I. Theory

1. Which sequence correctly ranks the regions of the electromagnetic radiation spectrum in order of increasing energy? (3 points)

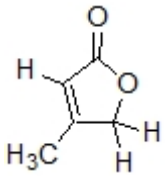
infrared	ultraviolet	visible
1	**2**	**3**

a) 1<2<3 b) 2<3<1 c) 3<1<2 d) 3<2<1 e) 2<1<3 f) 1<3<2

2. Circle all equations that are correct as written. (4 points)

a) $\lambda = \nu/c$ b) $\nu = h/\lambda$ c) $E = hc/\lambda$ d) $\Delta E = \gamma(h/2\pi)B_o$

3. Circle the bond in the following structure that has the highest IR absorption frequency value. (3 points)

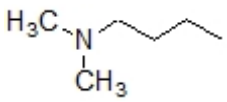


4. A(n) _____ NMR spectrum is a 2D NMR with a ^{1}H NMR scan along the y-axis and a ^{13}C NMR scan along the x-axis. (2 points)

5. Circle all species that may be detected by a mass spectrometer. (4 points)

a) H_2O b) $[CH_3CH_3]^{\oplus\cdot}$ c) $CH_3NH_3^{\oplus}$ d) CH_3

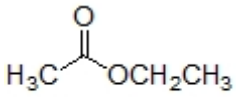
6. Predict the m/z value for the base peak of the following compound observed in its mass spectrum. Draw a structure for the corresponding fragment. (5 points)



7. Low resolution mass spectrometry has a resolution of ____ amu. (2 points)

a) 1 b) 0.1 c) 0.5 d) 0.01 e) 0.001

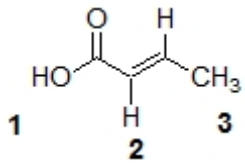
8. If the splitting pattern for the methylene group (CH_2) in ethyl acetate has a width of 21.6 Hz, what is the total width of the splitting pattern generated by the neighboring methyl group? (3 points)



ethyl acetate

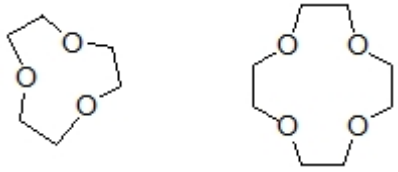
9. If a peak has a chemical shift of 3.5 ppm using a 300 MHz NMR, what is the value of this chemical shift in hertz? (3 points)

10. Which sequence ranks the indicated protons in order of increasing amount of electron shielding in proton NMR spectroscopy? (3 points)



a) 1<2<3 b) 2<3<1 c) 3<1<2 d) 3<2<1 e) 2<1<3 f) 1<3<2

11. Of the different analytical methods we have studied, which would be best suited for differentiating the following two structures? (2 points)



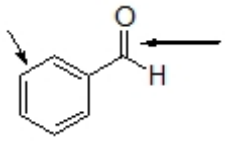
12. Which of the following spectroscopic methods provides the foundation for MRI examinations? (2 points)

a) IR b) UV / Vis c) ^{1}H NMR d) ^{13}C NMR e) ^{31}P NMR f) x-ray

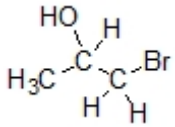
II. Spectra interpretation and prediction

1. Compound **A**, $C_8H_{16}O$, gave the following ^{1}H NMR spectrum: 2.4 ppm, triplet, 2H; 2.1 ppm, singlet, 3H; 1.5 ppm, triplet, 2H; 0.9 ppm, singlet, 9H. The compound also gave 6 peaks in its ^{13}C NMR spectrum. Propose a structure for compound **A**. (6 points)

