1) Show proper arrow notation to show the movement of electrons that correspond to the following transformations:

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{O}^- \\
\text{Cl} & \quad \text{CH}_3
\end{align*} \rightarrow \quad \begin{align*}
\text{H}_3\text{C} & \quad \text{C} \quad \text{CH}_3 \\
\text{O}^- & \quad \text{Cl}^-
\end{align*}
\]

\[
\begin{align*}
\cdot & \quad + \quad \text{Br}_2 \\
\text{H} & \quad \text{CH}_3
\end{align*} \rightarrow \quad \begin{align*}
\text{Br} & \quad \text{H} \quad \text{CH}_3 \\
\cdot & \quad \text{Br}^-
\end{align*}
\]

\[
\begin{align*}
\text{H} & \quad \text{CH}_3 \\
\text{CH}_3 & \quad + \quad \cdot \text{OH}
\end{align*} \rightarrow \quad \begin{align*}
\text{H} & \quad \text{CH}_3 \\
\text{CH}_3 & \quad + \quad \text{H}_2\text{O}
\end{align*}
\]
2) Given each value, determine whether the starting material or product is favored at equilibrium:

   a) \( K_{\text{eq}} = 22 \)
   b) \( \Delta G^\circ = -32 \text{ kca/mol} \)
   c) \( \Delta G^\circ = 11 \text{ kca/mol} \)
   d) \( \Delta H^\circ = 113 \text{ kca/mol} \)
   e) \( \Delta S = -3 \text{ ca/mol*K} \)
   f) \( K_{\text{eq}} = 0.10 \)

3) Draw an energy diagram for the following reaction. Label the axes, the starting material, product, transition state, \( \Delta H^\circ \) and \( E_a \).

A two-step reaction, \( A \rightarrow B \rightarrow C \) in which the relative energy of the compounds is \( A < B < C \) and the step \( B \rightarrow C \) is the rate determining step.
4) Which of the compounds below will react fastest with NH₃?

A: \( \text{BrCH}_2 \)  
B: \( \text{ICH}_2 \)  
C: \( \text{FCH}_2 \)  
D: \( \text{ClCH}_2 \)

5) Which of the reactions below will give the highest yield of amine (product)?

X: \( \text{C}_7\text{H}_8\text{Br} + \text{NH}_3 \rightarrow \text{C}_7\text{H}_8\text{NH}_2 \)
Y: \( \text{C}_7\text{H}_8\text{Br} + \text{NH}_3 \rightarrow \text{C}_7\text{H}_8\text{NH}_2 \)
Z: \( \text{C}_7\text{H}_8\text{Br} + \text{NH}_3 \rightarrow \text{C}_7\text{H}_8\text{NH}_2 \)

6) Mark each of the following alkyl halides as primary, secondary or tertiary:

- \( \text{BrCH}_2 \)  
- \( \text{ICH}_2 \)  
- \( \text{FCH}_2 \)  
- \( \text{ClCH}_2 \)
7) Answer the following questions regarding the reaction below:

\[
\text{OH} + \text{Br} \quad \rightarrow \quad \text{O} \quad \quad \text{+ \quad HBr}
\]

a) What type of reaction is this?

b) What is the rate equation for this reaction?

c) What happens to the rate of reaction when the [alcohol] is doubled?

d) What happens to the rate of reaction when the [alkyl halide] is halved?

8) In each pair of molecules circle the one with the bond that is easiest to break homolytically (see Table 6.2 on p. 207 of the Smith text for help):

- H Cl
- OH F
- H H
- Br I
- H O H H O
8) Complete the following reactions with the MAJOR product(s):

1. 
   
   \[
   \text{Br} \quad \text{NH}_3
   \]

2. 
   
   \[
   \text{Cl} \quad \text{H}_2\text{S}
   \]

3. 
   
   \[
   \text{I} \quad \text{NaOH}
   \]

4. 
   
   \[
   \text{Br} \quad \text{NaO}^+\text{fBu}
   \]

5. 
   
   \[
   \text{Cl} \quad \text{Na}^-\text{CN}
   \]

6. 
   
   \[
   \text{H} \quad \text{Na}^+\text{+NH}_2
   \]