1. Give the structure of the principal organic product(s) produced from 3-ethyl-2-pentene under each of the following reaction conditions.
   a. \( \text{H}_2/\text{Pd-C} \)
   b. \( \text{H}_2\text{O}, \text{Br}_2 \)
   c. \( \text{Cl}_2 \text{ in } \text{CCl}_4 \text{ at } 0 \, ^\circ\text{C} \)
   d. (i) aq. \( \text{Hg(OAc)}_2 \); (ii) \( \text{NaBH}_4 \)
   e. \( \text{HBr} \)
   f. \( \text{Br}_2, \text{dilute solution in } \text{CH}_3\text{OH} \)

2. What product do you expect to obtain from the following reaction? Propose a mechanism to rationalize your prediction.

   \[
   \text{O} \quad \text{CH}_3\text{OH} \quad \text{H}_2\text{SO}_4
   \]

3. Treatment of a trialkylborane with many molar equivalents of dimethylsulfoxonium methylide, followed by alkaline hydrogen peroxide gives long-chain alcohols. This reaction is called the polyhomologation reaction. Explain how this reaction occurs, suggesting mechanisms that illustrate the key steps.

   1. \( \text{R}_3\text{B} \quad (3\text{n equivalents}) \)
   2. \( \text{NaOH, H}_2\text{O}_2, \text{H}_2\text{O} \)
   3. \( \text{R(CH}_2)_n\text{OH} \)

4. a. The following cyclization has been observed in the oxymercuration–demercuration of this unsaturated alcohol. Propose a mechanism for this reaction.

   \[
   \text{O} \quad 1. \quad \text{Hg(OAc)}_2
   \]
   \[
   \text{O} \quad 2. \quad \text{NaBH}_4
   \]

b. Reaction with bromine in dichloromethane of the same unsaturated alcohol shown above yields a product that has only one bromine atom in it. Draw its structure and propose a mechanism that supports your prediction.
5. Which of the following compounds cannot be made as the major product by hydroboration of an alkene followed by oxidation and hydrolysis with \( \text{H}_2\text{O}_2 \) and \( \text{OH}^- \)?

a.  

\[
\begin{align*}
\text{cyclic HOH} & \\
\text{cyclic HO} & \\
\text{cyclic HOH} & \\
\text{linear HOH} & \\
\end{align*}
\]

6. Give the structure of the alkene that would yield each of the following product mixtures upon ozonolysis followed by reductive workup.

a. 

\[
\begin{align*}
\text{CH}_3-\text{C}-\text{CH}_2-\text{CH}_2-\text{C}-\text{CH}_3 & \\
\text{cyclic CO} & \\
\text{CH}_3-\text{C}-\text{CH}_2-\text{C}-\text{H} & \\
\end{align*}
\]

7. In the cleavage reaction of a vicinal diol by \( \text{IO}_4^- \), a cyclic intermediate is generated:

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

Which compound, A or B, would you expect to be cleaved faster by periodate ion? Explain.

8. (Please skip problem a)

What is the major product that you would expect to isolate from the reaction of 2-methylpropene with the following reagents, each of which undergoes electrophilic addition to alkene double bonds:

a. \( \text{Br-CN} \)  
   b. \( \text{RS-Cl} \)