Give the product(s) expected in each of the following reactions:

(1) \( \text{O} \quad + \quad \text{H} _ \text{N} _ \text{H} _ 3 \quad \text{O} \quad + \quad \) \( \text{H} _ 3 \text{O} ^+ \)

(2) \( \text{O} \quad + \quad \text{H}_2 \text{NH} _ 2 \quad \text{H} _ 3 \text{O} ^+ \)

(3) \( \text{O} \quad + \quad 1) \text{NaBH}_4 \quad 2) \text{H}_3 \text{O} ^+ \)

(4) \( \text{O} \quad + \quad 1) \text{CH}_3\text{Li} \quad 2) \text{H}_3 \text{O} ^+ \)

(5) \( \text{O} \quad + \quad \text{CrO}_3 \quad \text{pyridine} \)

(6) \( \text{O} \quad + \quad \text{PPh}_3 \quad \text{strong base} \)
Rationalize the difference between the equilibrium constants of hydration of acetaldehyde (1) and chloral (2). Also, provide a mechanism for the hydrate formation.

\[
\begin{align*}
&\text{H}_3\text{C} \overset{\text{H}_3\text{O}^+}{\rightarrow} \text{H}_3\text{C} \overset{\text{K}_{eq} = 1}{\rightarrow} \text{H}_3\text{C} \overset{\text{H}_3\text{O}^+}{\rightarrow} \text{H}_3\text{C} \\
&\text{H}_3\text{C} \overset{\text{H}_3\text{O}^+}{\rightarrow} \text{H}_3\text{C} \overset{\text{K}_{eq} = 100}{\rightarrow} \text{H}_3\text{C}
\end{align*}
\]

Number the following compounds in order of decreasing acidity [most acidic (1) to the least acidic (5). The first proton lost is underlined for each compound.

\[
\begin{align*}
&\text{CH}_3 \\
&\text{C} \overset{\text{H}_2}{\rightarrow} \\
&\text{F}_3\text{C} \overset{\text{OH}}{\rightarrow} \\
&\text{CH}_3 \\
&\text{NH}_2
\end{align*}
\]
Provide a reasonable mechanism for the following reaction:
Provide reagents for converting cyclohexanone to each of the following compounds.
When bromo ketone 2 is treated with potassium tert-butoxide in tert-butyl alcohol at room temperature, it gives exclusively the 5,5-fused bicyclic ketone 1. In contrast, when 2 is treated with LDA in THF at –72 °C, followed by heating, the product is predominantly the 5,7-fused ketone 3. Write mechanisms for these cycloalkylation reactions and explain why the different reaction conditions favor different products.

![Mechanisms for cycloalkylation reactions](image-url)