1. Give the structure of the principal organic product(s) produced from 3-ethyl-2-pentene under each of the following reaction conditions.

   a. \(H_2, \text{Pd}/\text{C}\)  
   b. \(H_2O, \text{Br}_2\)  

   c. \(\text{Cl}_2 \text{ in CCl}_4 \text{ at 0 } \text{°C}\)  
   d. (i) \(\text{aq. Hg(OAc)}_2\), (ii) \(\text{NaBH}_4\)  

   e. \(\text{HBr}\)  
   f. \(\text{Br}_2, \text{dilute solution in CH}_3\text{OH}\)

2. a. What product do you expect to obtain from the following reaction?

   \[
   \text{catalytic quantity of } H_2SO_4 \\
   \text{in CH}_3\text{OH}
   \]

   b. Propose a mechanism to rationalize your prediction.
3. Treatment of a trialkylborane with many molar equivalents of dimethylsulfoxonium methyliide, followed by alkaline hydrogen peroxide gives long-chain alcohols. This reaction is called the polyhomologation reaction.

\[
\begin{align*}
&1. \quad \text{(3n equivalents)} \\
&\quad \text{R}_3\text{B} \quad \overset{(3n \text{ equivalents})}{\longrightarrow} \quad \text{3} \quad \text{R(CH}_2\text{)}_n\text{OH} \\
&2. \quad \text{NaOH, H}_2\text{O}_2, \text{ H}_2\text{O}
\end{align*}
\]

Explain how this reaction occurs, suggesting mechanisms that illustrate the key steps.

4. 

a. Predict the major product that you would expect to isolate from the reaction of 1-hexene with the reagent phenylselenyl bromide PhSeBr, which undergoes electrophilic addition to alkene double bonds. (Note that you have not learned this reaction in your textbook but should be able to predict it using the principles that you have learned.)

b. Explain why you would predict this product, suggesting a mechanism that illustrates the key steps. Make sure to explain the preferred regiochemistry.
5. The following cyclization has been observed in the oxymercuration-demercuration of this unsaturated alcohol.

\[
\text{\begin{tikzpicture}[baseline=(current bounding box.center)]
  \node[draw, circle, inner sep=0.5pt] (1) at (0,0) {$\text{OH}$};
  \node[draw, circle, inner sep=0.5pt, fill=gray!30] (2) at (1,0) {$\text{Hg(OAc)}_2$};
  \node[draw, circle, inner sep=0.5pt] (3) at (2,0) {$\text{NaBH}_4$};
  \node[draw, circle, inner sep=0.5pt] (4) at (3,0) {$\text{O}$};
\end{tikzpicture}}
\]

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

\[\]

**a.** Propose a mechanism for this reaction.

**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.
6. Isobutylene (2-methylpropene) reacts in the presence of strong acids to form polymer that consists of many molecules linked together in a long chain.

**a.** Write a curved-arrow mechanism that shows how acid (e.g., H⁺) can promote the sequential linking of isobutylene molecules together, in a process called *cationic polymerization*.

**b.** Show the structure of the polymer that forms, polyisobutylene, and illustrate its relationship to isobutylene.

**c.** Explain why isobutylene would be particularly good for this reaction, compared to other simple alkenes, such as ethylene or propene.
7. Write a radical chain mechanism for the free-radical cyclization reaction of bromo compound 1 to cyclic compound 2, which occurs when bromo compound 1 is heated with tributyltin hydride (Bu₃SnH) in the presence of a small amount of the radical initiator AIBN (shown below). Use proper fishhook notation to show the making and breaking of bonds. Show all of the initiation and propagation steps. Provide two or three examples of termination steps.

**Initiation**

**Propagation**

**Termination** (two or three examples will suffice)
8.

a. 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 $\text{OH}^-$

ⅰ.  

ⅱ.  

ⅲ.  

ⅳ.  


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

ⅰ.  

ⅱ.  


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

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

ⅱ. Explain. (Hint, build models of these two molecules.)