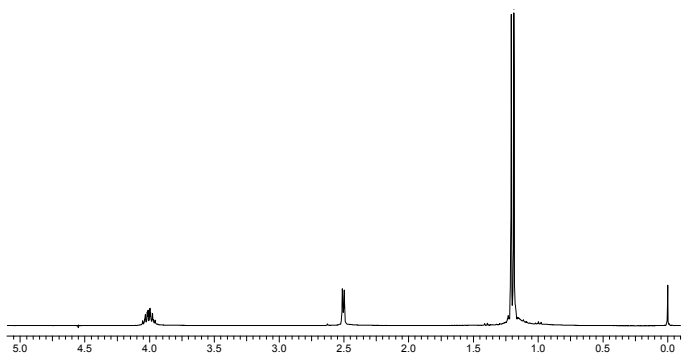
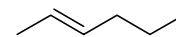
or



or



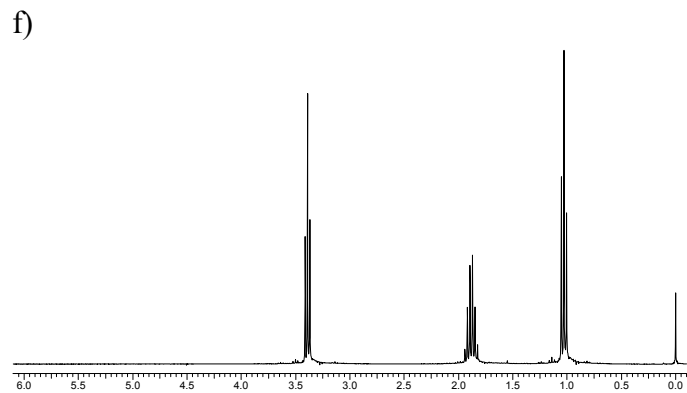
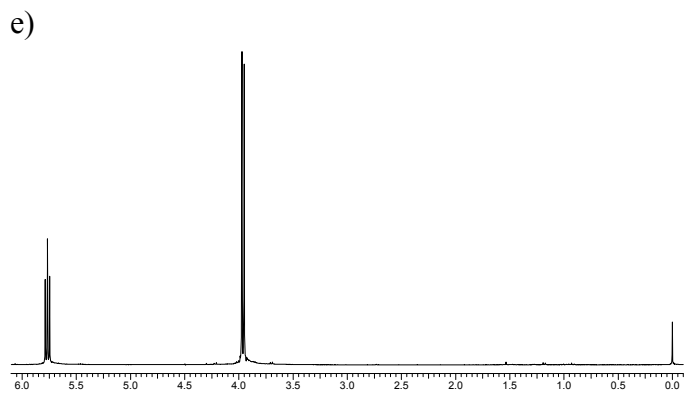
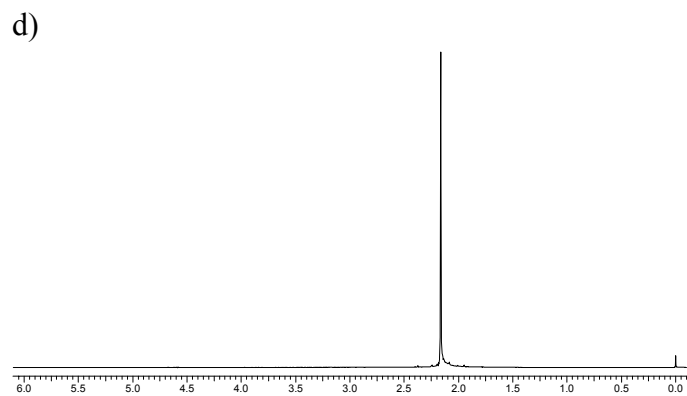
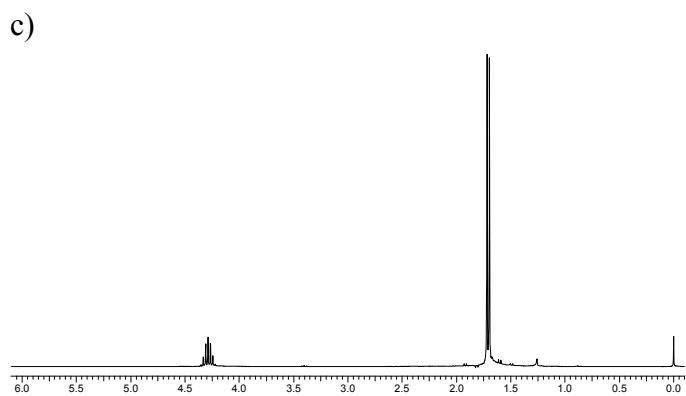
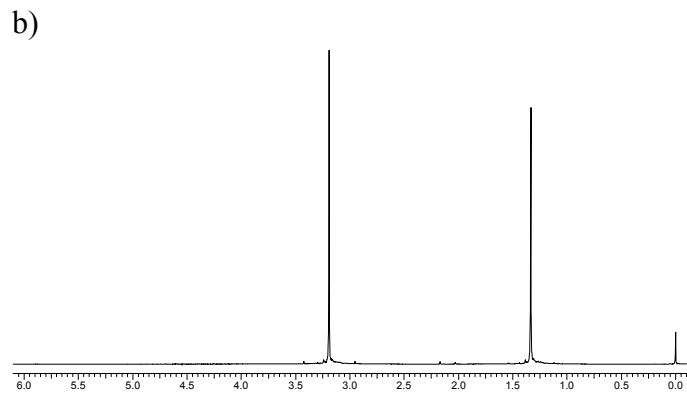
