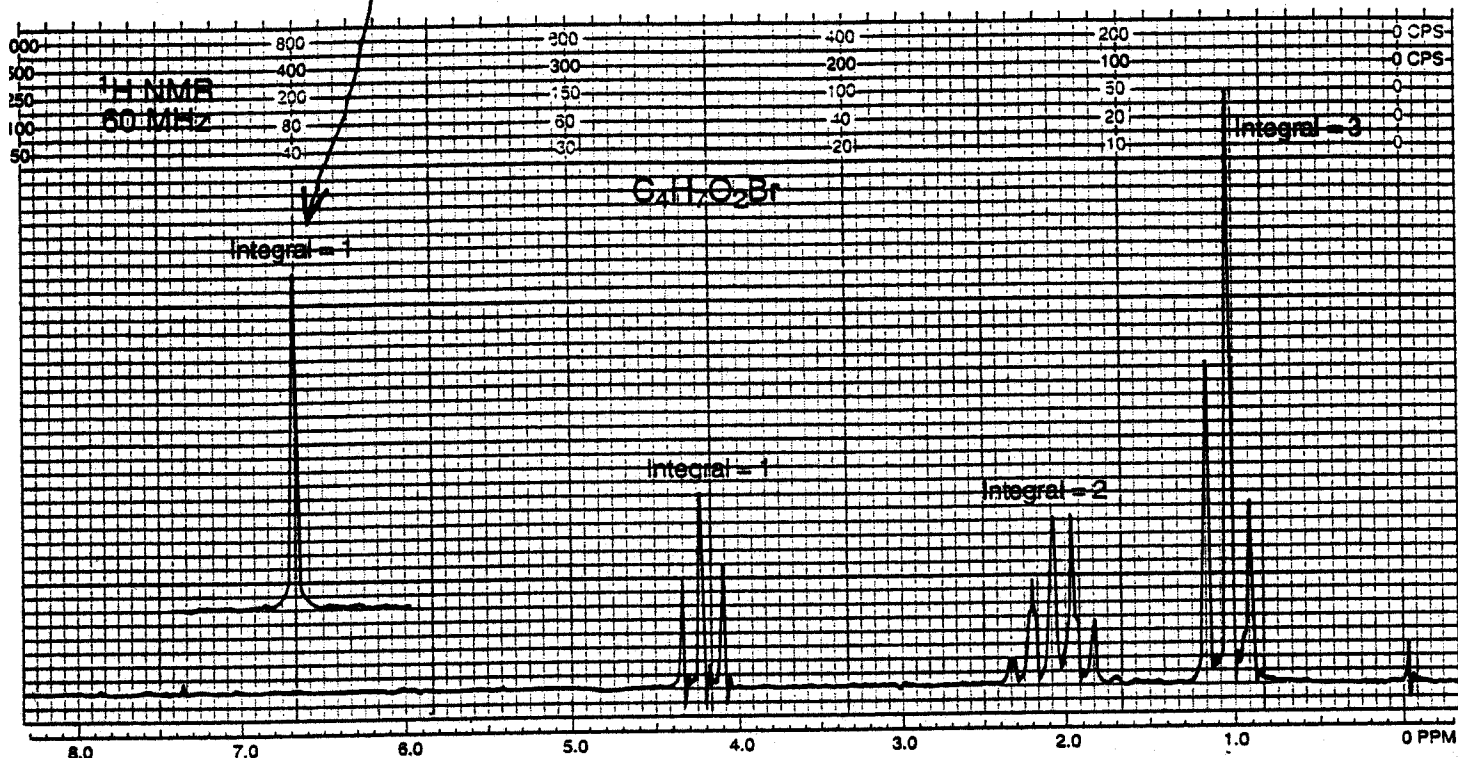


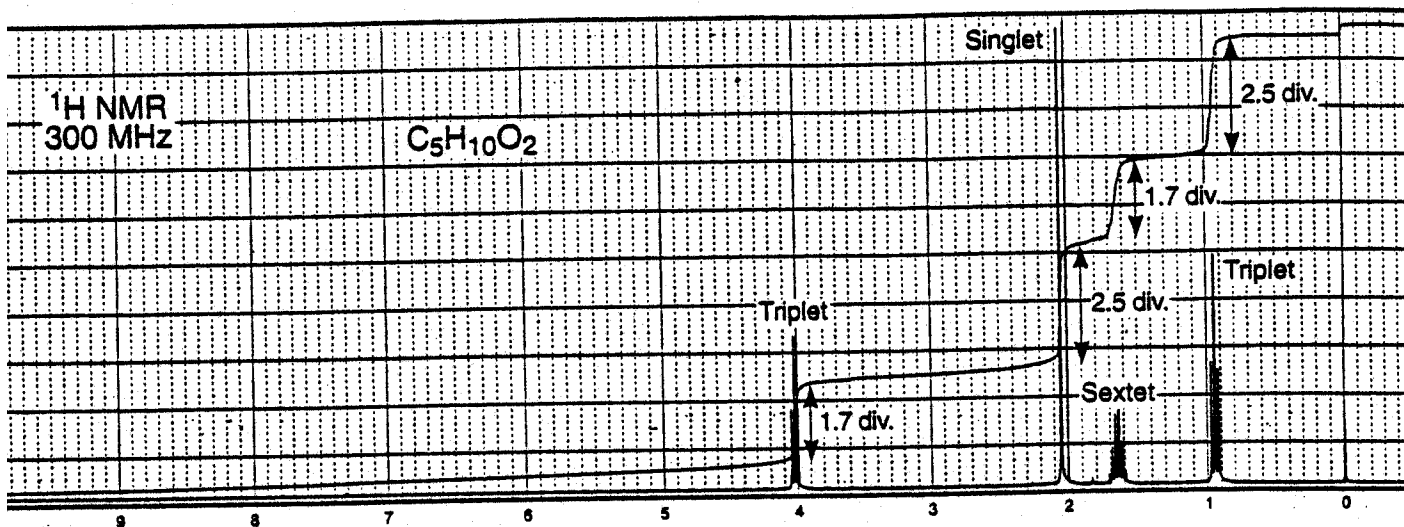
16. The following compound is a carboxylic acid which contains a bromine atom: $C_4H_7O_2Br$. The peak at 10.97 ppm was moved onto the chart (which runs only from 0 to 8 ppm) for clarity. What is the structure of the compound?



