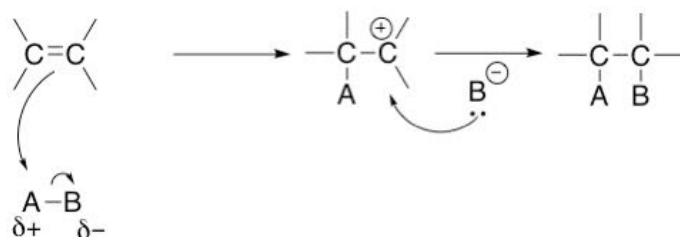
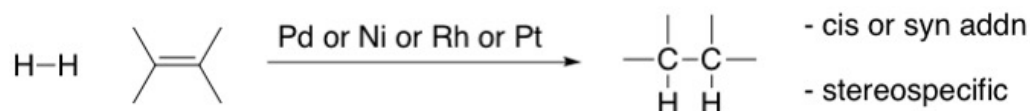
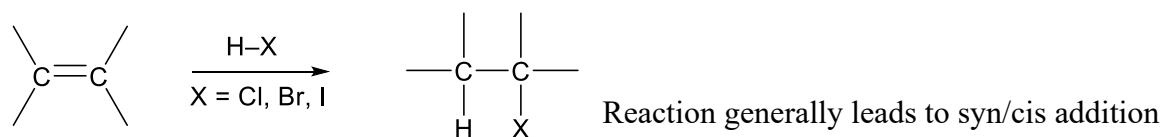
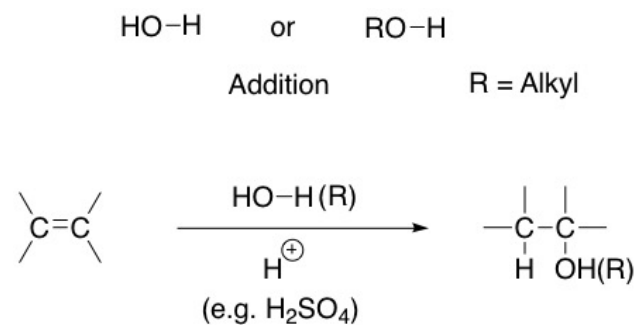


RECALL:**Addition Reactions**

- Occurs on double bonds and triple bonds

**Hydrogenation Addition of H₂****Hydrogen Halide (HX) Addition**

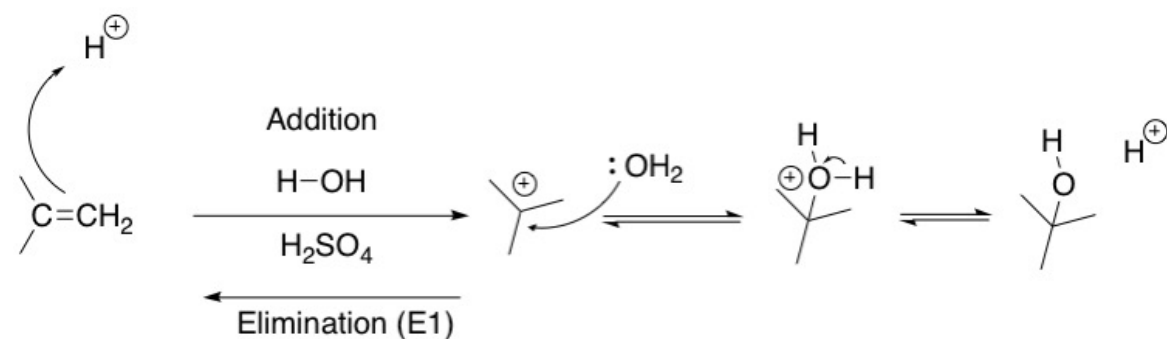
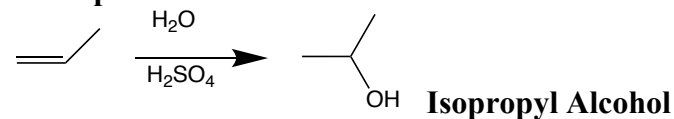
Markovnikov's Rule: In an addition reaction, the positive end of an A-B system (e.g. I-Cl) adds to the least substituted end of the double bond to make the more stable carbocation.

