1. Organic chemists must often use a series of reactions to obtain a desired molecule. This is called a **synthesis**. Fill in the question marks in each sequence with appropriate reagents and products.

\[ \text{OCH}_3 \xrightarrow{?} \text{ } \xrightarrow{H_2SO_4} \text{ } \xrightarrow{H_2, \text{Pd/C}} \] 

\[ \text{OH} \xrightarrow{?} \xrightarrow{H_2SO_4} \xrightarrow{1) \text{?} \text{BH}_3, \text{THF} } \xrightarrow{2) \text{?} \text{H}_2\text{O}_{2\text{L}}, \text{NaOH}} \]

2. Draw a mechanism for the following transformation. Explain the observed regioselectivity.

\[ \text{CH}_2=\text{CH}_2 \xrightarrow{\text{HBr}} \text{Br}\text{CH}_2\text{CH}_2\text{Br} \rightarrow 2 \xrightarrow{\text{O}} \]

\[ \text{Br}\text{CH}_2\text{CH}_2\text{OH} \rightarrow \text{H}_2\text{O} + \text{Br}^- \]

\[ \text{Br}\text{CH}_2\text{CH}_2\text{CH}_3 \rightarrow \text{Br}\text{CH}(\text{CH}_3)\text{CH}_2\text{Br} \]

\[ \text{Br}\text{CH}(\text{CH}_3)\text{CH}_2\text{Br} \rightarrow \text{Br}\text{CHCH}_2\text{CH}_2\text{CH}_2\text{Br} + \text{Br}^- \]
3. Draw the mechanism for the dehydration reaction shown below. Show all intermediates and electron-pushing arrows.

4. Provide reagents over/under the arrows for the following transformations. Circle the reactions which are regioselective.

a) \[ \text{cyclohexane} \xrightarrow{\text{H}_2\text{SO}_4} \text{cyclohexene} \]

b) \[ \text{cyclohexane} \xrightarrow{\text{Cl}_2} \text{cyclohexane} \]

c) \[ \text{cyclohexene} \xrightarrow{\text{H}_2, \text{Pd/C}} \text{cyclohexane} \]

d) \[ \text{cyclohexene} \xrightarrow{\text{Br}_2, \text{CH}_3\text{CH}_2\text{OH}} \text{cyclohexyl methoxide} \]

e) \[ \text{cyclohexene} \xrightarrow{\text{HI}} \text{cyclohexyl iodide} \]

f) \[ \text{cyclohexene} \xrightarrow{\text{H}_2\text{SO}_4, \text{CH}_3\text{OH}} \text{cyclohexyl methoxy} \]
5. This is a **two-step synthesis** which means two reactions one right after the other. Your answer should include an arrow with reagents going to an intermediate isolated compound followed by another arrow with reagents going to the product. The D is deuterium an isotope of hydrogen. What is the difference between a **mechanism** and a **synthesis**?

\[
\begin{align*}
\text{OH} & \quad \xrightarrow{\text{H}_2\text{SO}_4} \quad \text{D} \\
\text{H} & \quad \xrightarrow{\text{1,} \text{BD}_3, \text{THF}} \quad \text{1, NaOH, H}_2\text{O}_2}
\end{align*}
\]

A **mechanism** shows all steps of one reaction with electron-pushing arrows and intermediates. A **synthesis** is a series of reactions.

6. Draw the mechanism of the following reaction. Show all intermediates and electron-pushing arrows. Remember in a mechanism your job is to push the electrons showing how you make the desired product. It doesn't have to be the only product that could form. You will have to migrate a ring bond.

\[
\begin{align*}
\text{H} & \quad \xrightarrow{\text{HCl}} \quad \text{Cl} \\
\text{H} & \quad \xrightarrow{\text{+}} \quad \text{Cl}
\end{align*}
\]