1. Consider the compounds F, G, H, I, J and K.

![Structures of F, G, H, I, J, and K]

In answering the following questions note that more than one answer could be correct: all correct answers are required.

Which (if any) of the compounds strongly absorb infrared radiation in the range 1650-1800 cm\(^{-1}\)?

I, J

Which (if any) of the compounds strongly absorb infrared radiation in the range 3200-3700 cm\(^{-1}\)?

K

Which (if any) of the compounds strongly absorb radiation in the ultraviolet region?

F

Which (if any) of the compounds would have a \(^1\)H NMR spectrum consisting of only three singlets?

H, I

Which of the compounds will show peaks of approximately equal intensity at m/z 168 and 170 in its mass spectrum?

G

2. Consider the compounds T, U, V, W and X.

![Structures of T, U, V, W, and X]

In answering the following questions note that more than one answer could be correct: all correct answers are required.

Which of the compounds will absorb strongly in the infrared spectrum in the range 3200-3600 cm\(^{-1}\)?

T, U

Which of the compounds have a \(^1\)H NMR spectrum consisting only of

i) one singlet?

W, X

ii) two singlets?

U, V

Which of the compounds have a mass spectrum with a parent ion at m/z 46?

T, X
3. Consider the compounds having constitutional formulas H to M.

\[
\begin{align*}
\text{(H)} & \quad \text{CH}_3\text{-CH}_2\text{-CH}_2\text{-H} & \quad \text{CH}_3\text{-CH}_2\text{-C}-\text{H} \\
\text{(I)} & \quad \text{CH}_3\text{-CH}_2\text{-C}-\text{H} & \quad \text{CH}_3\text{-CH}_2\text{-C}-\text{H} \\
\text{(K)} & \quad \text{CH}_3\text{-CH}_2\text{-C}-\text{H} & \quad \text{CH}_3\text{-CH}_2\text{-C}-\text{H} \\
\text{(L)} & \quad \text{CH}_3\text{-CH}_2\text{-C}-\text{H} & \quad \text{CH}_3\text{-CH}_2\text{-C}-\text{H} \\
\text{(J)} & \quad \text{CH}_3\text{-CH}_2\text{-C}-\text{H} & \quad \text{CH}_3\text{-CH}_2\text{-C}-\text{H} \\
\text{(M)} & \quad \text{CH}_3\text{-CH}_2\text{-C}-\text{H} & \quad \text{CH}_3\text{-CH}_2\text{-C}-\text{H}
\end{align*}
\]

Which (if any) of compounds H to M would have a parent ion in the mass spectrum at \(m/z\) 86? All of them

Which one of the compounds H to M has the \(^1\)H NMR spectrum below?
State the relative areas of signals a:b.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Areas a : b</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>2 : 3</td>
</tr>
</tbody>
</table>

Which (if any) of compounds H to M would absorb strongly in the IR spectrum in the given frequency ranges?

<table>
<thead>
<tr>
<th>Frequency Range</th>
<th>Compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1650-1750 cm(^{-1})</td>
<td>H, I, K, M</td>
</tr>
<tr>
<td>2850-2950 cm(^{-1})</td>
<td>All of them</td>
</tr>
<tr>
<td>3200-3600 cm(^{-1})</td>
<td>J, L</td>
</tr>
</tbody>
</table>

4. Outline, by means of equations, a simple chemical test that could be used to distinguish between I and K. State what is observed in each case.

\[
\begin{align*}
\text{I} & \quad [\text{Ag(NH}_3\text{)}_2]^+ \\
\text{K} & \quad [\text{Cr}_2\text{O}_7^{2-}\text{(red)} + \text{H}^+] \\
\text{I} & \quad \text{[Ag(NH}_3\text{)}_2]^+ \quad \text{Ag mirror} \\
\text{K} & \quad \text{[Cr}_2\text{O}_7^{2-}\text{(red)} + \text{H}^+] \quad \text{Cr}^{3+}\text{(green)} \\
\end{align*}
\]

In both cases K would not react