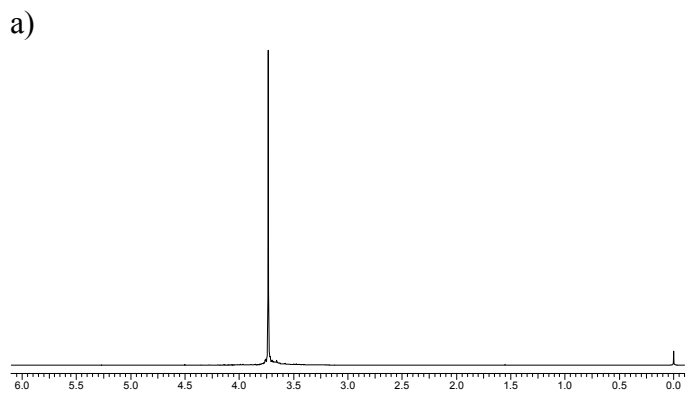
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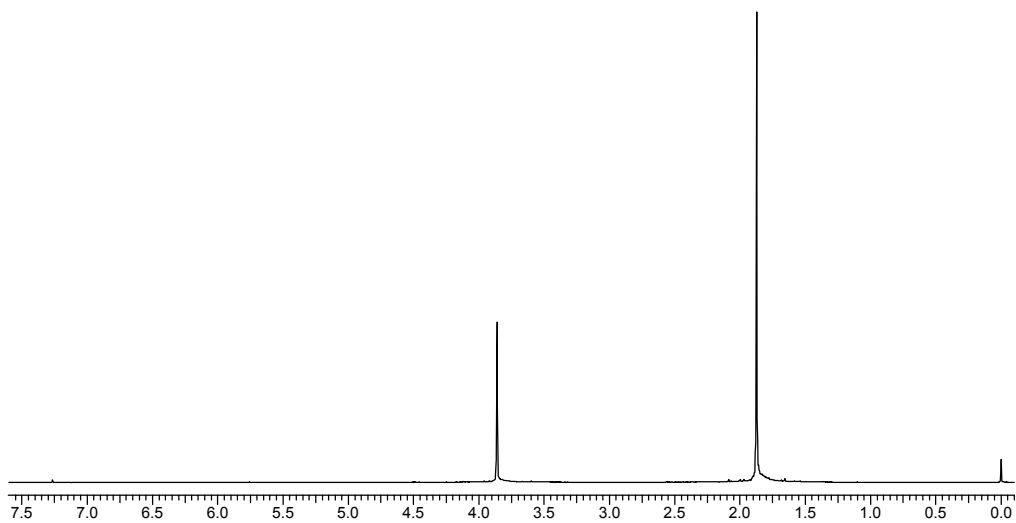
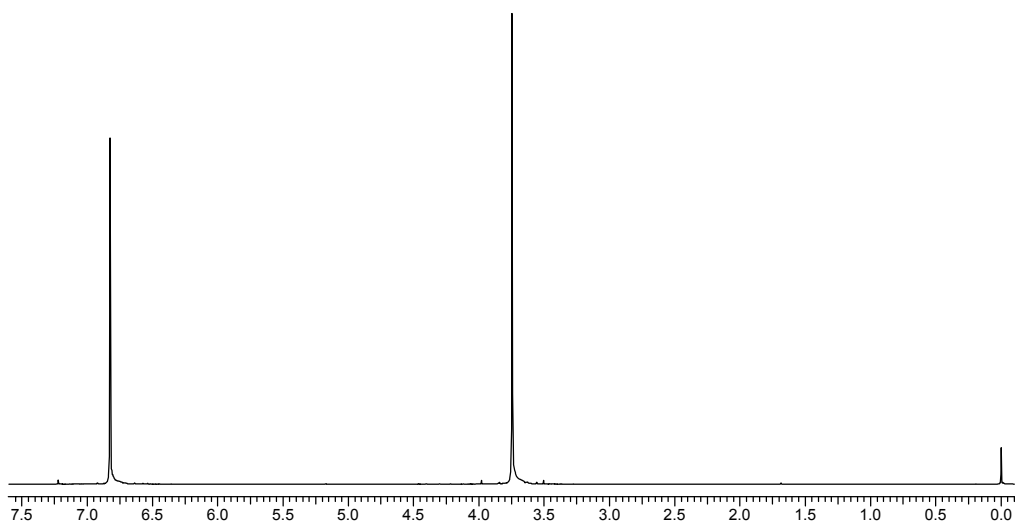
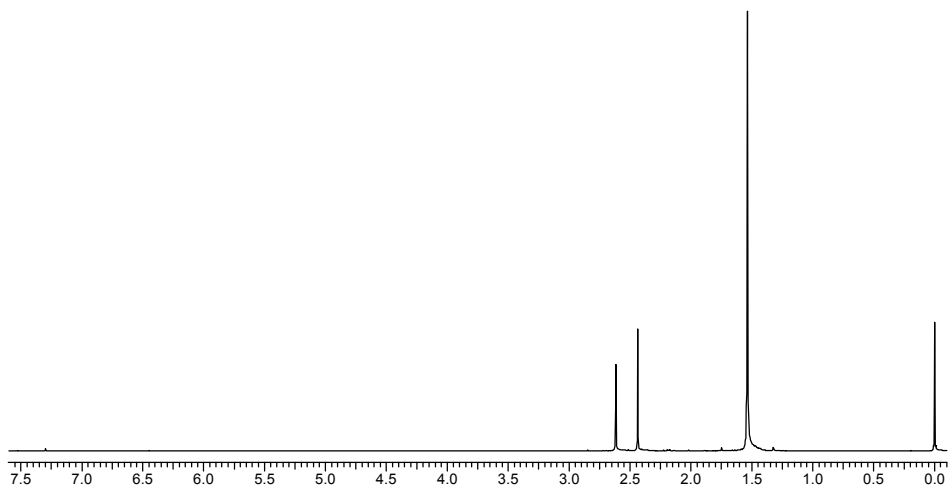
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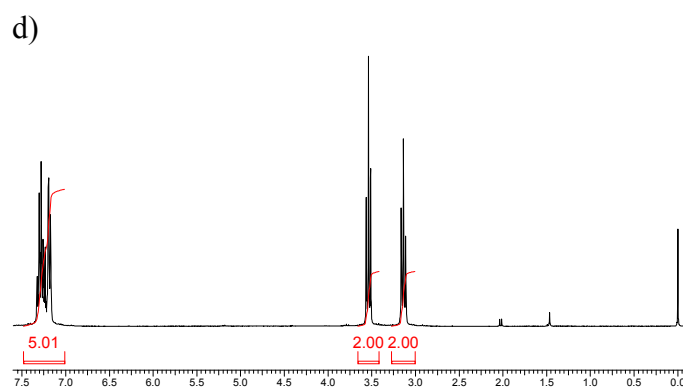
