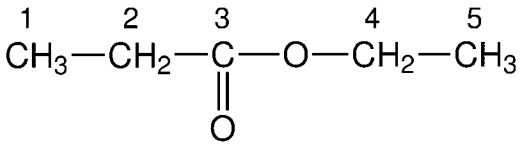
Problem 4

The ^{1}H and $^{13}C\{^{1}H\}$ NMR spectra of ethyl propionate ($C_5H_{10}O_2$) recorded in $CDCl_3$ solution at 298 K and 300 MHz are given below.

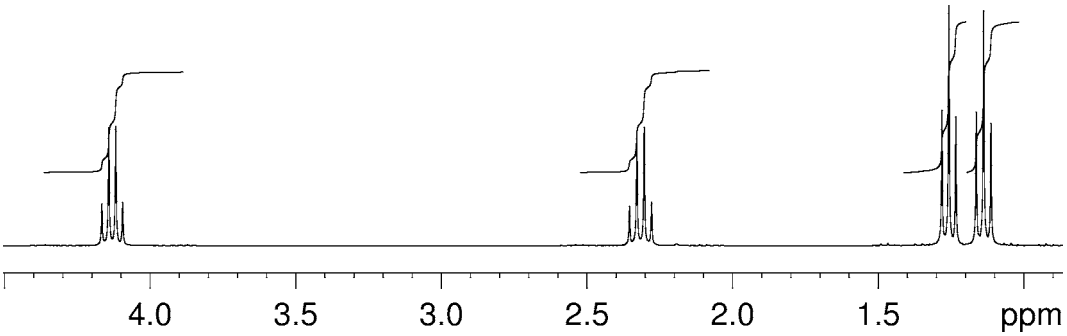
The ^{1}H NMR spectrum has signals at δ 1.14 (H_1), 1.26 (H_5), 2.31 (H_2) and 4.12 (H_4) ppm.

The $^{13}C\{^{1}H\}$ NMR spectrum has signals at δ 9.2 (C_1), 14.3 (C_5), 27.7 (C_2), 60.3 (C_4) and 174.5 (C_3) ppm.

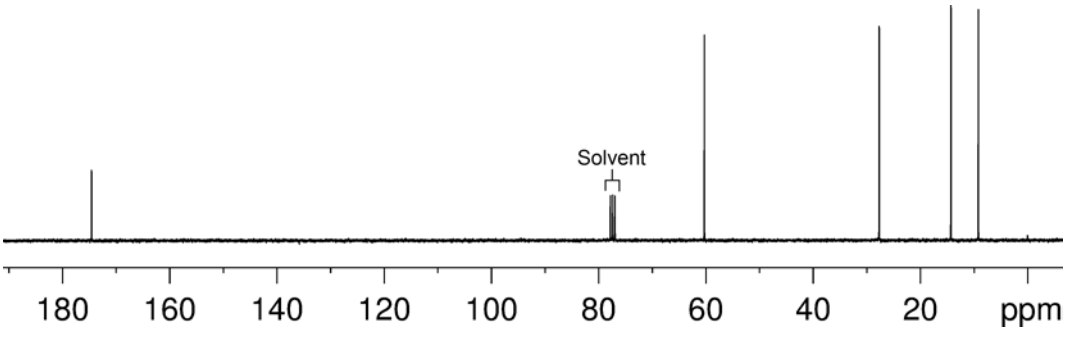
Use this information to produce schematic diagrams of the COSY, HSQC and HMBC spectra, showing where all of the cross peaks and diagonal peaks would be.