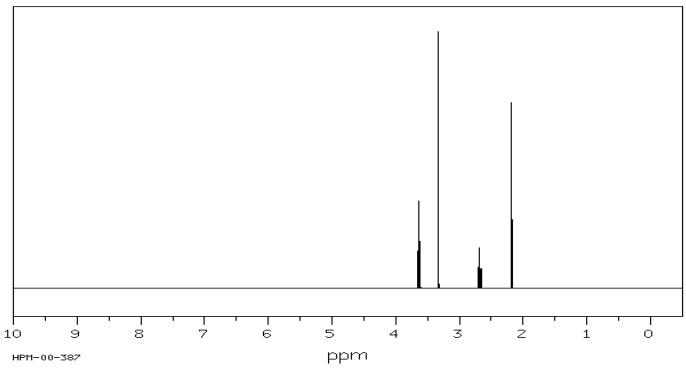
2. Predict where stretching of the two indicated bonds would appear in an IR spectrum in wavenumbers. (4 points.)

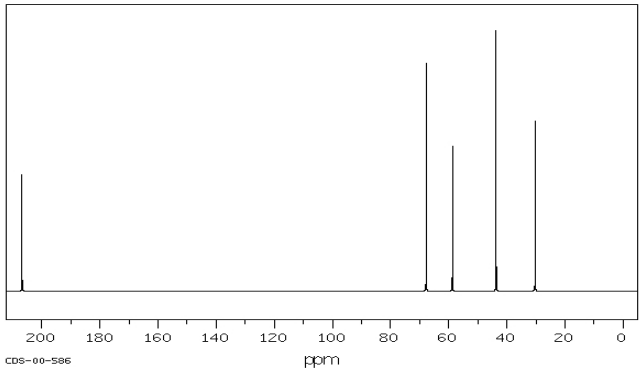


3. Alphabetically label each proton chemical environment, and then indicate the spin-spin splitting pattern of each proton environment in the structure below. (10 points)

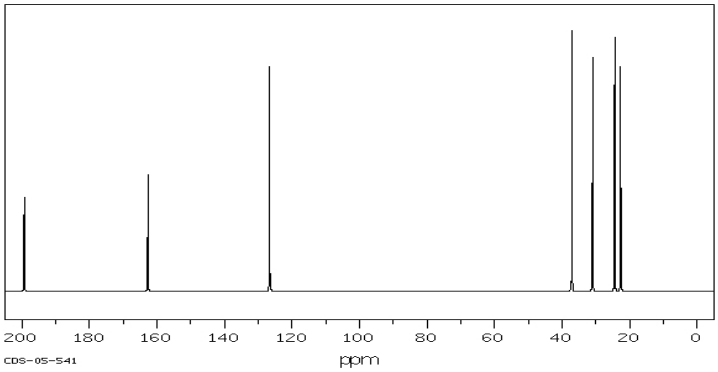


4. Identify compound **B**, $C_5H_{10}O_2$, from the following ^1H NMR and ^{13}C NMR spectra. Correlate your structure with each peak in both spectra. (10 points)