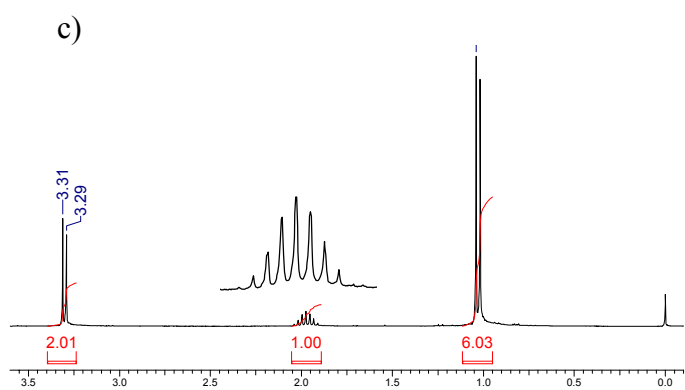
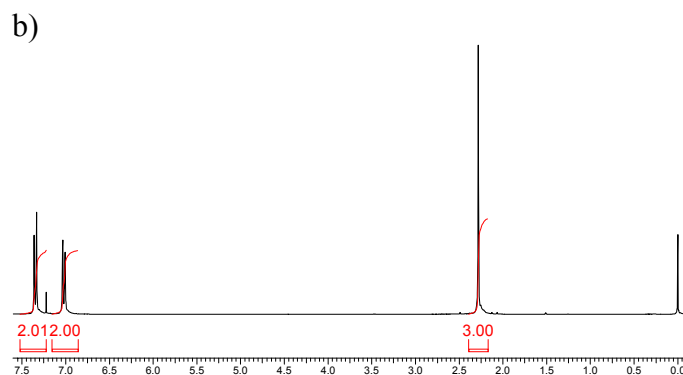
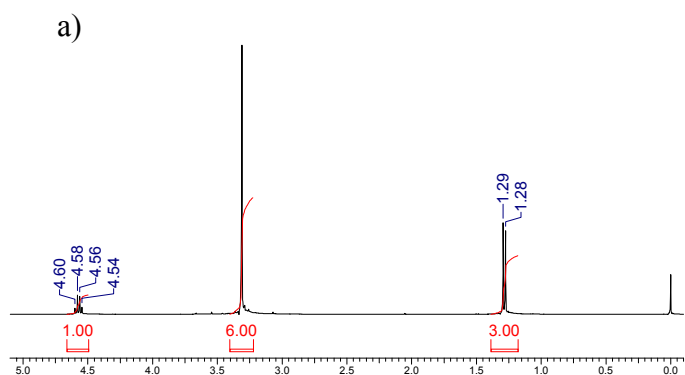
6) The spectra below are of acetone, 1,2-dichloroethane, 1,1,2-trichloroethane, 2,2-dimethoxypropane, 1-bromopropane and 2-bromopropane. Assign them.



