Multiple Choice Questions:
1. What is the major product of the following reaction?

   ![Reaction Image]

   (a)  
   (b)  
   (c)  
   (d)  

2. Why do carboxylic acids have considerably higher boiling points compared to their alcohol, aldehyde, or ketone counterparts?
   (a) They have more acidic protons
   (b) Can form hydrogen dimers
   (c) Have more oxygens than the other compounds
   (d) The carbonyl carbon is more electrophilic
   (e) None of the above

3. What is the correct order of carboxylic acid derivative stability? (Most Stable > Less Stable)
   (a) Esters > Anhydrides > Acid Chlorides
   (b) Acid Chlorides > Esters > Amides
   (c) Anhydrides > Amides > Esters
   (d) Amides > Anhydrides > Esters
   (e) None of the above

4. What is the IUPAC name of the following compound?

   ![Compound Image]

   (a) 6-isopropylester-2,6-hexandione
   (b) isopropyl 2,6-hexanioate
   (c) isopropyl hexanoic anhydride
   (d) 1-methylethyl 5-oxo-hexanoate
   (e) None of the above

5. What is the best reagent for the following reaction?

   ![Reaction Image]

   (a) CH₂N₂ in ether
   (b) NaOCH₃
   (c) H₂SO₄ and CH₃CH₂OH
   (d) CH₃CH₂Li
   (e) Two or more will work
6. What of the following reactions would produce an anhydride?
   (a) An amide with a carboxylic acid
   (b) Heating a 1,5-pentadioic acid
   (c) A carboxylic acid with Tollens’ and LiAlH₄
   (d) An ester with carboxylic acid and grignards
   (e) Two of the above will work

7. Rank the following in acidity? (Most Acidic > Least Acidic)

   ![Chemical Structures]

   (I) ![Chemical Structure of I]
   (II) ![Chemical Structure of II]
   (III) ![Chemical Structure of III]

   (a) I>III>II    (b) II>III>I    (c) III>II>I    (d) I>II>III    (e) Not Listed

   (a) Ketone; 3° Alcohol
   (b) 2° Alcohol; 3° Alcohol
   (c) Carboxylic Acid; 3° Alcohol
   (d) Aldehyde; Carboxylic Acid
   (e) None of the above

9. What is the product when you react 4-hydroxyl-butyric acid with sulfuric acid?
   (a) Ketone
   (b) Diol
   (c) Anhydride
   (d) Lactone
   (e) None of the above

10. What is the product after the following reactions?

    ![Chemical Reaction]

    (a) Carboxylic Acid
    (b) Amide
    (c) 1° Amine
    (d) 1° Alcohol
    (e) None of the above
Short Answer Questions:
1. Show the complete mechanism of Claisen condensation followed by saponification and decarboxylation. Be sure to show all intermediates, reaction arrows, and reagents for each step.

2. Provide a reasonable synthesis including all intermediates and reagents.
3. Propose a reasonable malonic ester synthesis to form the following carboxylic acid. Show all intermediates, reaction arrows, and reagents for each step.

\[
\begin{align*}
\text{Ph} \quad \text{CH} \quad \text{CH} \quad \text{CH}_2 \quad \text{COH} \\
\text{Ph} \quad \text{CH}_2 \quad \text{CO} \quad \text{OH}
\end{align*}
\]

4. What else is needed for this reaction to take place? Why is it required and what would happen if it isn’t used?

\[
\begin{align*}
\text{Ph} \quad \text{Cl} \quad \text{CH} \quad \text{OH} & \quad \text{Ph} \quad \text{CO} \quad \text{COOH} \\
\text{Ph} \quad \text{Cl} \quad \text{CH} \quad \text{OH} & \quad \text{Ph} \quad \text{CO} \quad \text{COOH}
\end{align*}
\]
5. Provide the missing piece of the following reactions

a. 
\[
\begin{array}{c}
\text{NH}_2 \quad \text{NH}_2 \\
\text{O} \\
\text{NH}_2 \quad \text{NH}_2 \\
\end{array}
\xrightarrow{\text{1. LiAlH}_4, \text{ether}}
\begin{array}{c}
\text{O} \\
\text{NH}_2 \quad \text{NH}_2 \\
\end{array}
\xrightarrow{\text{2. H}_2\text{O}^+}
\]

b. 
\[
\begin{array}{c}
\text{O} \\
\text{O} \\
\end{array}
\xrightarrow{1. \text{DIBALH, toluene, } -78^\circ\text{C}}
\begin{array}{c}
\text{HO} \\
\text{O} \\
\end{array}
\xrightarrow{2. \text{H}_2\text{O, HCl}}
\]

c. 
\[
\begin{array}{c}
\text{O} \\
\text{O} \\
\end{array}
\xrightarrow{1. \text{LiAlH}_4, \text{ether}}
\begin{array}{c}
\text{O} \\
\text{O} \\
\end{array}
\xrightarrow{2. \text{H}_2\text{O}^+}
\]

d. 
\[
\begin{array}{c}
\text{N} \\
\end{array}
\xrightarrow{2. \text{CH}_2\text{CH}_2\text{NH}_2}
\begin{array}{c}
\text{O} \\
\end{array}
\]

e. 
\[
\begin{array}{c}
\text{O} \\
\end{array}
\xrightarrow{1. \text{LiAlH}_4, \text{ether}}
\begin{array}{c}
\text{O} \\
\end{array}
\xrightarrow{2. \text{H}_2\text{O}^+}
\]

f. 
\[
\begin{array}{c}
\text{O} \\
\end{array}
\xrightarrow{2. \text{CH}_2\text{CH}_2\text{NH}_2}
\begin{array}{c}
\text{O} \\
\end{array}
\]

g. 
\[
\begin{array}{c}
\text{NH}_2 \\
\end{array}
\xrightarrow{1. \text{2. CH}_3\text{CH}_2\text{CH}_2\text{Li, ether}}
\begin{array}{c}
\text{O} \\
\end{array}
\xrightarrow{2. \text{H}_2\text{O}^+}
\]

h. 
\[
\begin{array}{c}
\text{O} \\
\end{array}
\xrightarrow{1. \text{2. CH}_3\text{CH}_2\text{CH}_2\text{Li, ether}}
\begin{array}{c}
\text{O} \\
\end{array}
\xrightarrow{2. \text{H}_2\text{O}^+}
\]