Alkyne reactions and organic synthesis

*Hydrogenation and using the proper catalyst*

Alkynes can undergo hydrogenation, just like alkenes:

\[
\begin{align*}
\text{CH}_2 &= \text{CH}_3 \\
\text{H}_2 &\xrightarrow{\text{Pd/C}} \text{CH}_3
\end{align*}
\]

\[
\begin{align*}
\text{H}_3\text{C} &= \text{CCH}_3 \\
\text{H}_2 &\xrightarrow{\text{Pd/C}} \text{H}_3\text{C} - \text{CH}_3
\end{align*}
\]

In this reaction, the alkene is formed first, but is immediately hydrogenated by the catalyst. To stop at an alkene, we must use a different catalyst:

\[
\begin{align*}
\text{H}_3\text{C} - \text{C} &= \text{CCH}_3 \\
\text{H}_2 &\xrightarrow{\text{Lindlar}} \text{H}_3\text{C} - \text{CH}_3
\end{align*}
\]

We can also obtain a trans alkene from an alkyne by using what is known as the *Birch reduction*:

\[
\begin{align*}
\text{H}_3\text{C} - \text{C} &= \text{CCH}_3 \\
\text{Na} &\xrightarrow{\text{NH}_3} \text{H}_3\text{C} - \text{CH}_3
\end{align*}
\]

**Alkynes as Brønsted acids; acetylides as Brønsted bases and nucleophiles**

Unlike vinyl and alkyl hydrogens, acetylenic hydrogen atoms are somewhat acidic and can be removed by very strong bases. The resulting *acetylide* anion is a strong Bronsted base and therefore an excellent nucleophile, which can react with primary alkyl halides (and only primary ones – we will learn why next week) to form new carbon-carbon bonds by displacing a halide anion.

\[
\begin{align*}
\text{H}_3\text{C} - \text{C} &= \text{C}^- \text{CH}_3 + \text{Br}^- \\
\text{Br}^- &\xrightarrow{\text{Na}} \text{H}_3\text{C} - \text{C}^- \text{CH}_3
\end{align*}
\]

Acetylide ions are generated *in situ* by reacting a terminal alkyne with a strong base. What bases would be strong enough to deprotonate the C-H of a terminal alkyne? (What is the pKₐ of a terminal alkyn e?)

More acidic groups elsewhere in the molecule will interfere with this reaction: a Brønsted acid-base reaction will always happen before a Lewis acid-base reaction.

\[
\begin{align*}
\text{H}_3\text{C} - \text{C}^- &+ \text{Br}^- \text{OH}^- \rightarrow \text{H}_3\text{C} - \text{C}^- \text{CH}_3 \quad \text{H}_3\text{C} - \text{C}^- \text{CH}_3 + \text{Br}^- \text{OH}^-\quad \text{Br}^- \text{OH}^-\quad \text{H}_3\text{C} - \text{C}^- \text{CH}_3
\end{align*}
\]
**Synthesis using alkynes**

How would you make each of the compounds shown below from propyne,* with any other reagents needed? Some may have more than one correct answer.

* You may use other sources of carbon atoms, but you must use propyne in your synthesis.