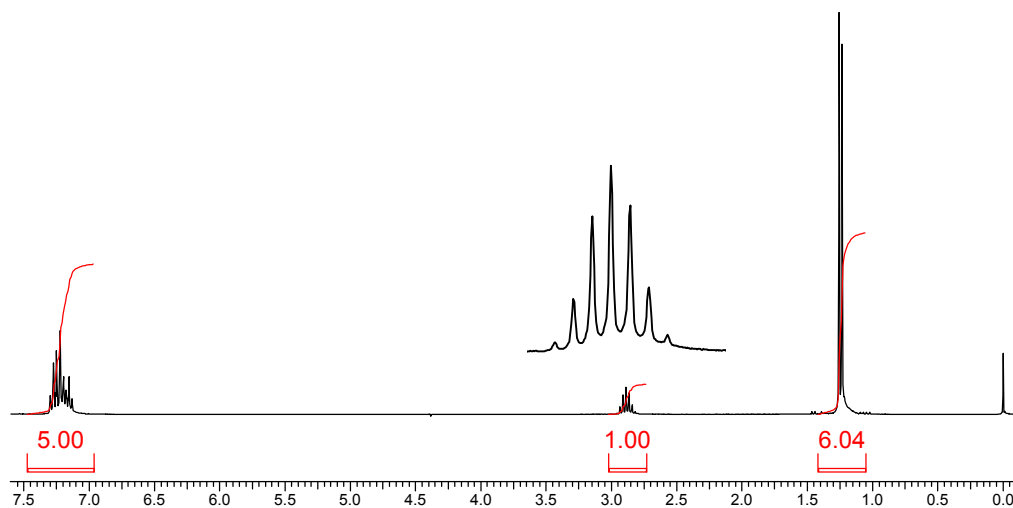
7) Assign the following spectra to one of the compounds listed: 1,4-dimethylbenzene, 1,4-dimethoxybenzene, phenylethyne, 3-methyl-3-hydroxy-1-butyne, 2-bromobutane, 1,2-dibromo-2-methylpropane.



