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

\[
\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} \xrightarrow{1. \text{Na} \text{NH}_2} \text{CH}_3\text{CH}_2\text{CH}_2\text{O}\text{CH}_2\text{CH}_3
\]

Marks: 6
Compound X was isolated as a derivative of a natural product.

Carbon 4 of X is a stereogenic centre. List the substituents attached to C4 in descending order of priority according to the sequence rules.

<table>
<thead>
<tr>
<th>highest priority</th>
<th>lowest priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>-CH₂COCH₃</td>
<td>CH₂CH=CHCH₃</td>
</tr>
<tr>
<td>CH₃</td>
<td>-CH₃</td>
</tr>
<tr>
<td>-H</td>
<td></td>
</tr>
</tbody>
</table>

What is the systematic name for compound X? Make sure you include all relevant stereochemical descriptors.

(4S,6Z)-4-methyloct-6-en-2-one. As shown above, the stereochemistry about carbon 4 is (S) (anticlockwise). The C=C bond has the two higher priority groups (-CH₃ and –CH₂CH(CH₃)CH₂COCH₃) on the same side so it has a (Z) configuration.

Reduction of X with sodium borohydride (NaBH₄) followed by quenching the reaction with dilute acid gives Y. Give the constitutional formula for Y.

Product Y can be separated into two isomers. Explain.

The reduction introduces a second stereogenic centre into the molecule. The two products are diastereoisomers (not enantiomers) and hence have different chemical and physical properties and can be separated.
• Compound Y can readily be identified by $^1H$ NMR spectroscopy.

On the diagram of Y, write the letters a, b, c, etc. as necessary to identify each unique hydrogen environment giving rise to a signal in the $^1H$ NMR spectrum.

![Image of compound Y](image)

Sketch the $^1H$ NMR spectrum of compound Y. Label each signal in the spectrum with a, b, c, etc. to correspond with your assignments on the diagram of Y. Make sure you show the splitting pattern (number of fine lines) you expect to see for each signal. Also write the relative number of hydrogens you expect above each signal.

![Image of NMR spectrum](image)

Compound Z is an isomer of Y.

What kind of isomers are they?

### constitutional isomers

Compounds Y and Z can be readily distinguished by instrumental techniques. Suggest how three different techniques can be used to distinguish between the two structures.

1. IR spectrometry: Y has a strong absorption at about 1700 cm$^{-1}$ due to the C=O group. Z does not.
2. Z has 5 signals in its $^1H$ NMR spectrum, Y has 4 signals in its $^1H$ NMR spectrum.
3. Z has 6 signals in its $^{13}C$ NMR spectrum, Y has 5 signals in its $^{13}C$ NMR spectrum.
4. Fragmentation patterns in their mass spectra. For example, Z would be expected to have a peak due to a OMe fragment.
Complete the two step mechanism for the reaction given below. Draw intermediate structures, curly arrows and partial charges as appropriate to illustrate the bonding changes that take place.