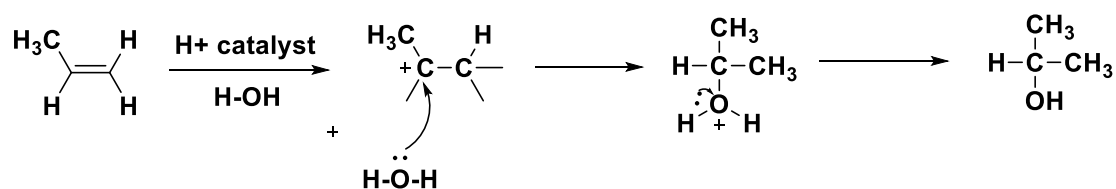
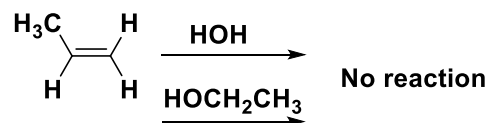
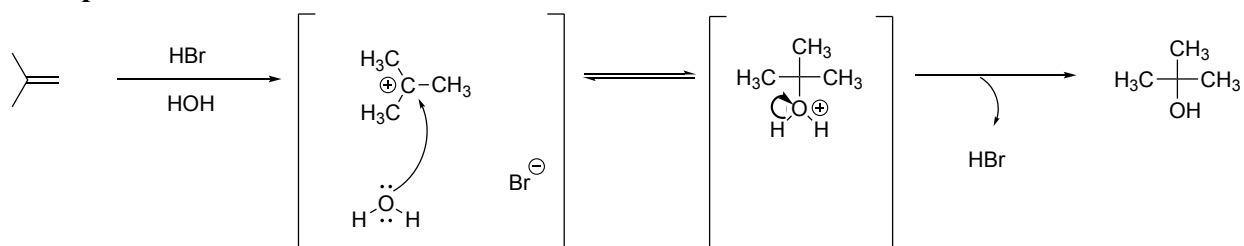
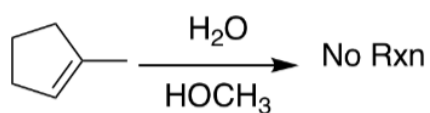
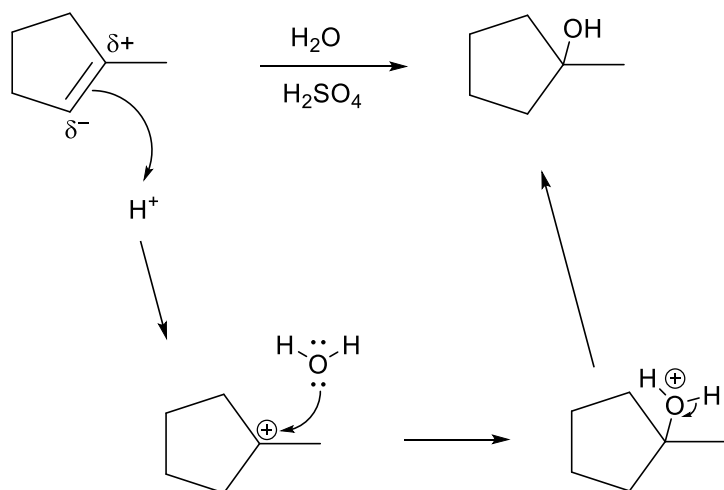
Addition of H₂O and ROH (Hydration and Ether Formation)

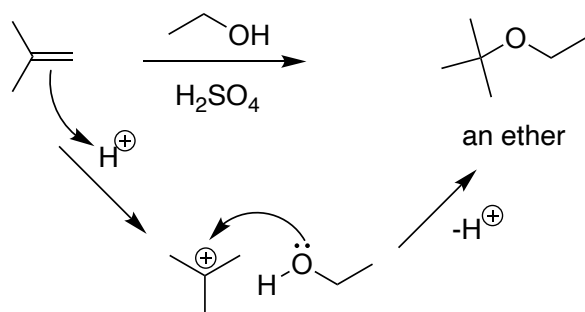
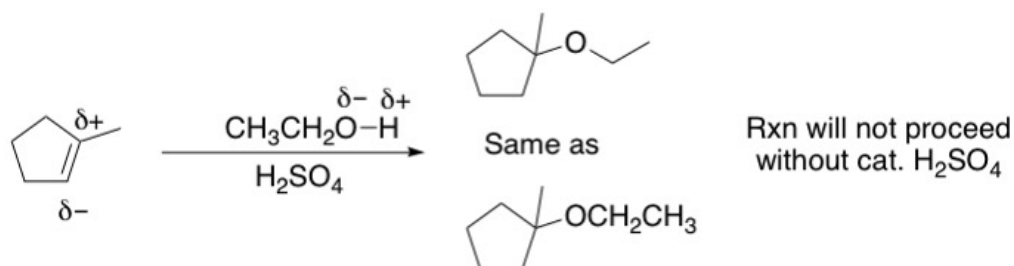
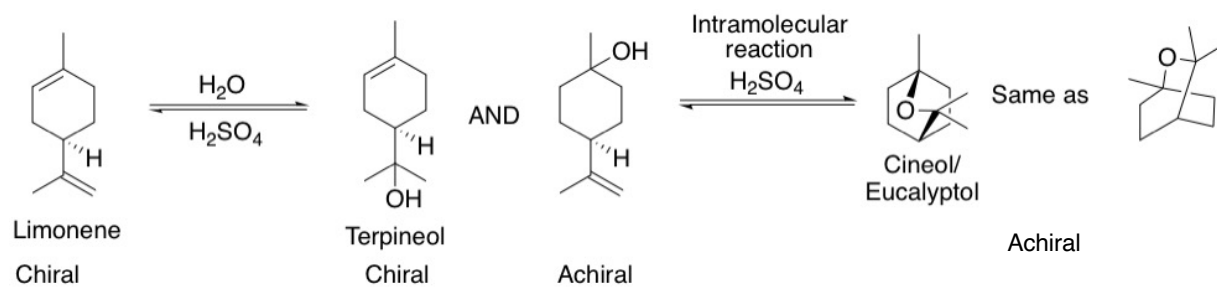
Not Stereospecific