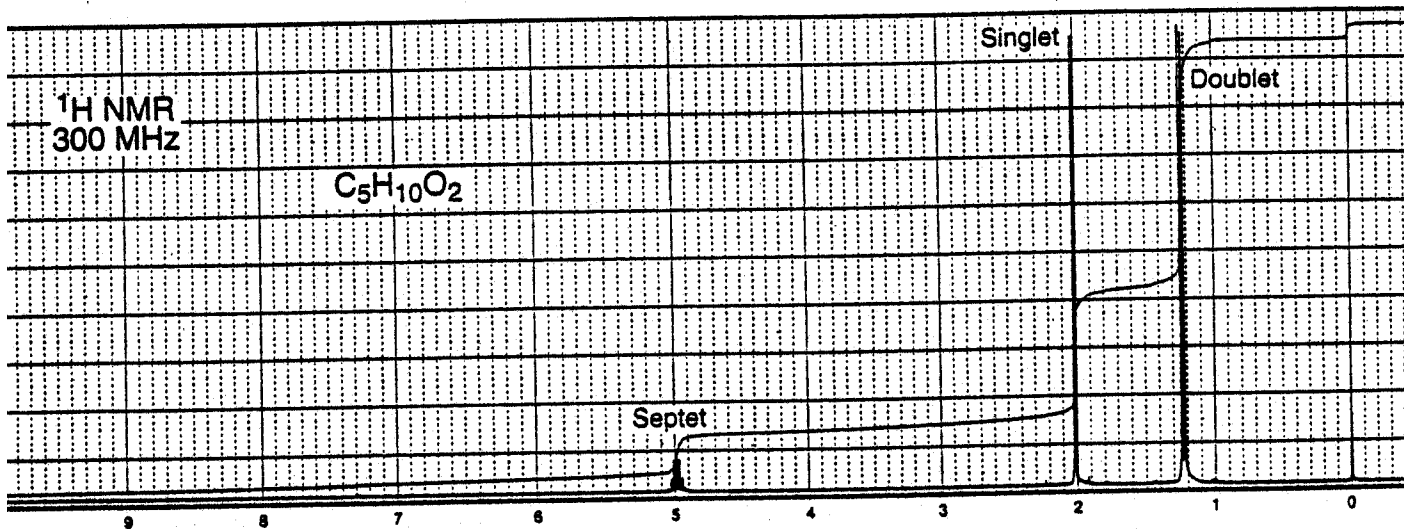
17. The following compounds are isomeric esters derived from acetic acid, each with formula $C_5H_{10}O_2$. The peaks of the spectrum have been labeled to indicate the degrees of splitting. With the first spectrum as an example, use the integral curve traced on the spectrum to calculate the number of hydrogens represented in each multiplet (pp. 113–114). The multiplets appear both on the spectrum and in the first column of the following table. The second column is obtained by dividing through by the lowest number (1.7 div). The third column is obtained by multiplying by 2 and rounding off the values. Notice that the sum of the numbers in the third column equals the number of hydrogen atoms (10) present in the formula. Often one can inspect the spectrum and visually approximate the relative numbers of hydrogen atoms, thus avoiding the more mathematical approach demonstrated in the following table. Using either method, the second spectrum yields a ratio of 1:3:6. What are the structures of the two esters?

1.7 div	1.0	2 H
2.5 div	1.47	3 H
1.7 div	1.0	2 H
2.5 div	1.47	3 H

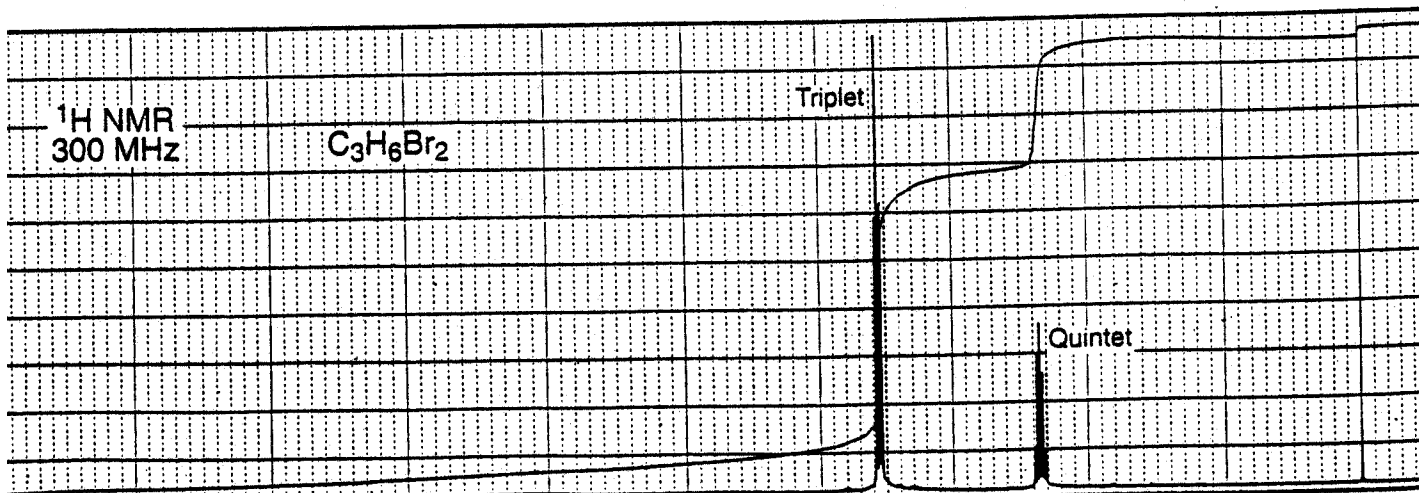
(a)



