How many signals would you expect each of the following molecules to have in its $^1$H NMR and $^{13}$C NMR spectra?

a. ![Molecule A](image)

b. ![Molecule B](image)

c. ![Molecule C](image)

d. ![Molecule D](image)

e. ![Molecule E](image)

f. ![Molecule F](image)

For the molecules below predict the number of $^1$H signals you would expect as well as the multiplicity (pattern of the signal) and integration (intensity) of the different hydrogen environments:

a. ![Molecule A](image)

b. ![Molecule B](image)

c. ![Molecule C](image)
For the following molecules below identify the major absorptions (and wavenumber range for each absorption) that would be observed in the IR spectrum.

a. \[ \text{\includegraphics[width=0.2\textwidth]{cyclohexanone.png}} \]

b. \[ \text{\includegraphics[width=0.2\textwidth]{aniline.png}} \]

c. \[ \text{\includegraphics[width=0.2\textwidth]{allylalcohol.png}} \]

Given the following information, propose a structure for a compound with molecular formula \( \text{C}_5\text{H}_{12}\text{O} \).

IR: broad absorption around 3350, absorptions between 2760-2970.

\(^1\text{H NMR: }3.73 \delta (2 \text{ H, triplet}), 1.66 \delta (1 \text{ H, multiplet}), 1.57 \delta (1 \text{ H, singlet}), 1.49 \delta (2 \text{ H, quartet}), 0.92 \delta (6 \text{ H, doublet}). \) Singlet at 1.57 ppm disappears on treatment with \( \text{D}_2\text{O} \).

\(^{13}\text{C NMR: }4 \text{ signals} \)
Propose a structure for the following molecules given the molecular formula and respective spectra.

a. C₆H₁₂O₂

b. C₁₀H₁₂O
c. $\text{C}_7\text{H}_5\text{BrO}$

- 3 H, s

- 1 H, s

- Internal Standard, Ignore

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d. $\text{C}_5\text{H}_{10}\text{O}_2$

- 9 H, s

- 1 H, broad s
e. \( \text{C}_4\text{H}_{10}\text{O} \)

DEPT-135: positive peak at 16 ppm, negative peak at 66 ppm.

f. Determine the molecular formula based off the MS ion \((M^+ = 86)\) for a hydrocarbon. With the molecular formula propose a structure for the hydrocarbon based off the following data:

- Broadband-decoupled \(^{13}\text{C}\) NMR: 30.2, 31.9, 61.8, 114.7, 138.4 ppm
- DEPT-90: 138.4 ppm
- DEPT-135: positive peak at 138.4 ppm, negative peaks at 30.2, 31.9, 61.8, 114.7 ppm
Classify the following protons as homotopic, enantiotopic, or diastereotopic:

- Structure 1
- Structure 2
- Structure 3
- Structure 4
- Structure 5
- Structure 6