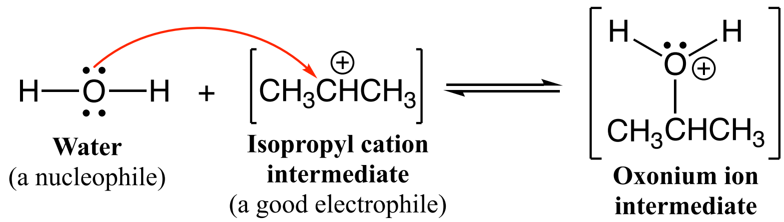
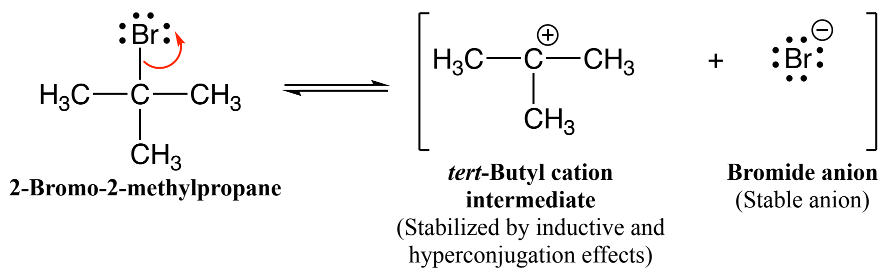
Polar Reaction Mechanisms: Polar reactions are most of what you will see in organic chemistry. There are only four different mechanistic elements that combine to make up the different steps of almost all the mechanisms you saw in CH320M/CH328M. Better yet, in CH320N the following four mechanistic elements are pretty much all you need to think about until we get to electrophilic aromatic substitution.

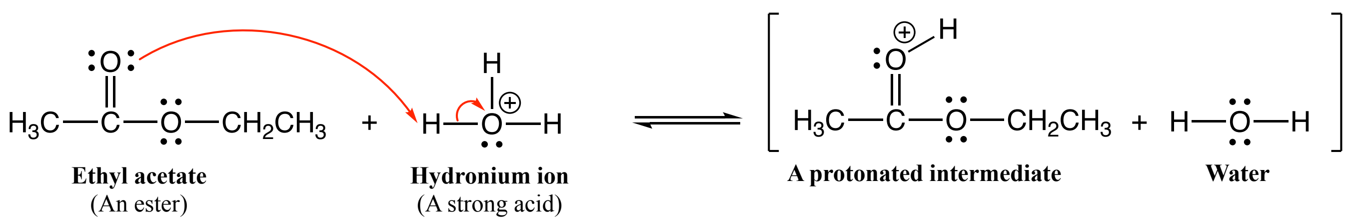
1. **Make a new bond between a nucleophile (source for an arrow) and an electrophile (sink for an arrow).** Use this element when there is a nucleophile present in the solution as well as an electrophile suitable for reaction to occur.



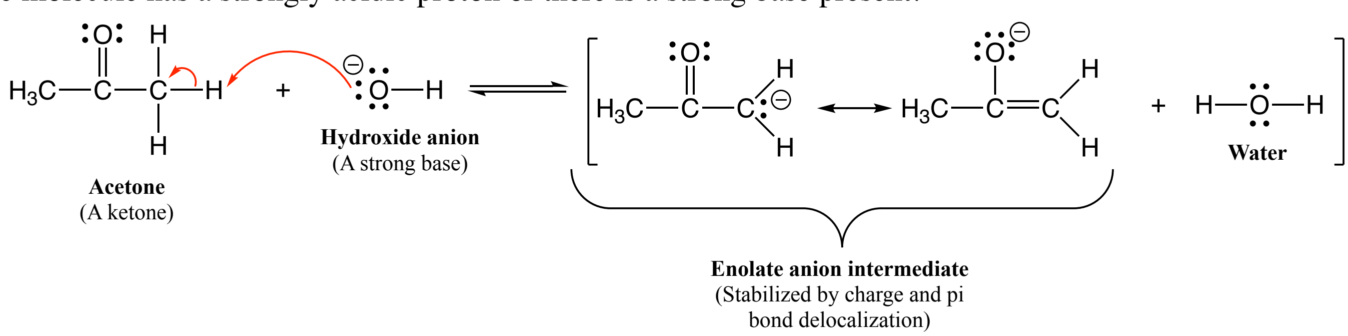
2. **Break a bond so that relatively stable molecules or ions are created** Use this element when there is no suitable nucleophile-electrophile or proton transfer reaction, but breaking a bond can create neutral molecules or relatively stable ions, or both.