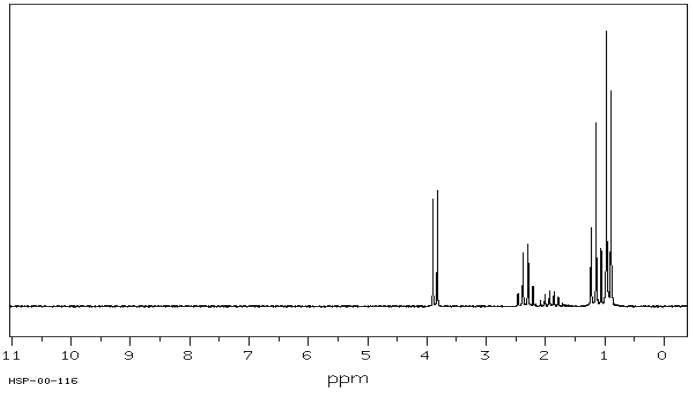




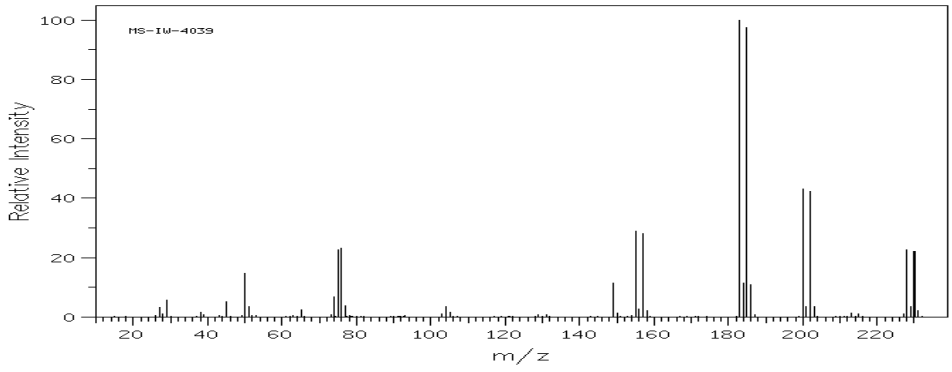
5. Compound **C** has a molecular formula of $C_7H_{10}O$, and gave the following ^{13}C NMR with off-resonance coupling shown above each peak. Predict the structure and justify your answer through correlation with each peak in the spectrum. (8 points)

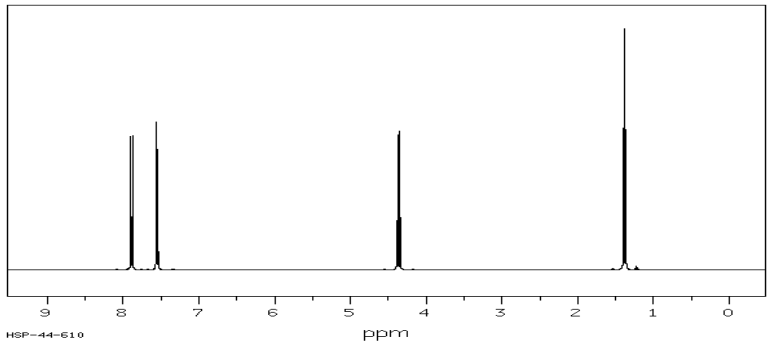


6. Compound **D**, $C_7H_{14}O_2$, gave the following 1H NMR spectrum. Provide a structure for compound **D** and justify your answer by correlation of the peaks with your structure. (8 points)

