Hydration (addition of water)  
\[
\text{C}_7\text{H}_8 + \text{H}_2\text{SO}_4 + \text{H}_2 \xrightarrow{\text{H}_2\text{O}} \text{C}_7\text{H}_9\text{O}
\]

Dehydration (elimination of water)  
\[
\text{C}_7\text{H}_9\text{O} \xrightarrow{\text{H}_2\text{SO}_4} \text{C}_7\text{H}_8
\]

(don't add water here because it would push the equilibrium of the reaction the wrong way)

Because these reactions have a carbocation intermediate, they can undergo rearrangements which result in a more stable carbocation.

\[\text{H}_2\text{SO}_4 / \text{H}_2\text{O} \text{ homogeneous - all dissolved, one phase} \]

\[\text{Heterogeneous catalysts - solid in a solvent, two phases} \]

Catalytic Hydrogenation (heterogeneous catalyst to add \(\text{H}_2\) across a double bond)  
\[
\text{C}_7\text{H}_8 \xrightarrow{\text{H}_2 / \text{Pd/C}} \text{C}_7\text{H}_{10}
\]

(Pt + Ni also work)

Both reagents are adsorbed on the metal surface, where the reaction then occurs  
\[
\text{C}_7\text{H}_8 \xrightarrow{\text{Pd}} 2\text{H}_2 \xrightarrow{\text{Pd}} \text{C}_7\text{H}_{10}
\]
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\[
\text{CH}_3 - \text{C} = \text{C} - \text{CH}_3 \xrightarrow{\text{H}_2, \text{Pd}} \text{CH}_3\text{C} = \text{C}\text{H}_3 \xrightarrow{\text{H}_2, \text{Pd}} \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3
\]

Can't stop at this intermediate b/c it reacts faster than the alkyne

\[
\text{H}_2 \xrightarrow{\text{Pd/C}} \text{C} = \text{C}
\]

Benzene ring does not react because it is so stable.

Electrophilic addition of Br₂, Cl₂
(F₂ is too reactive, I₂ is too slow and gives unstable products)

\[
\text{Br}_2 \xrightarrow{\text{CH}_2\text{Cl}_2, \text{solvent}} \text{H} - \text{Br} \quad \text{H} \quad \text{Br}
\]

Simple cation does not form

"bromonium ion"

Formation of 3-membered ring occurs in a single step.
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Course: Chem 343  Lecturer: I. Reich
Day: Wednesday  Date: 9-28-11
Notes Taken By: JAK  Total # of Pages: 4

\[ \text{Chloronium ion} \]

\[ \text{Nucleophile attacks on the more substituted carbon} \]

\[ \text{Water and alcohols react similarly.} \]
Oxymercuration - Reduction

Recall: $\text{X} \rightarrow \frac{\text{H}_2\text{O}^+}{\text{H}_2\text{O}} \times OH$

Acidic conditions are harsh. Rearrangements can occur in solvent, tetrahydrofuran, "THF" (ether)

$\text{X} \rightarrow \begin{align*}
1) \text{Hg(OH)}_2, \text{H}_2\text{O}, \text{THF} \\
2) \text{NaBH}_4
\end{align*} \rightarrow \text{X} OH$

Milder conditions, no rearrangements.

Numbered reagents indicates that the reagents are added separately (each has its own mechanism).