3. **Add a proton** Use this element when there is no suitable nucleophile-electrophile reaction, but the molecule has a strongly basic functional group or there is a strong acid present.



4. **Take a proton away** Use this element when there is no suitable nucleophile-electrophile reaction, but the molecule has a strongly acidic proton or there is a strong base present.



The situation is even simpler than you might expect because 1 and 2 are the functional reverse of each other, as are 3 and 4.

Mechanism Summary

The following questions and mechanistic elements are described from the point of view of the carbon-containing reagent, written in the form of a flowchart.

Is there a strong acid present or is the carbon-containing reagent a strong base?

YES ⟹ **Add a proton**

NO ⇓

Is there a strong base present or is the carbon-containing reagent a strong acid?

YES ⟹ **Take a proton away**

NO ⇓

Are there a nucleophile and electrophile present?

YES ⟹ **Make a bond**

NO ⇓

Can a bond be broken to create stable molecules or ions?

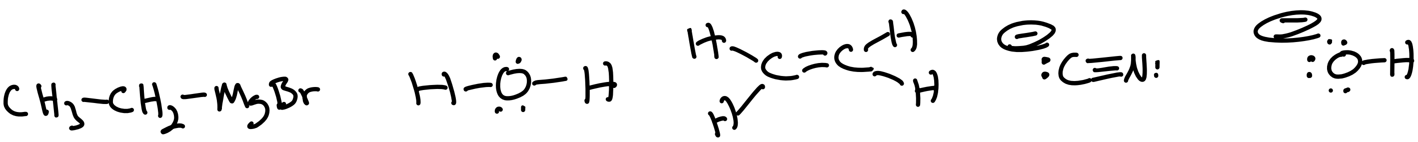
YES ⟹ **Break a bond**

NO ⇓

Think about alternative mechanistic elements (radical reaction, S_N2, E2, etc.)

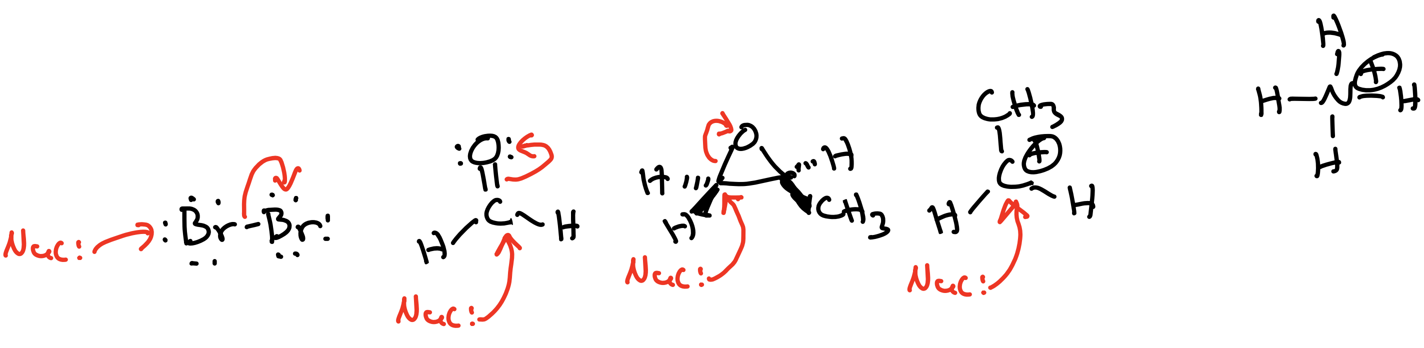
Nucleophiles react with electrophiles to MAKE A BOND

