There are 5 pages and 250 pts on this exam. Please read each question carefully before answering.

1. (15 pts) Rank the following compounds (from 1 to 5) in order of increasing acidity (1 = least acidic):

   ![Compounds](image)

2. (9 pts) Rank the following compounds (from 1 to 3) in order of increasing value of the C-H stretch in their infrared spectra in cm\(^{-1}\) (1 = smallest value of the IR stretch):

   ![Compounds](image)

3. (12 pts) Rank the following compounds (from 1 to 4) in order of increasing value of the C=O stretch in their infrared spectra in cm\(^{-1}\) (1 = smallest value of the IR stretch):

   ![Compounds](image)

4. (30 pts) In the electron ionization (E. I.) mass spectrum of 2,6-dimethyl-4-heptanol, there are prominent peaks at m/z 87, 111, and 126 amu. Provide structures for these 3 fragment ions. (C\(_9\)H\(_{20}\)O has a molecular weight of 144 amu.)

   ![Compounds](image)
5. (40 pts) Match each of the following structures (A through D) with the infrared (IR) spectroscopic data (in cm$^{-1}$) that corresponds best. Abbreviations: w, weak; m, medium; s, strong; br, broad. Explain the reasons for your choices.

- **A**
  - OH

- **B**
  - OH

- **C**
  - OH

- **D**

(i) 3400 (s, br), 3090 (m), 2850 - 2980 (s), 1640 (m), 1040 (m), 995 (m) and 905 (s)

(ii) 2930 (s) and 2840 (s)

(iii) 3030 (m), 2890 - 2990 (s) and 1665 (m)

(iv) 3300 (s, br), 2810 - 2930 (s) and 1040 (m)
6. (44 pts) Give the products of the following reactions. If there is more than one product, predict which will be major.

(a)  \[
\begin{array}{c}
1) \text{LDA, } -78^\circ \text{C} \\
2) \text{CH}_3\text{CH}_2\text{I}
\end{array}
\]

(b)  \[
\begin{array}{c}
\text{HO}^-
\end{array}
\text{heat}
\]

(c)  \[
\begin{array}{c}
\text{Br}_2
\end{array}
\text{CH}_3\text{CO}_2\text{H}
\]

(d)  \[
\begin{array}{c}
\text{HO}^-
\end{array}
\]

(e)  \[
\begin{array}{c}
\text{CH}_3\text{O}^-
\end{array}
\]

(f)  \[
\begin{array}{c}
1) \text{PBr}_3, \text{Br}_2 \\
2) \text{H}_2\text{O}
\end{array}
\]

(g)  \[
\begin{array}{c}
\text{H}^+
\end{array}
\]

(h)  \[
\begin{array}{c}
1) \text{NaOEt} \\
2) \text{CH}_2=\text{CH}-\text{CH}_2\text{Br} \\
3) \text{H}_3\text{O}^+, \text{heat}
\end{array}
\]

(i)  \[
\begin{array}{c}
1) \text{CH}_2=\text{CH}-\text{CH}_2\text{Br} \\
2) \text{H}_3\text{O}^+
\end{array}
\]

(j)  \[
\begin{array}{c}
\text{CH}_3\text{O}^-
\end{array}
\]

(k)  \[
\begin{array}{c}
1) \text{NaOCH}_3 \\
2) \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}
\end{array}
\]
7. (30 pts) Provide syntheses for these compounds and provide complete reagents and conditions.

(a) Start with \( \text{EtO}_2\text{C} \text{CO}_2\text{Et} \) and prepare \( \text{CO}_2\text{H} \)

(b) Start with \( \text{CH}_3\text{O} \text{CH}_3 \text{CO}_2\text{H} \) and prepare

8. (20 pts) When E.I. occurs in the mass spectrometer for 3-methyl-2-pentanone (molecular weight = 100 amu), a McLafferty rearrangement and other fragmentations occur. Predict the masses and structures of the 3 major expected charged fragments.
9. (30 pts) Provide the necessary reagents and conditions to accomplish the following transformations in an efficient and effective manner -- more than one step may be required and more than one set of methods may be viable.

10. (20 pts) Provide a mechanism for the following transformation (Robinson annulation).