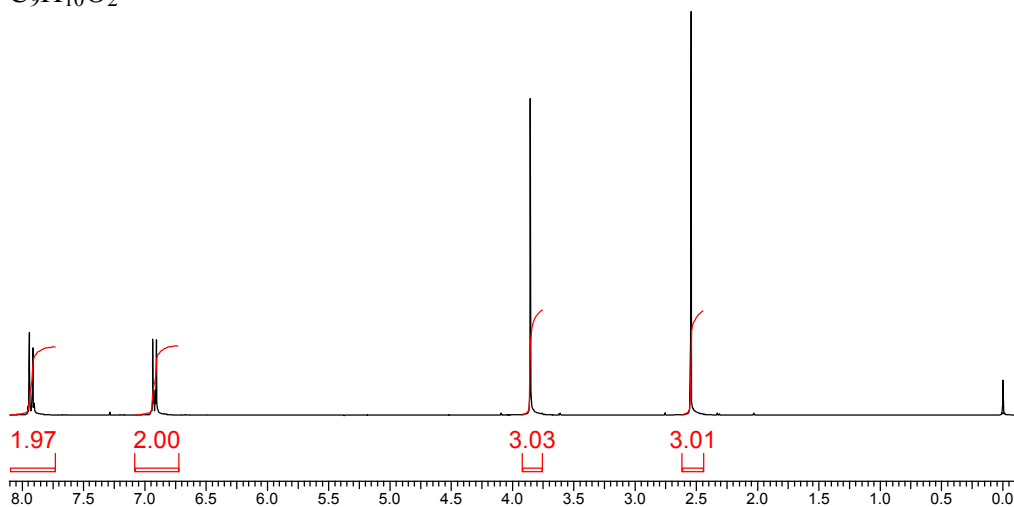
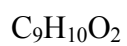
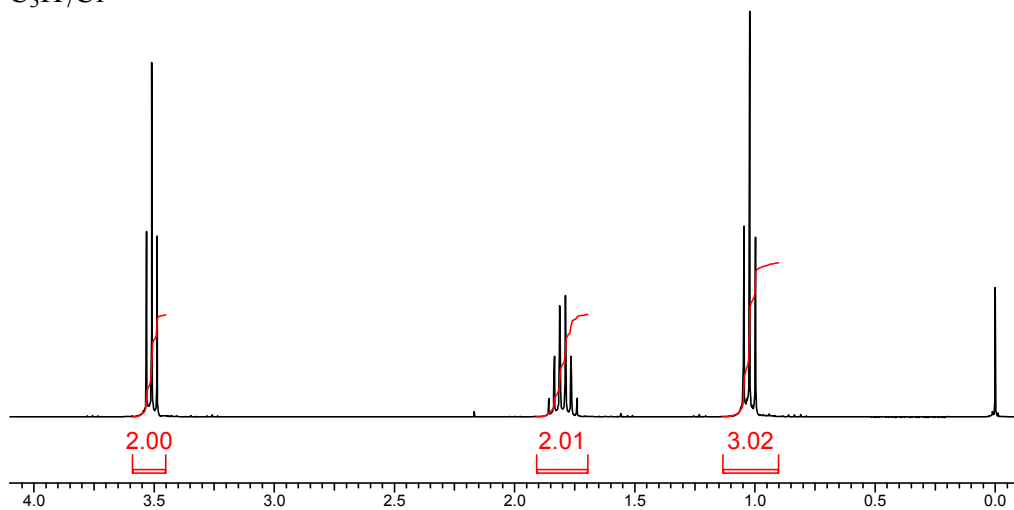
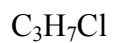
8) Propose plausible structures for the five compounds whose proton NMR spectra are shown: (a)  $C_4H_{10}O_2$ ; (b)  $C_7H_7Br$ ; (c)  $C_4H_9Br$ ; (d)  $C_8H_9Br$ .



