1. Use IUPAC nomenclature to write the systematic name of the following carboxylic acid.

![Structure of the carboxylic acid](image)

2. Draw the structure of the expected major organic product for each of the following three questions.

A.

![Image of the reaction](image)

B.

![Image of the reaction](image)

C.

![Image of the reaction](image)
3. Answer the following three questions precisely, succinctly, and with correct grammar.

A. Rank the following three compounds from highest to lowest $pK_a$. Explain your reasoning.

\[
\begin{align*}
&\text{HO} & &\text{CH}_3 & &\text{O} \\
&\text{H}_3\text{CO} & &\text{CH}_3 & &\text{CH}_3
\end{align*}
\]

B. Rank the following three compounds from highest to lowest $pK_a$. Explain your reasoning.

\[
\begin{align*}
&\text{HO} & &\text{CH}_3 & &\text{Cl} \\
&\text{HO} & &\text{CH}_3 & &\text{F} \\
&\text{HO} & &\text{CH}_3 & &\text{Cl}
\end{align*}
\]

C. What spectroscopic techniques could be used to distinguish between the following two organic compounds? Discuss all of the specific resonances that would be utilized.

\[
\begin{align*}
&\text{OH} \\
&\text{OH}
\end{align*}
\]