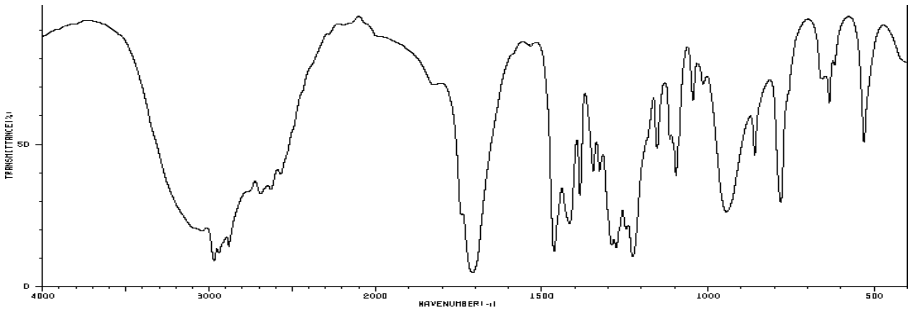


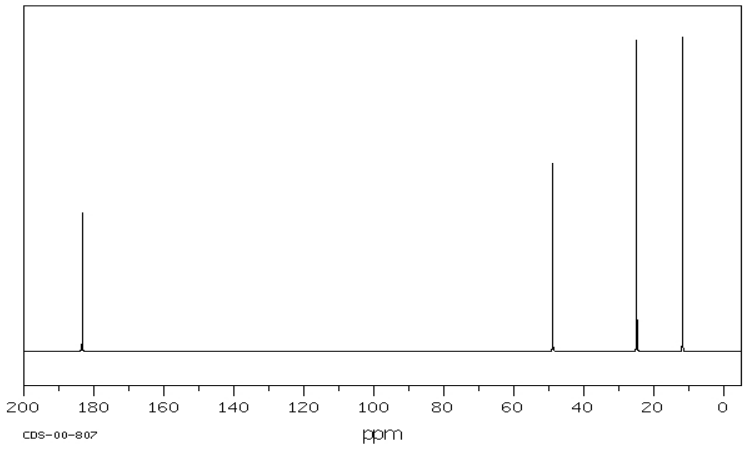
7. Provide a structure for compound **E**, given the following mass spectrum and ^{1}H NMR spectrum. Justify your answer through correlation of the structure with each spectra. (10 points)





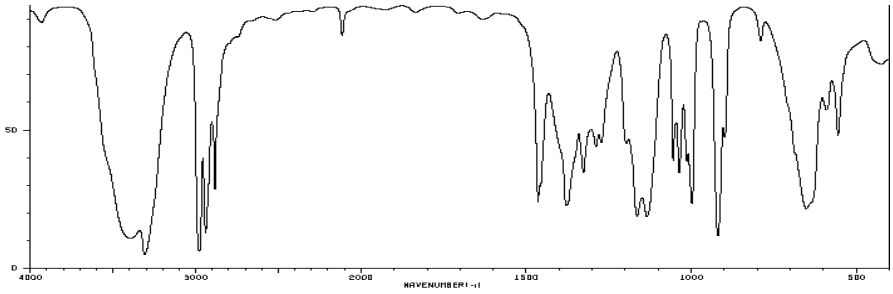
8. Identify compound **F**, having a molecular weight of 116, using the following IR and ^{13}C NMR spectra. Then **thoroughly** justify your answer by correlating your structure with the key peaks in each spectra. (8 points)

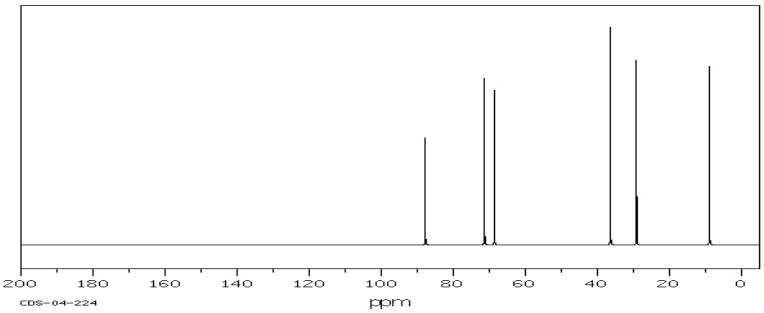


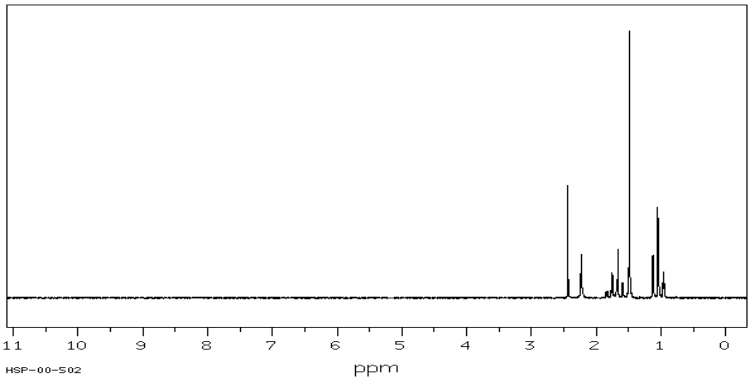


III. **Extra Credit** (5 points)

1. Identify compound **G** using the following spectra and given that the compound had a molecular ion peak of 98.







You received _____ points out of 100 points possible. To check your overall performance in lecture see http://canvas.weber.edu .