Method 1: D.O.U + Integration

D.O.U = O must be an alcohol or ether. Since there is only one oxygen and no peaks integrate to one, the compound is an ether.

\[ \text{Integrates to 6} \]

No integral \( > 3 \)

Alcohols \( \delta 4.5-9 \)

At room temperature, alcohols undergo rapid proton exchange (dissociation + reassociation).

If D\(_2\)O is added to a sample, proton/deuterium exchange can occur, which, if sufficient D\(_2\)O is added, can convert an alcohol to its deuterated analog.

\[ \text{H} \xrightarrow{\text{D}\_2\text{O}} \text{D} \]

Since H and D are different nuclei, they absorb NMR radiation at different frequencies, so when conducting \( ^1\text{H}-\text{NMR} \), the alcohol peak (after exchange) disappears.

\[ \text{H} \rightarrow \text{D} + \text{RT} \]

Proton exchange is rapid enough that splitting between an alcohol proton and its neighbors will not be observed.

Method 2: \( \delta \)

\[ \text{Integrates} \quad (\delta 4.5-9) \quad \text{(may be lower)} \]

\[ \text{H} \]

\[ \text{O} \]

\( \delta 3.3-4.0 \)

\[ \text{H} \]

\[ \text{O} \]

\( \delta 0.93, \tau 1.3, 3 \text{H} \)

\[ \text{H} \]

\[ \text{O} \]

\( \delta 5.22, \tau 1, 11 \text{H}, \tau_1 = 2 \text{H}, \tau_2 = 7 \text{H} \)
This compound has two peaks with $\delta \approx 3.4$, with a combined integration of 3. This must mean there are two carbons next to the only oxygen present, so the compound is an ether.

Method 3: Splitting

A singlet that has an integration of 3 often indicates there is a methyl group with blocked splitting.

It is a reasonable guess that the compound is a methyl ether, which must at least be a quartet due to the methyl group.

Since it is only a triplet, there cannot be any other neighboring hydrogens.
\( \text{C}_8\text{H}_8 \)  
\[ \delta \text{ 6.692, J } = 7 \text{ Hz, 12 Hz} \]
\[ \delta \text{ 5.737, J } = 2 \text{ Hz, 12 Hz} \]
\[ \delta \text{ 5.225, J } = 2 \text{ Hz, 7 Hz} \]

\( \text{not geminal} \)

\( \text{C}_5\text{H}_8\text{O} \)
\[ \delta \text{ 6.342, d, 1H, J } = 6.2 \text{ Hz} \]
\[ \delta \text{ 4.664, d, 1H, J } = 6.2 \text{ Hz} \]
\[ \delta \text{ 3.957, t, 2H} \]
\[ \delta \text{ 1.984, d, 2H} \]
\[ \delta \text{ 1.846, t, 2H} \]

\( \text{C}_6\text{H}_{12} \)
\[ \delta \text{ 5.45, d, 1H, J } = 14 \text{ Hz} \]
\[ \delta \text{ 5.42, d, 1H, J } = 14 \text{ Hz} \]
\[ \delta \text{ 1.95, d, 2H} \]
\[ \delta \text{ 1.643, d, 3H} \]
\[ \delta \text{ 1.360, t, 2H} \]
\[ \delta \text{ 0.885, t, 3H} \]