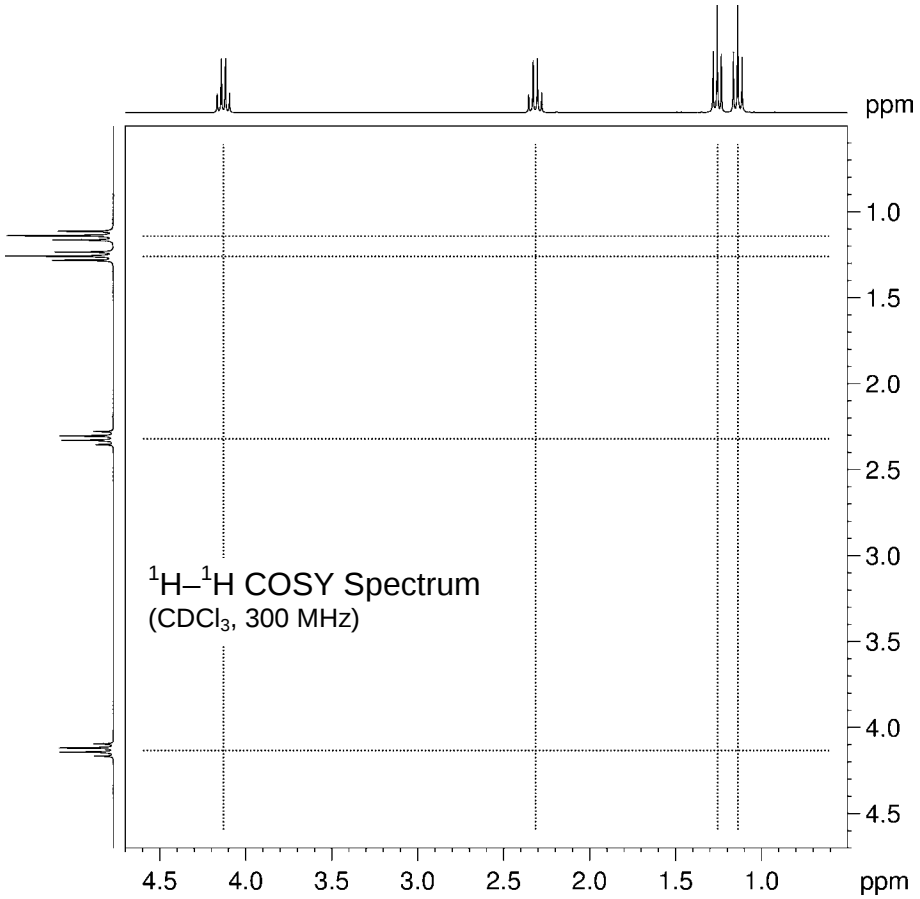


^{1}H NMR Spectrum
($CDCl_3$, 300 MHz)