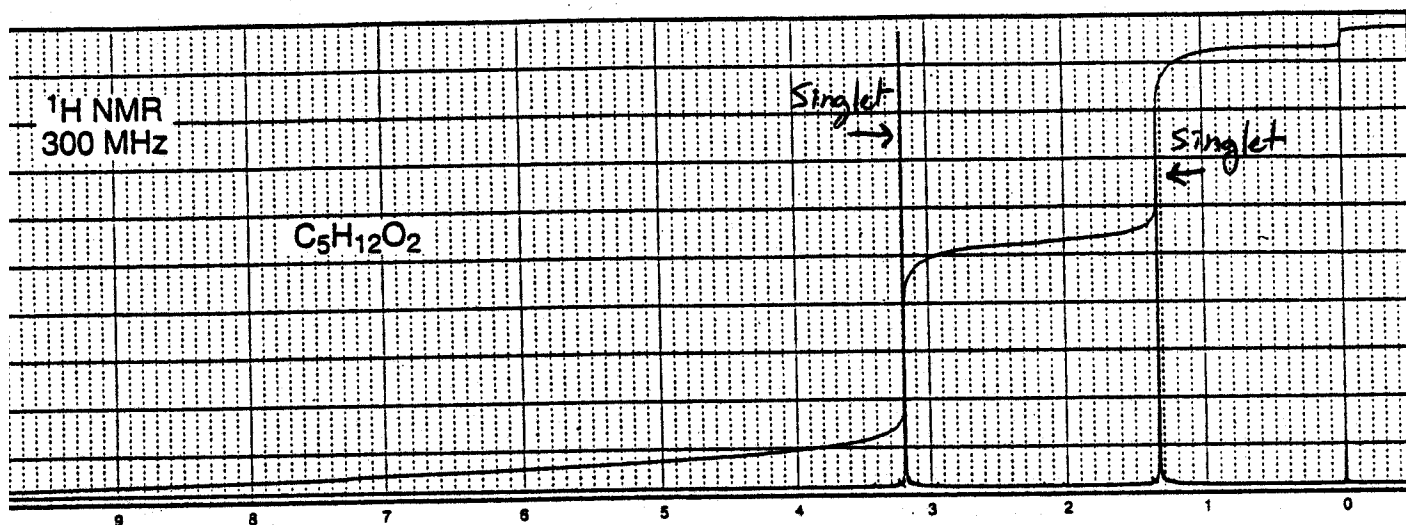
(b)



18. The compound which gives the following NMR spectrum has the formula $\text{C}_3\text{H}_6\text{Br}_2$. Draw the structure.

