1. Sketch the $^1\text{H}$ NMR spectrum of the following compound with the given coupling constants. Two of the vinyl protons appear around $\delta 4$ and one comes around $\delta 6$. Assign the vinyl hydrogens.

   \[ J_{ab} = 2 \text{ Hz} \]
   \[ J_{bc} = 10 \text{ Hz} \]
   \[ J_{ac} = 16 \text{ Hz} \]

2. Which of the structures has the $^{13}\text{C}$ NMR spectrum shown? Assign the carbons.

3. The $^1\text{H}$ NMR signals for the aromatic hydrogens of methyl $p$-hydroxybenzoate appear as doublets at approximately 7.05 and 8.04 $\delta$. Assign these two doublets to the respective hydrogens that produce each signal. Justify your assignments using arguments of relative electron density based on contributing resonance structures.
4. The three isomers of dimethylbenzene are commonly named *ortho-*xylene, *meta-*xylene and *para-*xylene.

(a) Describe how carbon NMR distinguishes these isomers.

(b) Explain why they are difficult to distinguish by proton NMR.

5. Analyze, assign and explain the spectra of the methoxynitrobenzenes using their chemical shifts and splittings. The spectra are on the next page.
Problem R-19B (C₇H₇NO₃)
300 MHz ¹H NMR spectrum in CDCl₃
Source: Aldrich Spectra Viewer/Reich

Isomeric Methoxynitrobenzenes

Chem 345
6. An unknown compound has the following molecular formula, C$_9$H$_{11}$Br. It's $^1$H NMR shows the following absorptions.

- Singlet, $\delta$7.1, integral 44 mm
- Singlet, $\delta$2.2, integral 130 mm
- Singlet, $\delta$2.3, integral 67 mm

Propose a structure for this compound.