When trying to recognize nucleophiles:



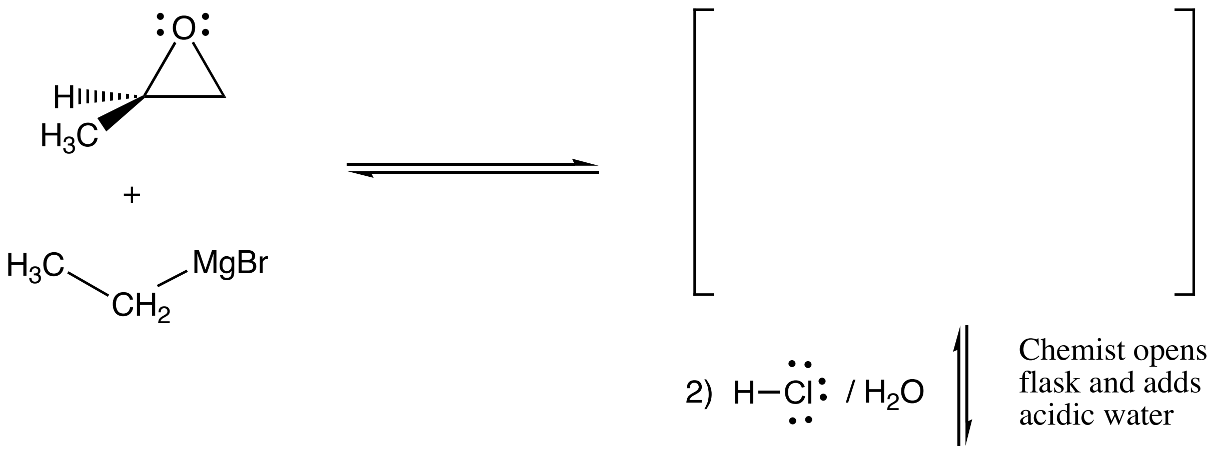
The O atom of a carbonyl is NOT a nucleophile because reacts at the lone pair and cannot make a stable bond

When trying to recognize electrophiles:



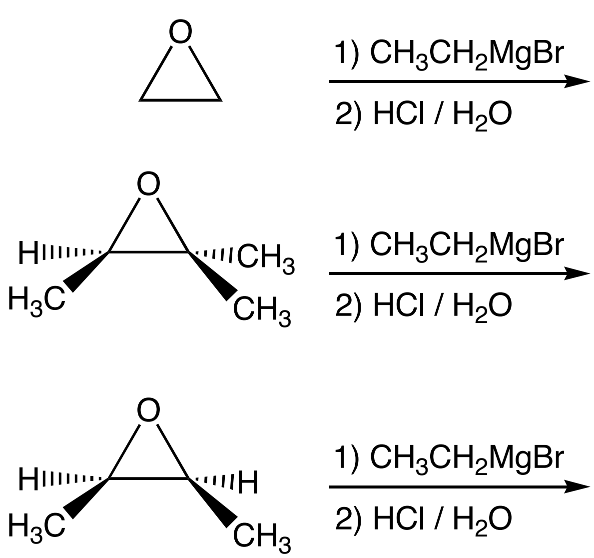
Organolithium and Gilman reagents react the same as Grignard reagents with epoxides

