1. (12 pts) Give the expected $^1$H NMR peak splitting pattern for the indicated protons (s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublets, dt = doublet of triplets, or dq = doublet of quartets). Assume that dissimilar protons (diastereotopic protons) will have different coupling constants.

2. (24 pts) Determine how the indicated protons are related (homotopic, enantiotopic, diastereotopic, or not related) and give the peak splitting pattern for proton "A" using: s, d, t, q, dd, dt, or dq.
3. (12 pts) Label the following carbon signals for compound A in the $^{13}$C NMR spectrum below.

![NMR spectrum of compound A with labels 1, 2, 3, 4, 5, and 6]

4. (16 pts) Match one compound to the $^1$H NMR spectra or tabulated data. Two structures will not be used.

- **A**: $\delta$ 4.13 (s, 3H), 2.47 (q, $J = 7.6$ Hz, 2H), 1.06 (t, $J = 7.6$ Hz, 3H)
- **B**: $\delta$ 3.75 (t, 4H), 1.85 (t, 4H)
- **D**
- **C**
5. (18 points) The following IR spectra for each of the compounds given below were obtained. Label the bands in the spectra that correspond to each of the functional groups in the indicated molecule. Your labeling would help to confirm that they are indeed present in the molecules. While we are looking for the 3–4 most diagnostic bands in each spectrum, you may label up to 6 bands. Note: If you label some bands incorrectly, we will take off points for that (i.e. indicating that a C=O is present, but there is not one in the molecule). (6 points)
6. (12 points) Predict the number of signals that would be observed in the $^{13}$C NMR spectrum of each of the compounds below.

![Compounds](image)

6  8  5  5

7. (16 pts) Use the following mass spectrometry data to propose a formula for the unknown compound. Then, calculate the Degrees of Unsaturation (DoU) for your formula. For full credit you must show all of your work.

<table>
<thead>
<tr>
<th>m/z</th>
<th>Int.</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M^+$</td>
<td>156.0</td>
</tr>
<tr>
<td>$M^+ + 1$</td>
<td>157.0</td>
</tr>
<tr>
<td>$M^+ + 2$</td>
<td>158.0</td>
</tr>
</tbody>
</table>

**Formula:** $C_6H_5Br$

**DoU:** 4
8. (30 pts) Using the following spectral data, propose a structure. Show your work for partial credit.

\[ \text{MF} = C_{10}H_{12}O_2 \]

\[ \text{DoU} = 5 \]