I. Nomenclature

1. Provide structures for the following compounds. (7 points)

- phthalic acid
- malonic acid
- β-methyl-γ-valerolactone

2. Using rules for common nomenclature, name the following substances. (8 points)

3. Provide an IUPAC name for citronellic acid, a natural product having antimicrobial activity. (3 points)

4. State the IUPAC name for each of the following structures. (6 points)
II. Theory

1. Which sequence correctly ranks the following compounds in order of increasing boiling point? (3 points)

   ![Chemical Structures]

   a) 1<2<3  b) 2<3<1  c) 3<1<2  d) 3<2<1  e) 2<1<3  f) 1<3<2

2. Which sequence correctly ranks the following carboxylic acid derivatives in order of increasing reactivity? (3 points)

   1 thioester  2 acid anhydride  3 amide

   a) 1<2<3  b) 2<3<1  c) 3<1<2  d) 3<2<1  e) 2<1<3  f) 1<3<2

3. Draw two repeating units of the polymer that is formed when the two copolymers react. (4 points)

   ![Polymer Structure]

4. What functional group is represented in the polymer formed in question # 3? (2 points)
5. Draw the most stable enol tautomer of the following structure. (3 points)

\[
\text{H}_3\text{C}^-\text{C}^-\text{C}^-\text{OCH}_2\text{CH}_3
\]

III. Reactions

1. Predict the products of the following reactions. (6 points)

\[
\begin{align*}
\text{O} & \quad \text{1) NaOCH}_3 \\
\text{O} & \quad \text{2) dil. HCl(aq)} \\
\text{O} & \quad \text{NaOH} \\
\text{H}_3\text{C} & \quad \text{water / ethanol} \\
\text{CH}_3
\end{align*}
\]

2. Complete each reaction below by filling in the missing reagents. (12 points)

\[
\begin{align*}
\text{O} & \quad \text{1) } \\
\text{O} & \quad \text{2) } \\
\text{OH} & \quad \text{OH}
\end{align*}
\]

\[
\begin{align*}
\text{O} & \quad \text{1) } \\
\text{O} & \quad \text{2) } \\
\text{O} & \quad \text{1) }
\end{align*}
\]
3. Indicate the necessary starting materials for the following reaction. (6 points)

\[
\text{Starting Materials: }
\]

4. For each reaction below fill in the missing intermediate product and reagents. (12 points)

\[
\text{Reaction 1: }
\]

\[
\text{Reaction 2: }
\]
IV. Mechanisms

1. Using correct arrow-pushing, provide a mechanism for each of the following reactions. Show all intermediates and formal charges. (17 points)

$$\text{H}_3\text{C}-\text{N}-\text{H} + \text{H}_3\text{C}-\text{Cl} \rightarrow \text{H}_3\text{C}-\text{N}-\text{C}=\text{O} + \text{H}_3\text{C}-\text{N}=\text{H} + \text{HCl}$$

$$\text{H}_3\text{C}-\text{OEt} + \text{H}_3\text{C}-\text{OEt} \xrightarrow{1) \text{NaOEt}} \rightarrow \text{H}_3\text{C}-\text{OEt} + \text{H}_3\text{C}-\text{OEt} \xrightarrow{2) \text{H}_3\text{O}^+}$$
V. Synthesis:

1. Complete each reaction below by filling in the missing product or reagents. (8 points)

\[
\text{C} = \text{H}_3 + \text{H}_3 \text{C} \text{C} \text{H}_3 \xrightarrow{\text{NaOH, heat}} \text{C} \text{H}_3 \text{C} \text{H}_3
\]

\[
\text{C} = \text{H}_3 \xrightarrow{1)} \xrightarrow{2)} \text{C} \text{CH}_3 \text{C} \text{H}_3 \text{H}_3 \text{C} \text{CO}_2
\]
VI. Extra Credit (5 points possible)

1. Without using any carboxylic acid derivatives, provide 5 different synthetic routes to cyclopentane carboxylic acid.

You received __________ points out of 100 points possible. For an update of your overall lecture grade go to http://courses.weber.edu