Grignard Reagent Reacting with an Epoxide

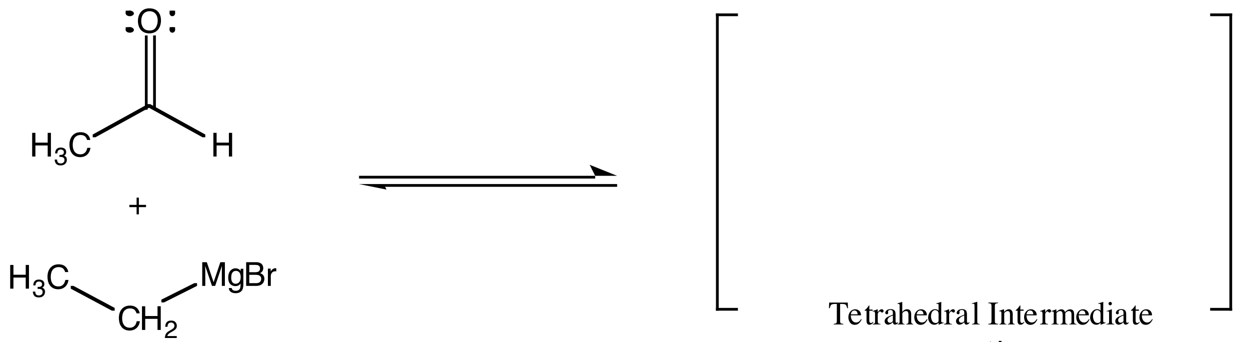


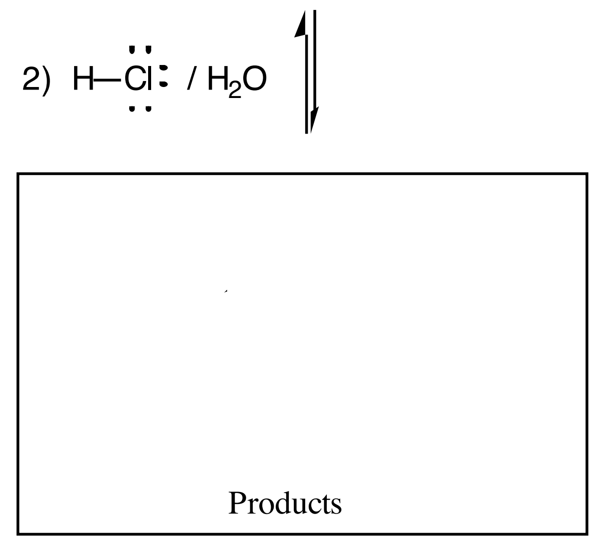
Key Recognition Element (KRE):

