1. Fill in the blanks of the following statements.

________________________ fatty acids contain one carbon-carbon double bond.

Fats are esters of glycerol and three __________________________.

________________________ and __________________________ are essential fatty acids needed in the diet.

The process of __________________________ gets rid of C=C's and makes liquid fats into solid fats.

Partial hydrogenation can create __________________________ which are unnatural and may be detrimental to health.

Soap works by forming __________________________ in which the organic tails are on the inside and the carboxylate heads are on the outside.

Some good sources of omega-3 fatty acids are __________________________.

2. Draw structures for the following compounds.

a) Trichloroacetic acid  
   b) 2-methylmalonic acid  
   c) 3-cyclopentylpentanedioic acid

   d) m-chlorobenzoic acid  
   e) Z-3-hexenoic acid  
   f) 1-methylcyclopentanecarboxylic acid

3. Name the following compounds.

a)

b)
4. Give the pKₐ of each of the following compounds as acids and rank them in order of decreasing acidity.

5. Circle any of the following compounds which can form hydrogen bonds with water. Then draw a square around any of the compounds which can form hydrogen bonds with itself.
6. Determine the structures of the following compounds from their NMR spectra. Label the H's on your compound with the letters in the spectral data.

   a) a - 1.6 ppm (3H, d)  \( \text{C}_9\text{H}_{10}\text{O}_2 \)
   b - 3.7 ppm (1H, q)
   c - 7.4 ppm (5H, s)
   d - 11.8 ppm (1H, s)

   b) a - 1.9 ppm (3H, s)  \( \text{C}_4\text{H}_6\text{O}_2 \)
   b - 5.5 ppm (1H, d)
   c - 5.9 ppm (1H, d)
   d - 12.2 ppm (1H, s)

   c) a - 4.5 ppm (2H, s)  \( \text{C}_8\text{H}_8\text{O}_3 \)
   b - 6.8 ppm (3H, m)
   c - 7.2 ppm (2H, d)
   d - 12.0 ppm (1H, s)

7. If you are given a mixture containing benzyl alcohol, phenol, and benzoic acid, dissolved in ether:

   a) What will happen if you then extract the mixture with 5% aqueous potassium carbonate, then neutralize the extract with acid and extract it with ether?

   b) What will happen if you then extract the mixture with 5% aqueous sodium hydroxide, then neutralize the extract with acid and extract it with ether?

   c) What will be left in the original solution?

8. Fill in the missing reagents and products.

   a)  \[ \text{CH}_3-\text{CH}-\text{CHCl}_2 + \text{NaCN} \rightarrow \] \[ \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CO}_2\text{H} \]

   b)  \[ \text{CH}_3-\text{CH}_2-\text{CHCl}_2 + \text{Mg} \rightarrow \] \[ \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CO}_2\text{H} \]
9. Give the products of the following reactions.

a) \[
\begin{align*}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} & \xrightarrow{\text{K}_2\text{CO}_3} \text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H} \\
& \xrightarrow{\text{Ar-Cl}} \text{Ar-COOH}
\end{align*}
\]
b) \[
\begin{array}{c}
\text{SOCl}_2
\end{array}
\]

c) \[
\begin{array}{c}
1. \text{LiAlH}_4 \\
2. \text{H}_3\text{O}^+
\end{array}
\]

d) \[
\text{heat}
\]

e) \[
\text{heat}
\]

f) \[
\begin{array}{c}
\text{H}_2\text{SO}_4 \\
\text{acetic acid}
\end{array}
\]

g) \[
\text{P}_4\text{O}_{10}
\]

h) \[
\text{heat}
\]

i) \[
\begin{array}{c}
\text{H}_2\text{SO}_4 \\
isobutyl alcohol
\end{array}
\]

j) \[
\begin{array}{c}
1. \text{NaOH} \\
2. \text{Li} \\
3. \text{H}_3\text{O}^+
\end{array}
\]
10. Which of the following reactions will give the desired isotopically labeled compound? Hint: consider the mechanism of both reactions. Explain your choice!
11. Show the step-by-step mechanism for the following reactions. Account for all electron pairs, charges, etc.

a) 

\[
\begin{align*}
\text{Cl} & : \text{O} : \text{C} : \text{H} \quad \xrightarrow{\text{K}_2\text{CO}_3} \\
\end{align*}
\]

b) 

\[
\begin{align*}
\text{O} : \text{C} : \text{H} & \quad \xrightarrow{\text{heat}} \\
\text{H} & : \text{O} : \text{C} : \text{H}
\end{align*}
\]

(1st step only)

c) 

\[
\begin{align*}
\text{O} & : \text{C} : \text{H} \quad \xrightarrow{2 \text{ eq } \text{MgBr}} \\
\text{H} & \quad \xrightarrow{2. \text{H}_3\text{O}^+} \\
\end{align*}
\]

d) 

\[
\begin{align*}
\text{O} & : \text{C} : \text{H} \quad \xrightarrow{\text{H}_2\text{SO}_4} \\
\text{H} & \quad \text{O} : \text{C} : \text{H}
\end{align*}
\]
12. Show a reaction sequence (reagents and products) that will accomplish the following transformations. Reactions from previous chapters will be used.

a) 

b) 

c) 

d) 

e)