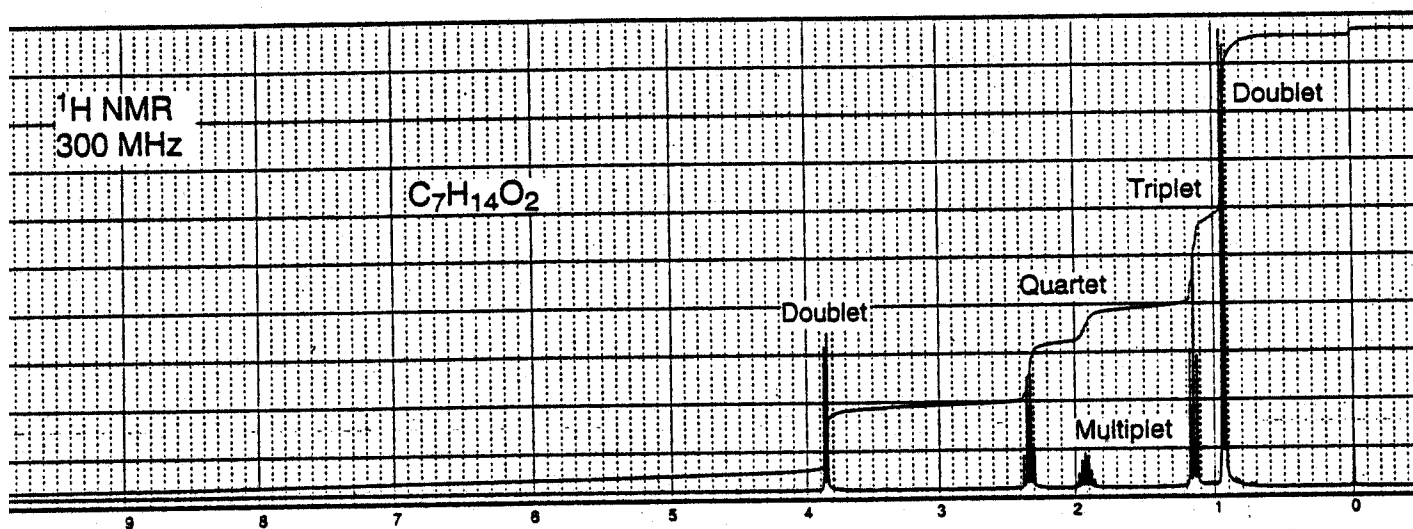


19. Draw the structure of an ether with formula $C_5H_{12}O_2$ that fits the following NMR spectrum.

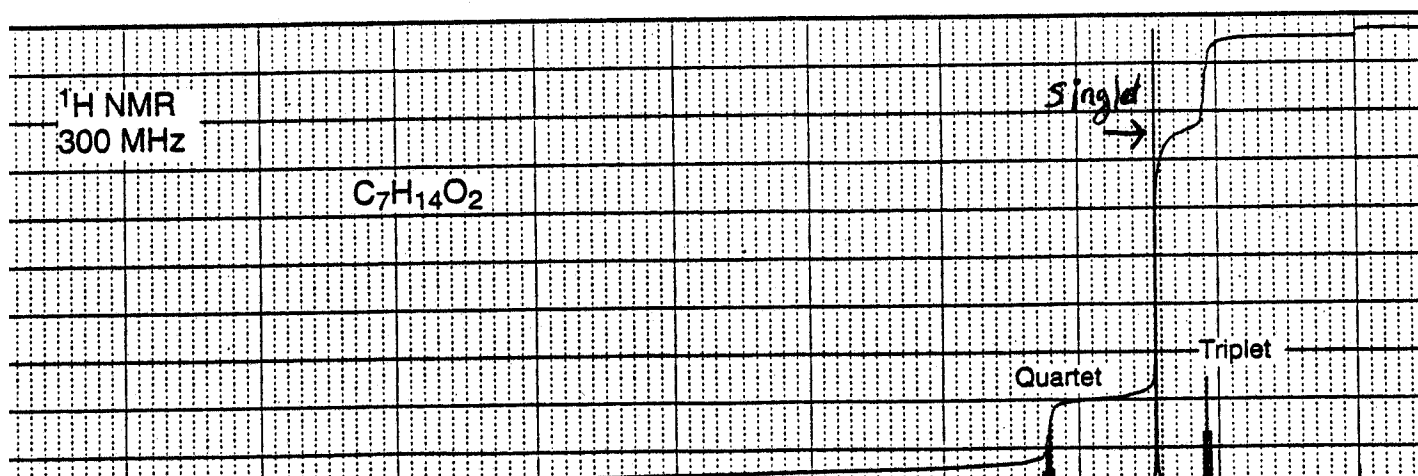


20. Following are the NMR spectra of three isomeric esters with the formula $C_7H_{14}O_2$, all derived from propanoic acid. Provide a structure for each.

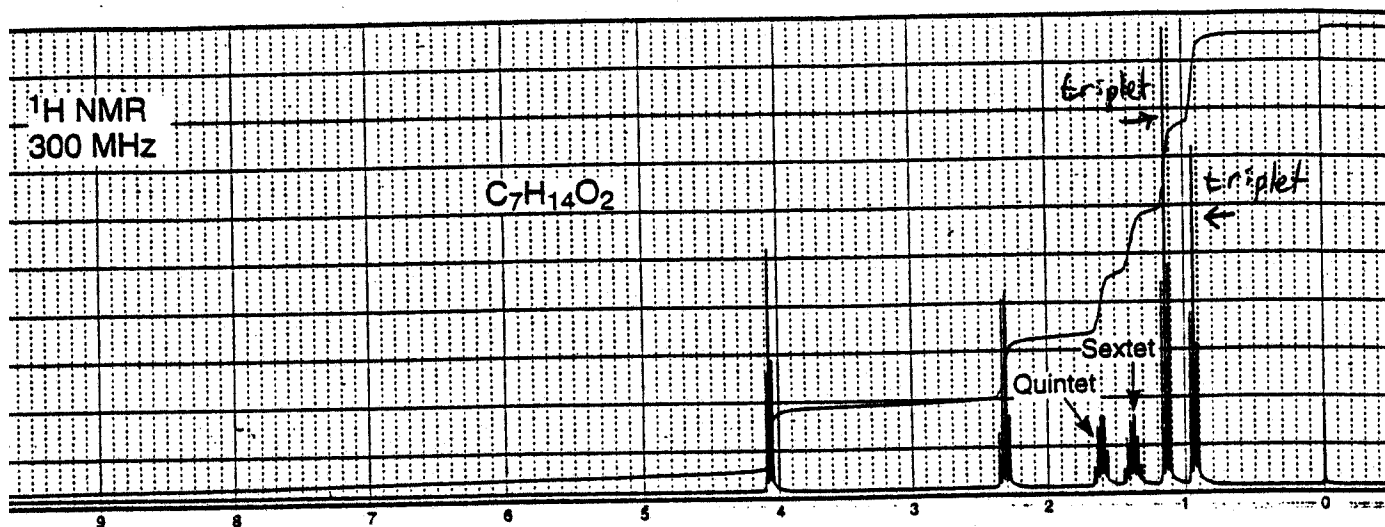
(a)



(b)

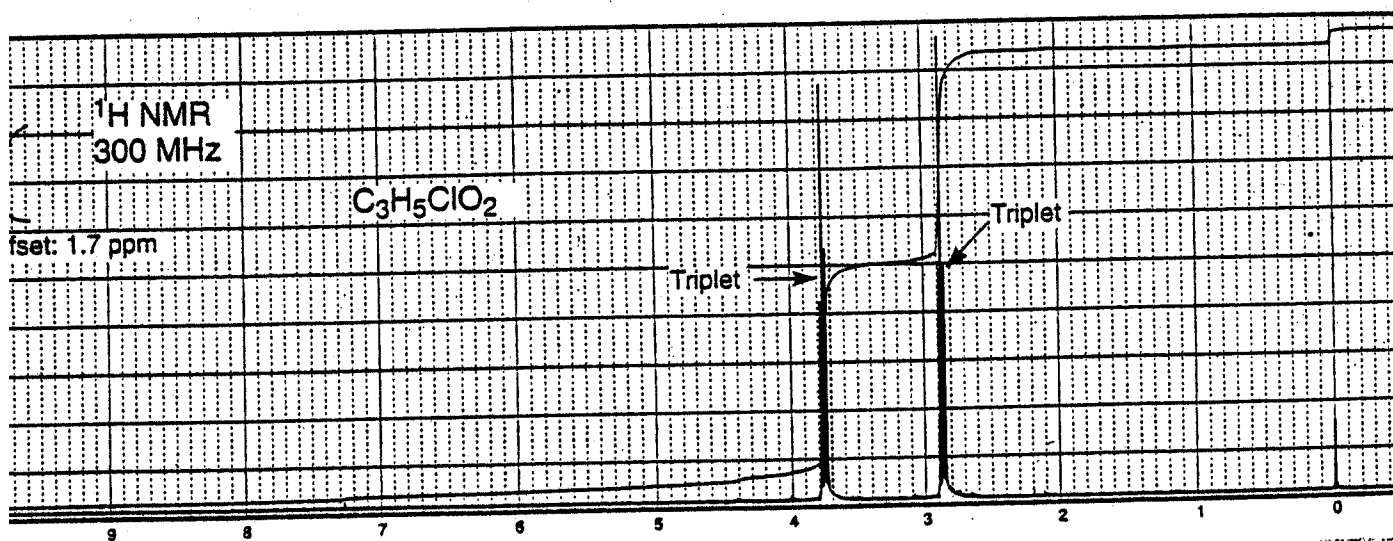


(c)