Products

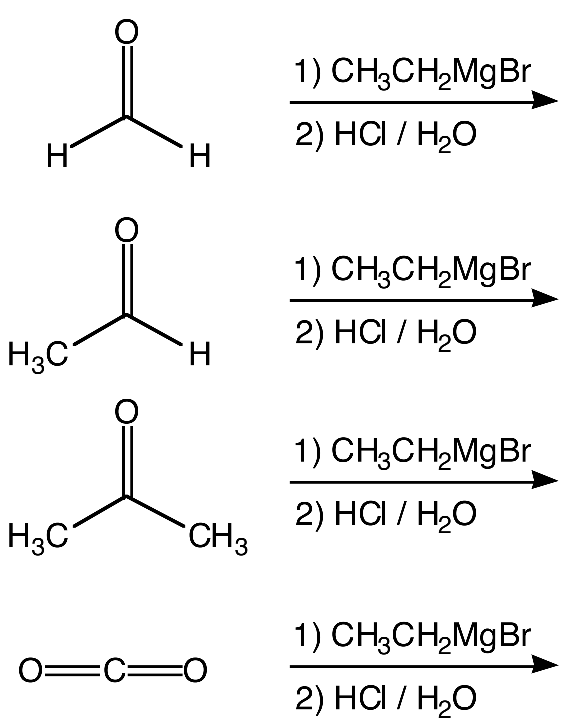


Grignard Reagent Reacting with an Aldehyde or Ketone



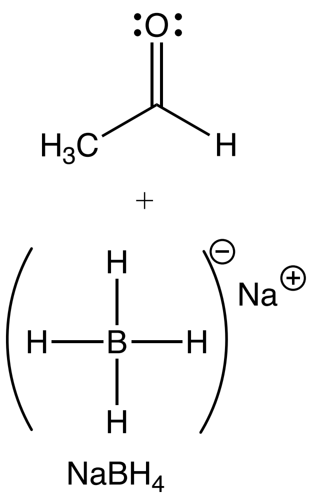


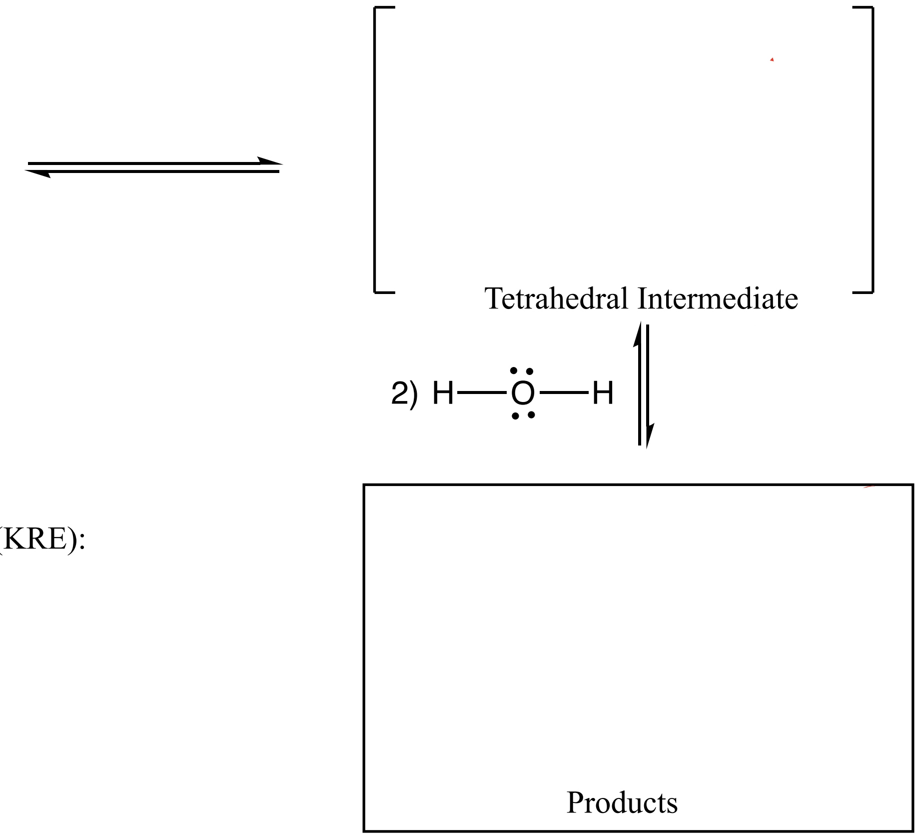
Key Recognition Element (KRE):



↗ Same as $LiAlH_4$

Sodium Borohydride Reacting with an Aldehyde or Ketone



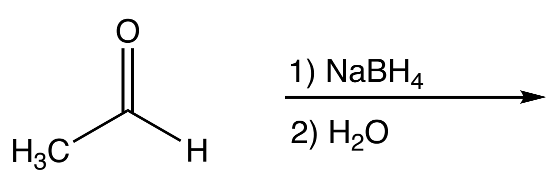


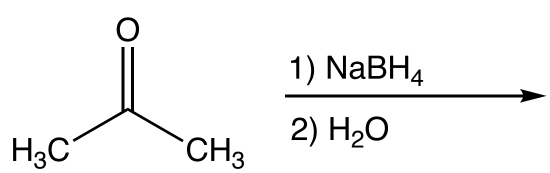
Key Recognition Element (KRE):

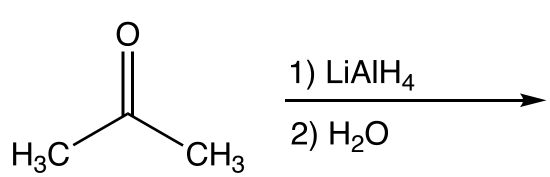
All four H of BH_4^- react!

$$4\ CH_3-\overset{O}{\overset{\|}{C}}-H + BH_4^- \rightleftharpoons\rightleftharpoons\rightleftharpoons\rightleftharpoons (CH_3CH_2-O)_4B^- \xrightarrow{2)\ H_2O} 4\ CH_3CH_2OH$$