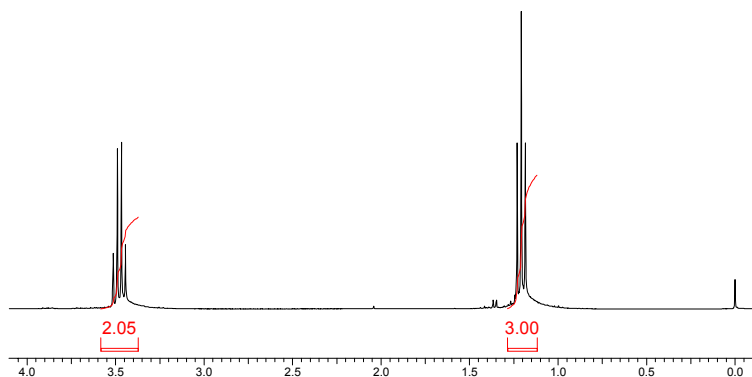
9) Compound  $H_3C_9H_{12}$ , gives a proton NMR spectrum as shown below. Assign a structure.



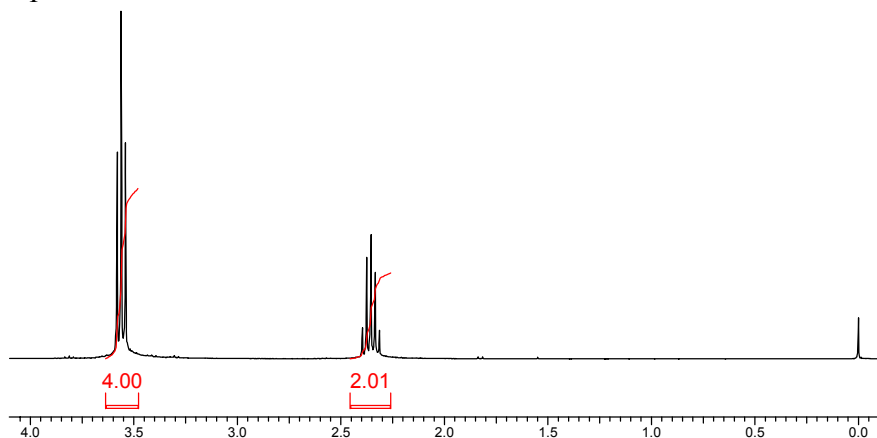
10) Two spectra are given below along with their molecular formulas. Propose a structure that corresponds to each spectrum.



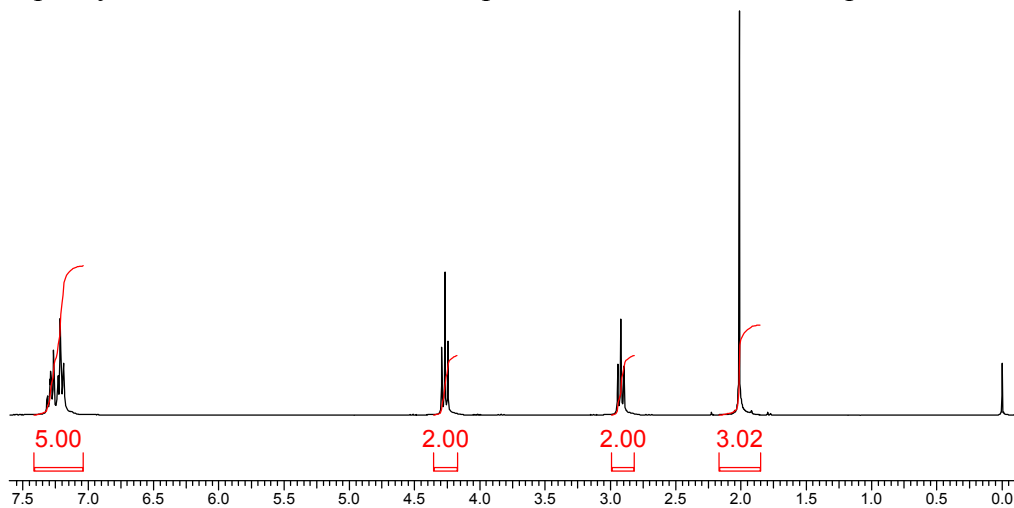
11) The integrated  $^1H$  NMR spectrum of a compound of formula  $C_4H_{10}O$  is shown. Propose a structure consistent with the data.