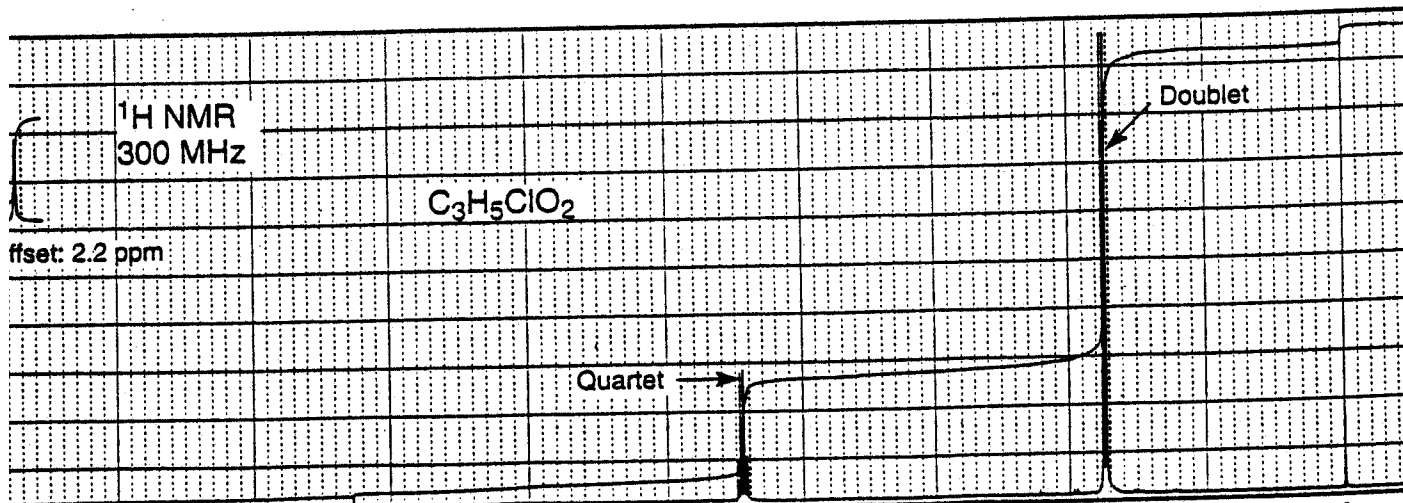


21. The two isomeric carboxylic acids which give the following NMR spectra both have the formula $\text{C}_3\text{H}_5\text{ClO}_2$. Draw their structures.

(a)

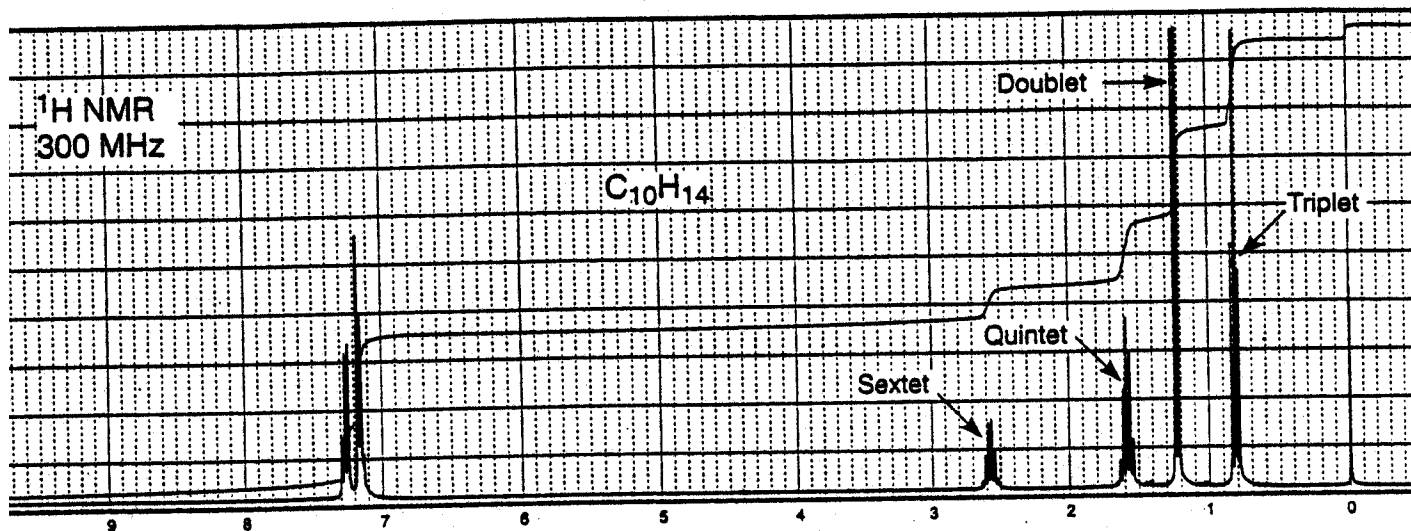


(b)