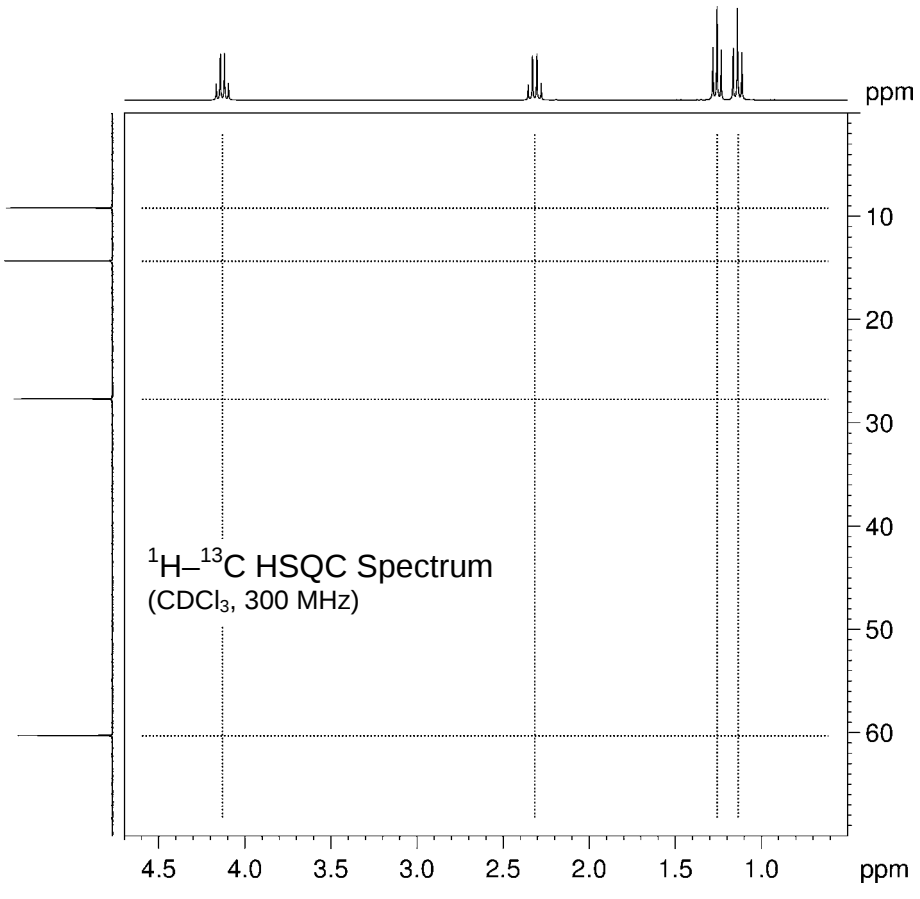


$^{13}C\{^{1}H\}$ NMR Spectrum
($CDCl_3$, 75 MHz)

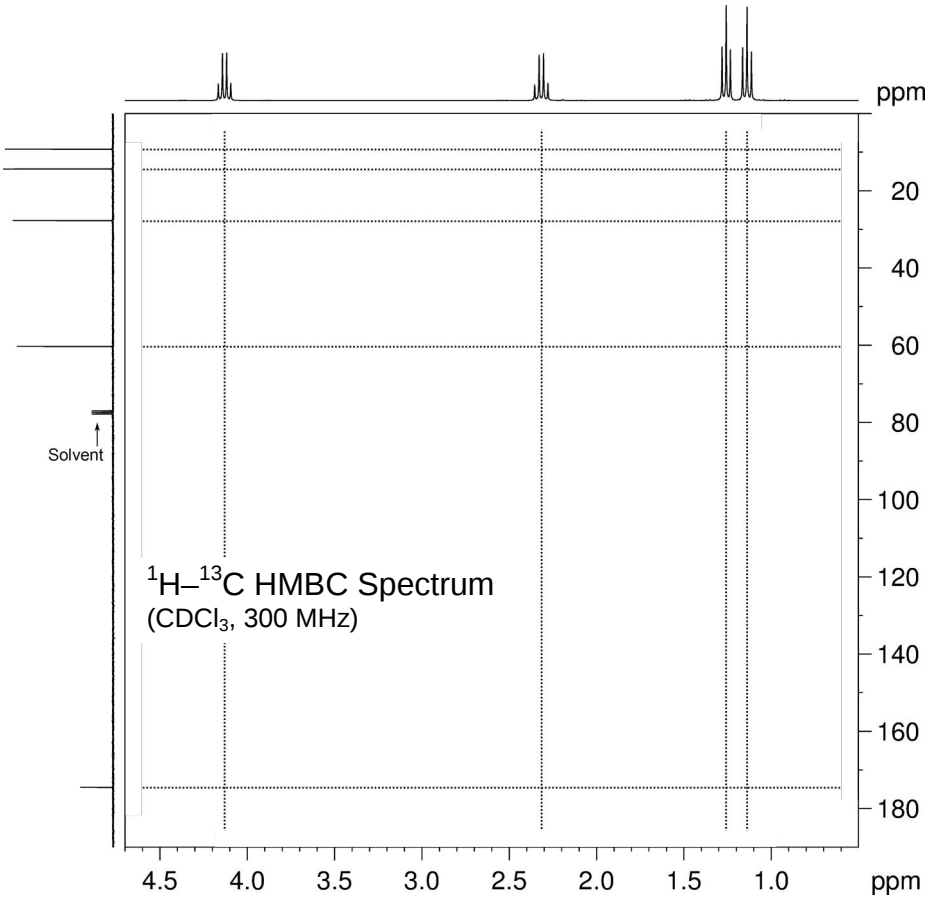


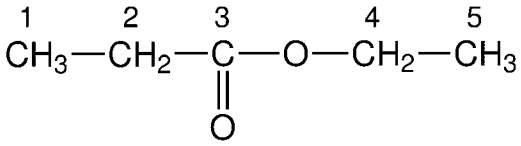


$^{1}H–^{1}H$ COSY Spectrum
($CDCl_3$, 300 MHz)



$^{1}H–^{13}C$ HSQC Spectrum
($CDCl_3$, 300 MHz)


ppm
20
40
60
80
100
120
140
160
180
Solvent
^{1}H–^{13}C HMBC Spectrum
($CDCl_3$, 300 MHz)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
ppm


1
2
3
4
5
CH3—CH2—C—O—CH2—CH3
O