- Draw the constitutional formula(s) of the major organic product(s) formed in each of the following reactions.

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Product(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \text{HBr} )</td>
<td>( \text{CH}_3 \text{CH}_2 \text{CH} = \text{CH}_2 )</td>
</tr>
<tr>
<td>( \text{CH}_3 \text{CH}_2 \text{CH}_3 )</td>
<td>( \text{CH}_3 \text{CH}_2 \text{OH} ) ( \text{conc. H}_2\text{SO}_4 )</td>
</tr>
<tr>
<td>( \text{C}<em>8\text{H}</em>{11}\text{OH} )</td>
<td>( \text{C}<em>8\text{H}</em>{11}\text{OH} ) ( \text{Cr}_2\text{O}_7^{2-} / \text{H}^+ / \text{H}_2\text{O} )</td>
</tr>
</tbody>
</table>
**Compound Z** can readily be identified by $^1$H NMR spectroscopy.

![Diagram of compound Z]

How many signals would you expect to see in the $^1$H NMR spectrum of compound Z?

Write the letters a, b, c, etc on the diagram of compound Z to identify each unique hydrogen environment giving rise to a signal in the $^1$H NMR spectrum.

Sketch the $^1$H NMR spectrum for compound Z. Label each signal in the spectrum with a, b, c, etc to correspond with your assignments on the diagram of Z above. Make sure you show the relative number of hydrogens and the splitting pattern (number of fine lines) you would expect to see for each signal.
• Draw the constitutional structure of the major organic product formed in the following reactions. Indicate the correct isomer where appropriate.
• Draw the constitutional formula of the major organic product formed in each of the following reactions.

\[
\text{Cr}_2\text{O}_7^{2-} / \text{H}^+ \rightarrow
\]

\[
\text{conc. HBr}
\]

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.