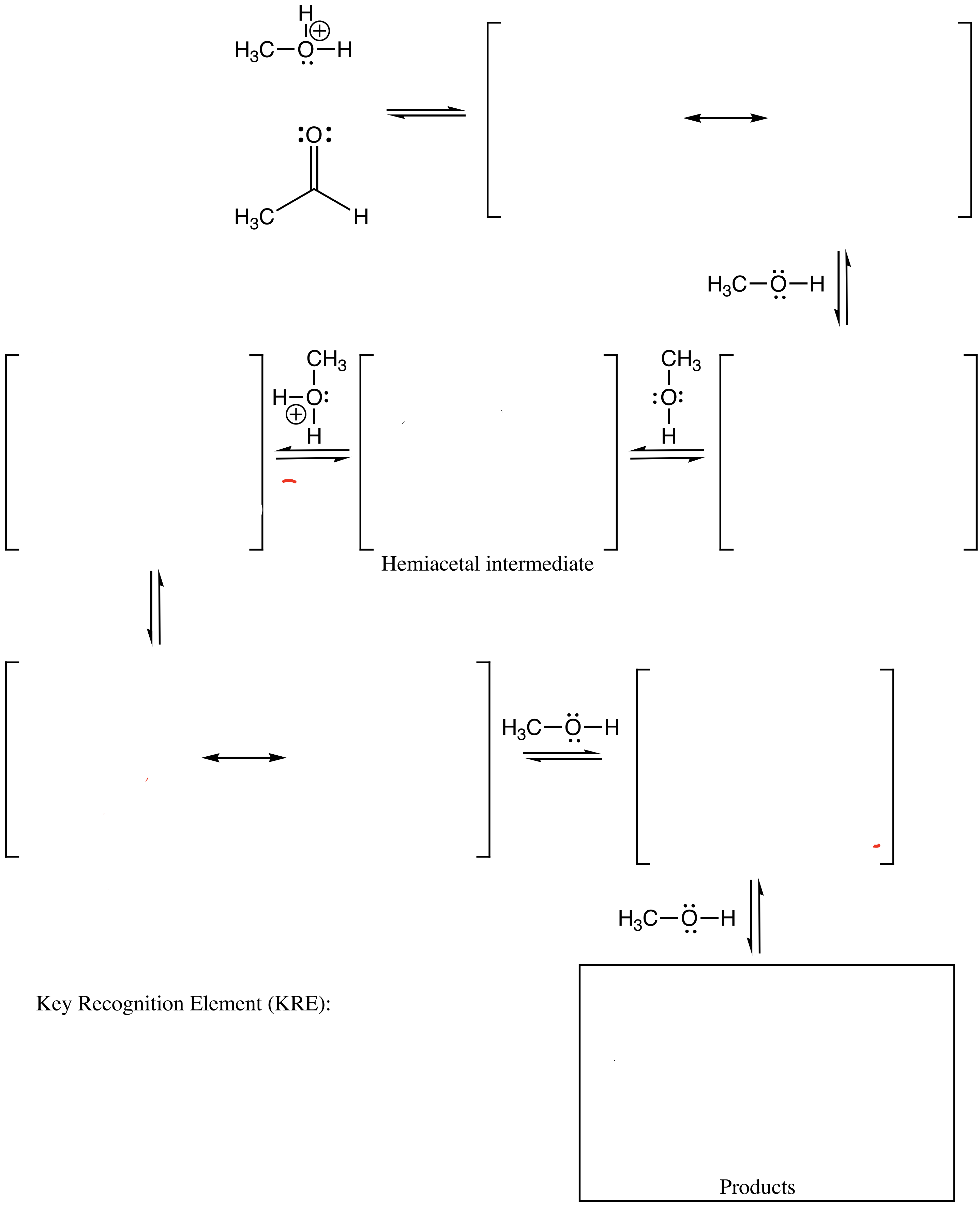
+ Borate salts







Acid Catalyzed Hemiacetal and Acetal Formation From an Aldehyde or Ketone



Key Recognition Element (KRE):