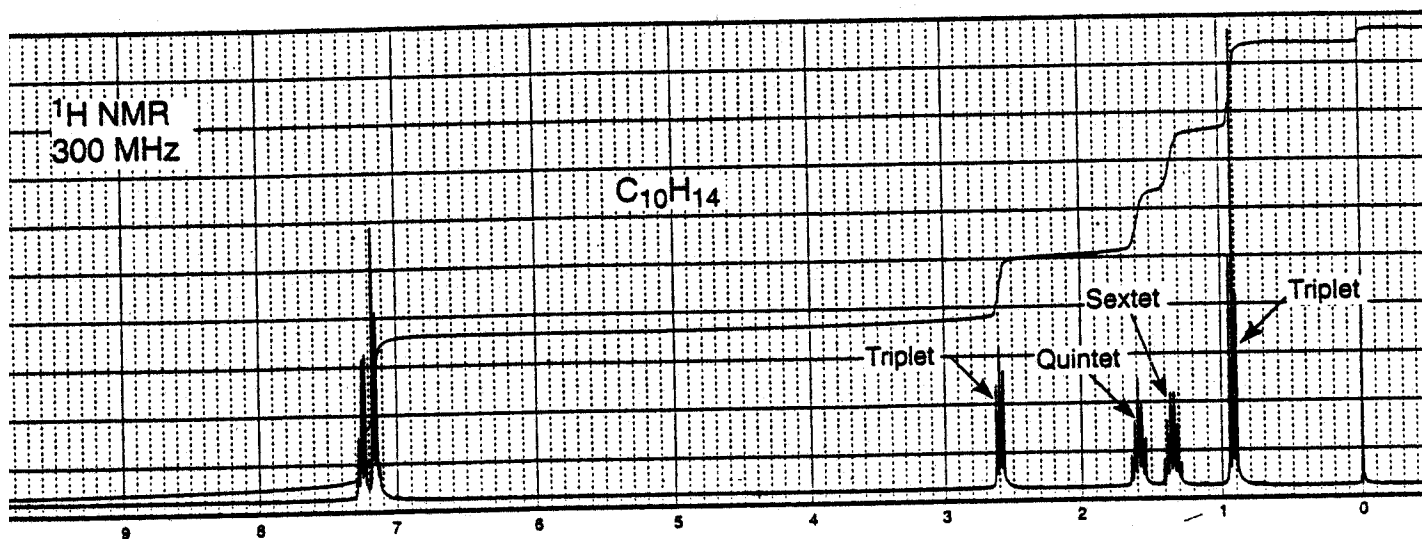


22. The following NMR spectra are of monosubstituted aromatic hydrocarbon compounds with the formula $C_{10}H_{14}$. Make no attempt to interpret the aromatic proton area between 7.1 and 7.3 ppm except to determine the relative number of hydrogen atoms. Draw structures for these compounds.

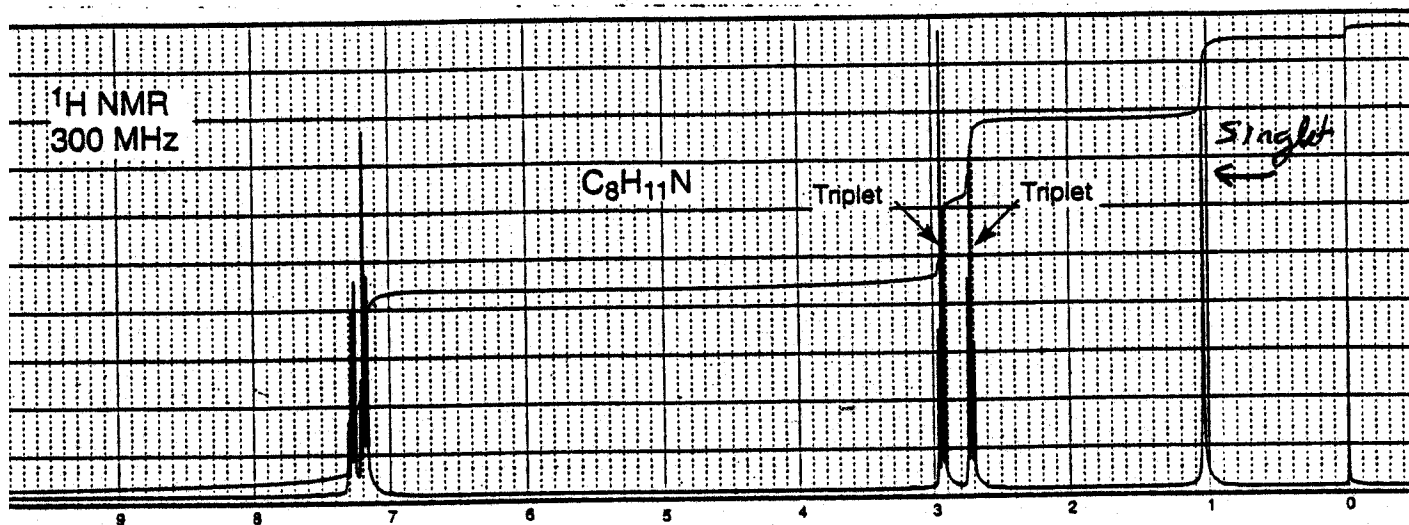
(a)



(b)