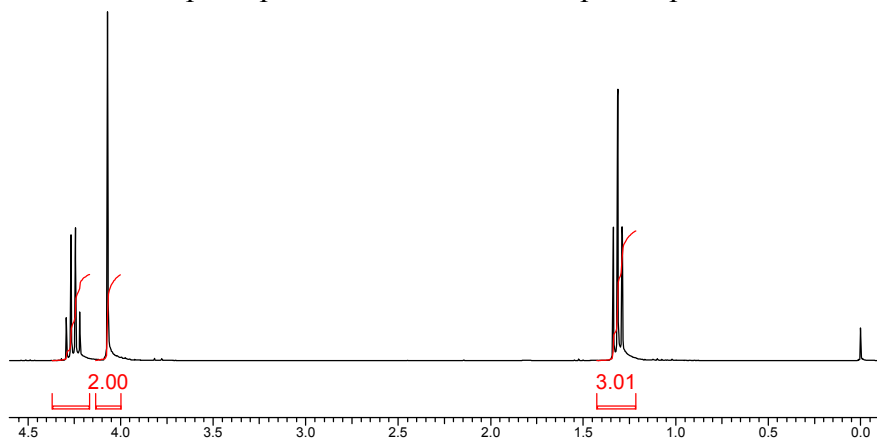
12) The compound whose proton NMR spectrum is shown below has the molecular formula  $C_3H_6Br_2$ . Propose a plausible structure.



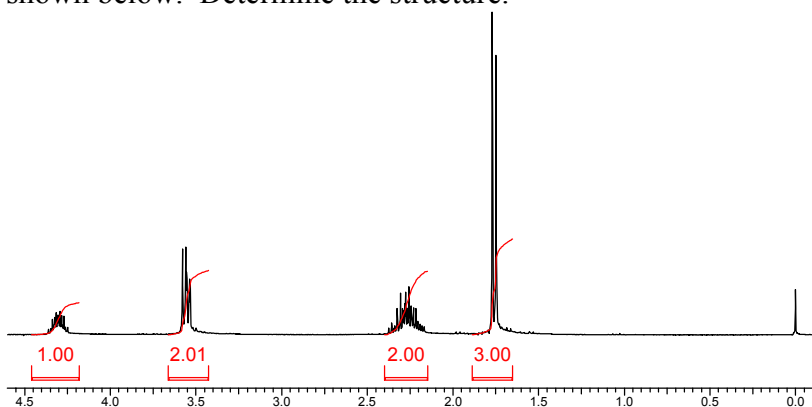
13) A compound ( $C_{10}H_{12}O_2$ ), whose spectrum appears below was isolated from a reaction mixture containing 2-phenylethanol and acetic acid. Propose a structure for this compound.



14) The compound whose proton NMR spectrum is shown has the molecular formula  $C_4H_7O_2Cl$  and shows an infrared absorption peak at  $1740\text{ cm}^{-1}$ . Propose a plausible structure.

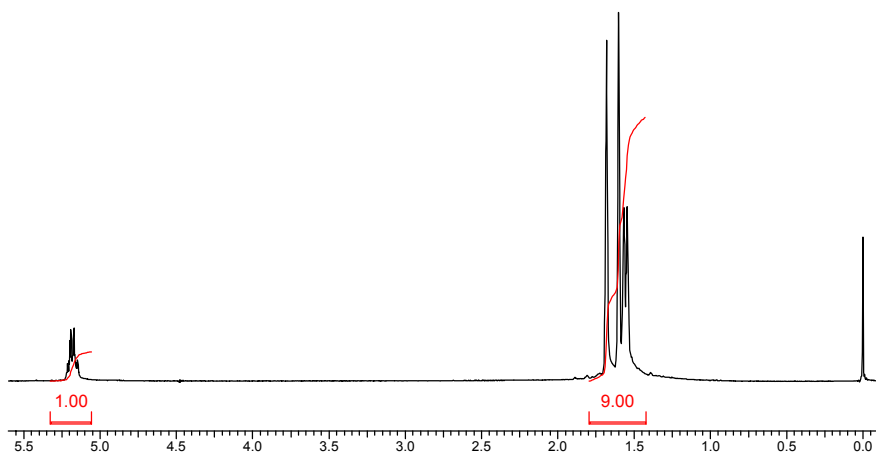


- 15) A small plant was adding bromine across the double bond of 2-butene to make 2,3-dibromobutane. A controller malfunction and allowed the reaction temperature to rise beyond safe limits. A careful distillation of the product showed that several impurities had formed, including the one whose NMR is shown below. Determine the structure.

