1. Physical Properties.
   a. Rank the following according to solubility in water, 1 being most soluble, 4 being least soluble.

   1. \( \text{OH} \)
   2. \( \text{O} \)
   3. \( \text{O} \)
   4. \( \text{O} \)

   b. Rank the following according to boiling point, 1 being highest boiling, 4 lowest boiling.

   1. \( \text{OH} \)
   2. \( \text{OH} \)
   3. \( \text{O} \)
   4. \( \text{O} \)

   c. Rank the following according to equilibrium enol content, 1 having the most and 3 the least enol.

   1. \( \text{O} \)
   2. \( \text{H} \)
   3. \( \text{O} \)
   4. \( \text{O} \)

   d. Rank the following according to acidity, 1 being most acidic and 4 least acidic.

   1. \( \text{O} \)
   2. \( \text{NO}_2 \)
   3. \( \text{O} \)
   4. \( \text{O} \)
2. **Nomenclature**. Provide Either the Name or the Structure for the Following Chemicals. (10 points)

a. 3-propylbenzaldehyde

b. (S)-3-phenylbutanal

c. (Z)-2-methyl-4-hepten-3-one
   (Z)-2-methylhept-4-en-3-one

d. (S)-4-hydroxyhexan-3-one

e. \((\alpha\)-3-bromocyclogentanone\)

3. Identify the starting carbonyl compound or compounds from which the following aldol-type reaction products are formed. (12 points)

a. \[
\begin{align*}
  \text{Ph-CH}_3 \text{H} & \quad \xrightarrow{\text{NaOMe, MeOH, 0°C}} \quad \text{Ph} \text{HOCH}_2 \text{Ph} \\
\end{align*}
\]

b. \[
\begin{align*}
  \text{Ph-CHO} + \text{CH}_3 \text{H} & \quad \xrightarrow{1. \text{NaOH, H}_2\text{O, 0°C}} \quad \text{Ph} \text{CH} = \text{CH} \text{CH}_2 \text{CH}_3 \\
  & \quad \xrightarrow{2. \text{heat}} \\
\end{align*}
\]

c. \[
\begin{align*}
  \text{CH}_3 \text{CH} & \quad + \quad \text{C}_5\text{H}_8 \text{O} \quad \xrightarrow{\text{NaOMe, MeOH}} \quad \text{C}_5\text{H}_{11} \text{OH} \\
\end{align*}
\]
4. Draw the mechanisms for the following transformations.
5. Draw the products for the following reactions. (2 points each)

- Propionaldehyde + H₂NOC₂H₃, H⁺ →
- Cyclohexanone + excess Br₂, NaOMe, MeOH →
- Ph₃Cl + (CH₃)₂CuLi →
- Acetaldehyde + MeOH, H⁺ →
- Acetone + NaOMe, MeOH →
- 2-Cyclopentanone + HOCH₂CH₂OH, H⁺ →
- Cyclohexanone + NaOMe, MeOH →
6. Provide the needed reagents for the following transformations. You may use anything you wish. The transformations can be completed within 2-4 steps.

\[
\text{OH} \quad \overset{1. \text{PCl}}{\longrightarrow} \quad \overset{2. \text{PhH}}{\longrightarrow} \quad \text{Ph}
\]

\[
\text{O} \quad \overset{1. \text{H}_2\text{O}, \text{OH}^-, \text{H}^+}{\longrightarrow} \quad \overset{2. \text{LiAlH}_4}{\longrightarrow} \quad \overset{3. \text{H}_2\text{C}, \text{H}^+}{\longrightarrow} \quad \overset{4. \text{PCl}}{\longrightarrow} \quad \text{CH}_3
\]

\[
\text{OH} \quad \overset{1. \text{PCl}}{\longrightarrow} \quad \overset{2. \text{PhH}, \text{NaOMe, MeOH, heat}}{\longrightarrow} \quad \text{Ph}
\]

\[
\text{Br} \quad \overset{1. \text{KCN}}{\longrightarrow} \quad \overset{2. \text{BrMgBr}}{\longrightarrow} \quad \overset{3. \text{H}_2\text{C}, \text{H}^+}{\longrightarrow} \quad \text{Ph}
\]