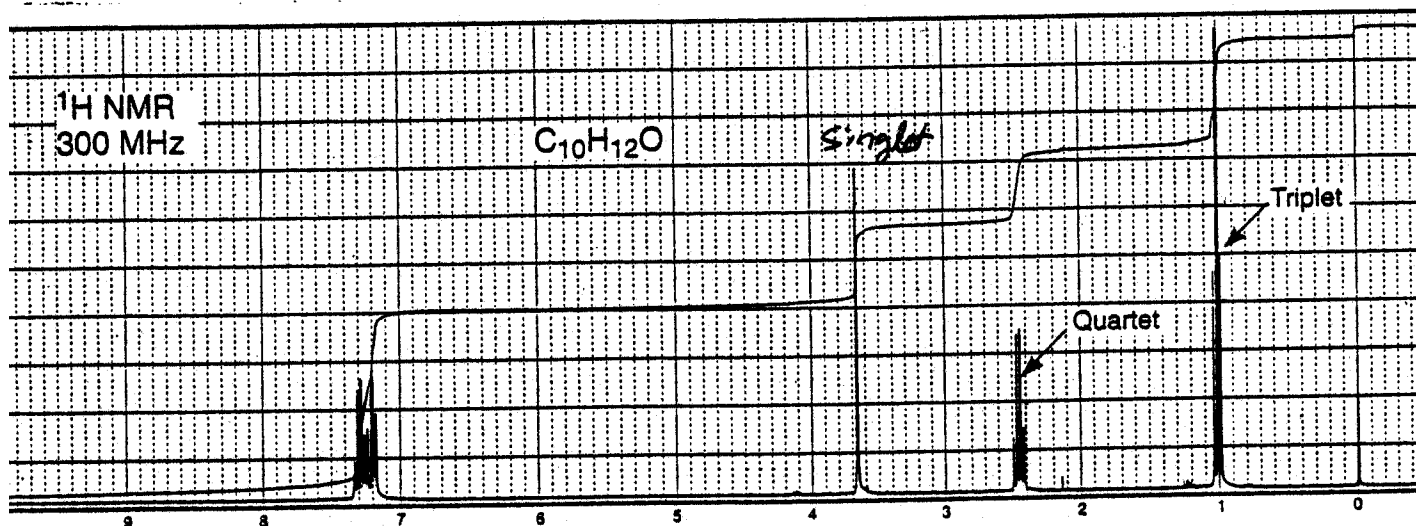


23. The following compound, with formula $C_8H_{11}N$, shows a doublet at about 5500 cm^{-1} and bands in the range from 1600 to 1450 cm^{-1} in the infrared spectrum. Draw its structure.

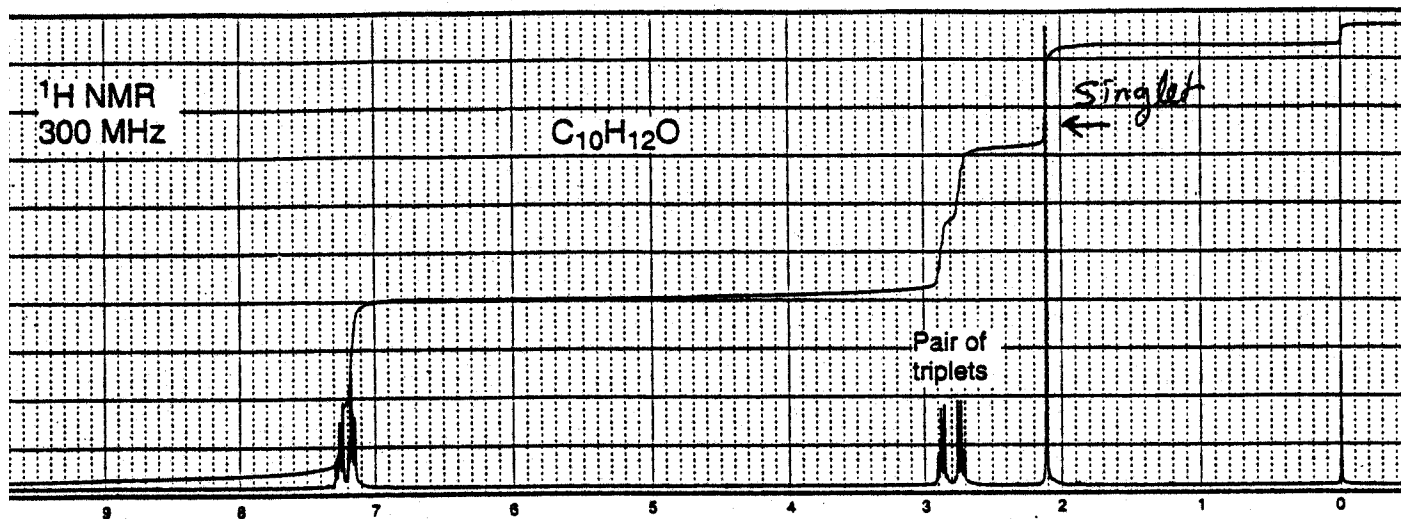


24. The following compounds are isomers with formula $C_{10}H_{12}O$. Their infrared spectra show strong bands near 1715 cm^{-1} and in the range from 1600 to 1450 cm^{-1} . Draw their structures.

(a)

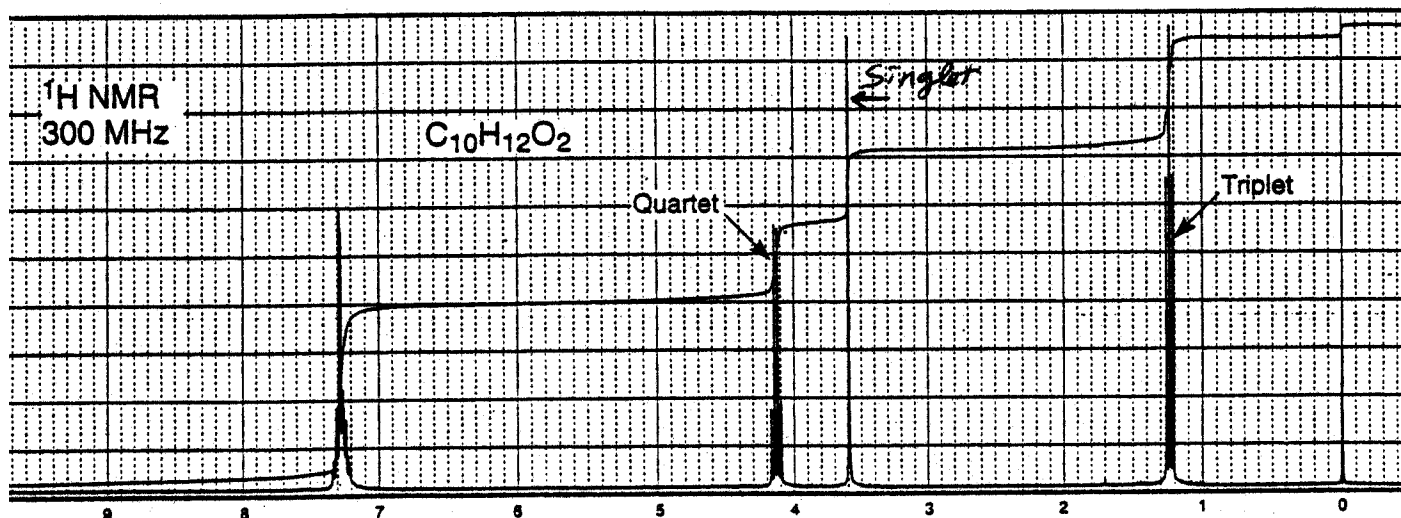


(b)