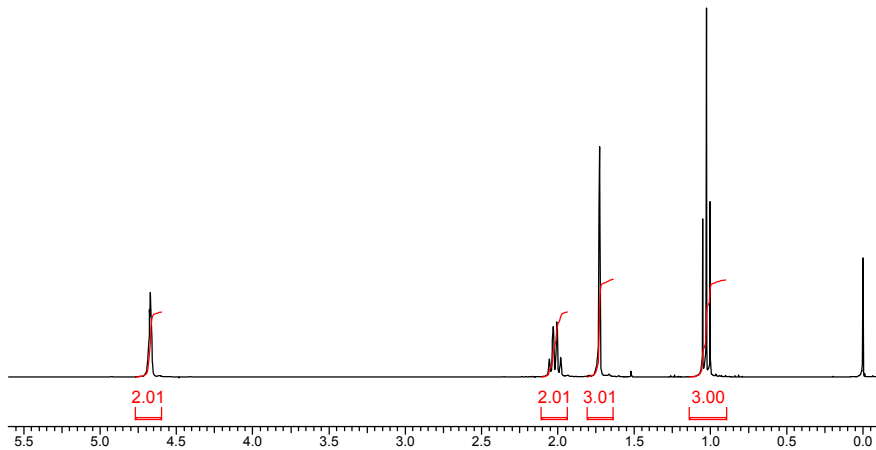


- 16) When 2-chloro-2-methylbutane is treated with a variety of strong bases, the products always seem contain two isomers (A and B) of formula  $C_5H_{10}$ . When sodium hydroxide is used as the base isomer B predominates. Determine the structures of A and B and explain the experimental results.

A)

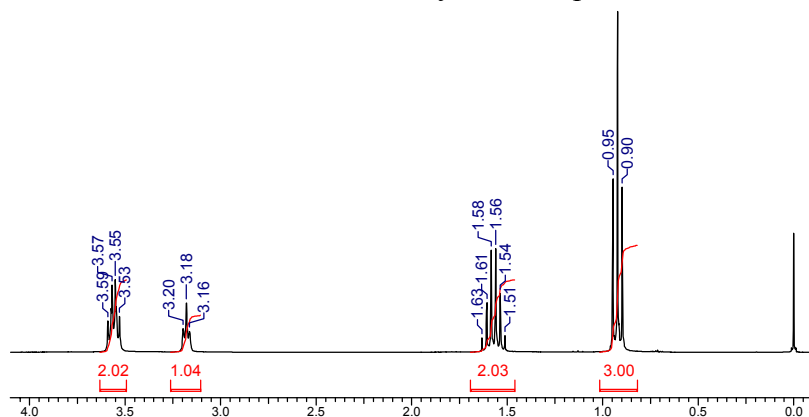


B)



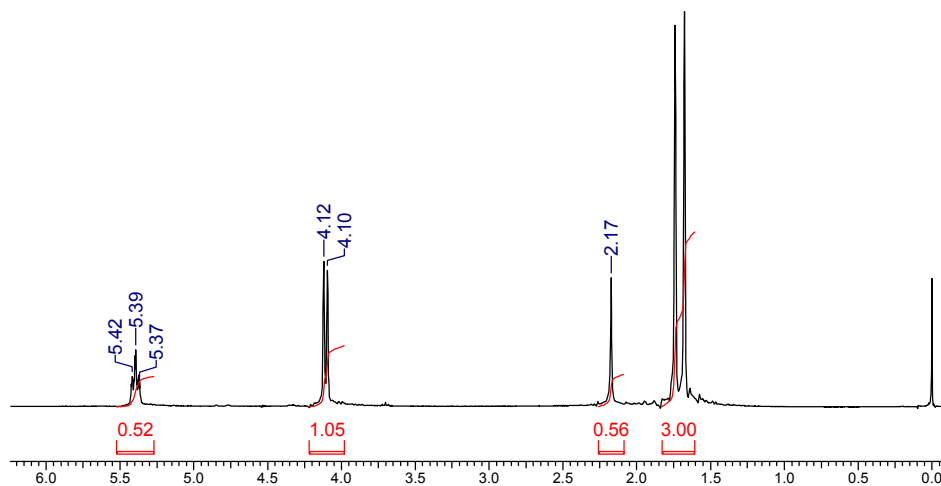


- 17) A new chemist moved into an industrial lab where work was being done on oxygenated gasoline additives. Among the additives that had been tested she found an old bottle containing a clear, pleasant smelling liquid but missing its label. She took a quick NMR and was able to determine the identity of the compound without additional information. Can you? The proton NMR is shown below.



- 18) An allylic halide A of formula  $C_5H_9Cl$  undergoes  $S_N1$  reaction with water to yield a mixture of two isomeric products, B and C. The proton NMR spectra of B and C are shown. Suggest structures for A, B, and C.

B)



C)

