1. In each of the boxes shown below, list all the types of bonds and approximate wavenumber (cm⁻¹) at which each bond type is expected to have an IR absorption.

\[
\begin{array}{|c|c|c|c|c|}
\hline
3600 & 3000 & 1800 & 1400 & 1000 \\
\hline
\end{array}
\]

2. For each of the following pairs of compounds, give one absorption band and its wavelength that could be used to distinguish between them:

a) CH₃CH₂CH₂CH₃ and CH₃CH₂OCH₃

b) CH₃CH₂COCH₃ and CH₃CH₂COH

c) CH₃CH₂COH and CH₃CH₂CH₂OH

d) CH₃CH₂CCCH₃ and CH₃CH₂CCH

e) \[\text{cyclic structure} \] and \[\text{benzene ring} \]

3. Indicate how you would carry out each of the following reactions. How would you distinguish between the starting material and product by IR? Your answer should include both disappearance as well as appearance of IR absorptions.

a) 1-methylcyclohexene to trans-2-methylcyclohexanol
b) cyclohexene to HOOCCH₂CH₂CH₂CH₂COOH (adipic acid)
c) 1-Hexyne to 2-Hexanone
d) 1-Hexyne to 1-Hexene
e) 3-chloropentane to 2-pentene
4. In each set of compounds shown below, choose the structure which best fits the spectra.

\[
\text{OH} \quad \text{O} \\
\text{C} \quad \text{CH}_3 \\
\text{O} \quad \text{CH}_2\text{OH} \\
\text{C} \quad \text{OH} \\
\text{C} \quad \text{CH}_2\text{CH}_3 \quad \text{C} \quad \text{CH}_2\text{CH}_2\text{C} \quad \text{C} \quad \text{H} \\
\text{C} \quad \text{OH} \\
\text{C} \quad \text{CH}_3
\]
5. Shown below are the mass spectra for 2,5-dimethylheptane, 2,4-dimethylheptane, and 3,5-dimethylheptane. Match the correct compound to its spectrum and justify your answer by identifying the major fragments.
6. Two products are formed when cis-2-pentene is reacted with H₂O and a trace of acid as a catalyst. The mass spectra of these two products are shown below. Identify the compounds which give rise to each spectrum.