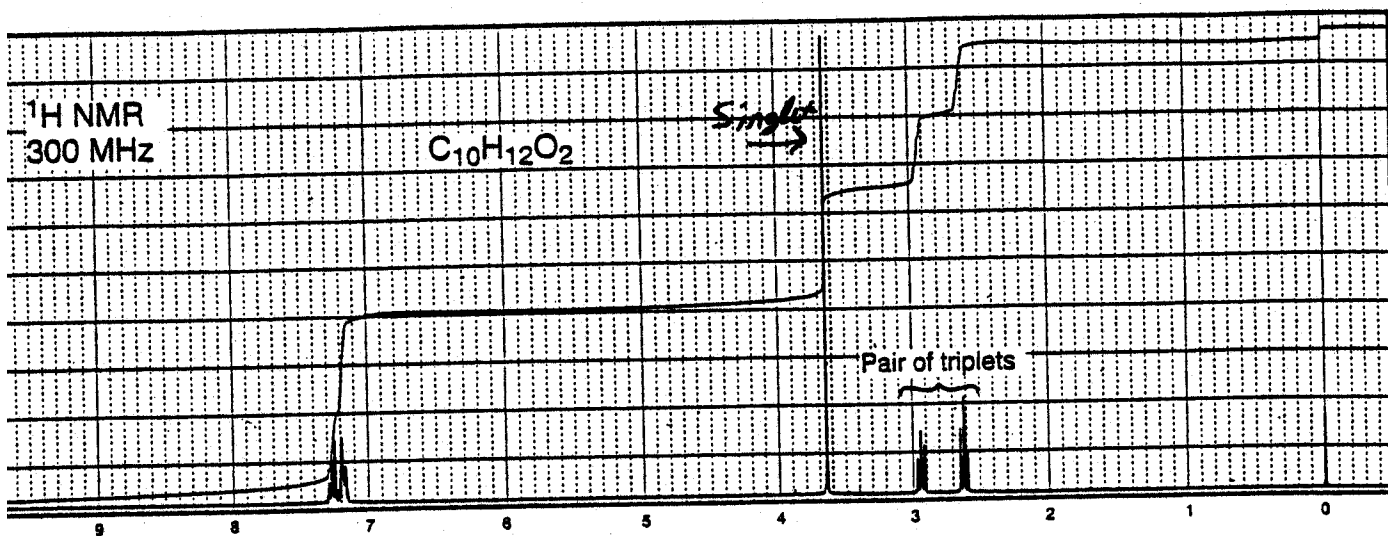


25. The following four NMR spectra are of isomeric monosubstituted aromatic esters with formula $\text{C}_{10}\text{H}_{12}\text{O}_2$. Make no attempt to interpret the aromatic proton areas between 7.1 and 7.4 ppm. Draw the structures of the compounds.

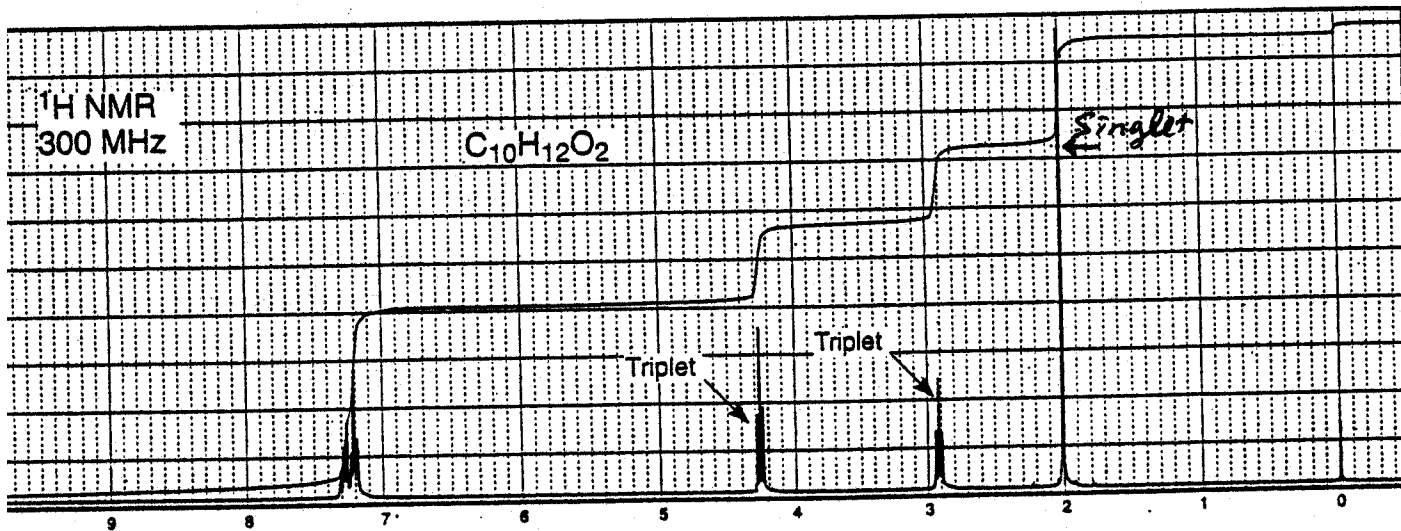
(a)



(b)



(c)



(d)