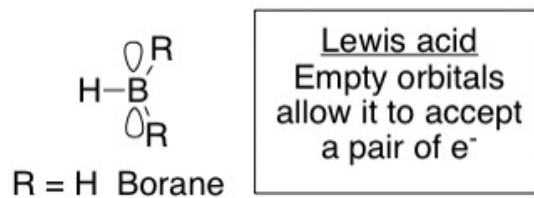
Hydration formation

- H₂O or ROH by itself cannot add to the double bond. Need an acid (H⁺) to pull the electrons from the double bond.
- H₂SO₄ (H⁺) is a catalyst, meaning that it is not transformed or used up in the reaction but is present to lower the activation energy.
- Follows Markovnikov rules

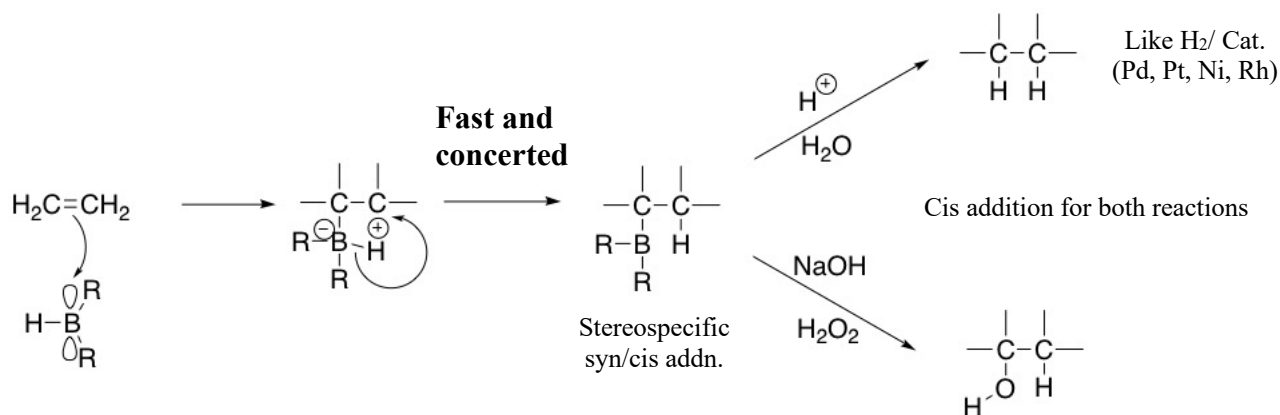
Example 1a:**Tert-butyl alcohol****Example 1b.**

**Example 3:****Example 4:****Example 5:**

Ether formation**Example 1:****Example 2:****Example 3 (Limonene):**

Hydroboration

- B when stable and uncharged has 3 bonds and no lone pairs
- Borane forms partial bonds with another borane molecule to form B₂H₆ (diborane)
- Borane is a hydride (H⁻) donor

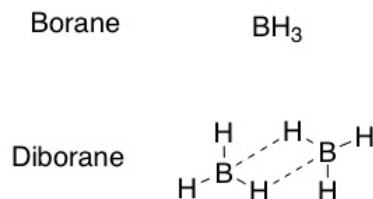


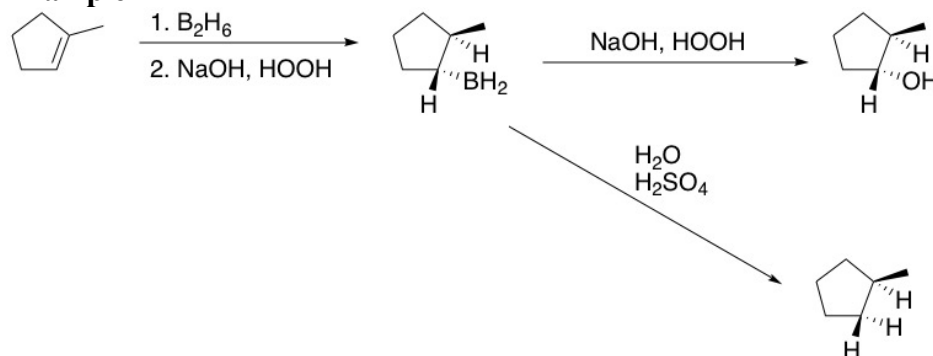
Concerted reaction: bond breaking and bond formation happens in a single step

Anti-Markovnikov: the hydrogen ends up on the more substituted C in a double bond. It is SYN.

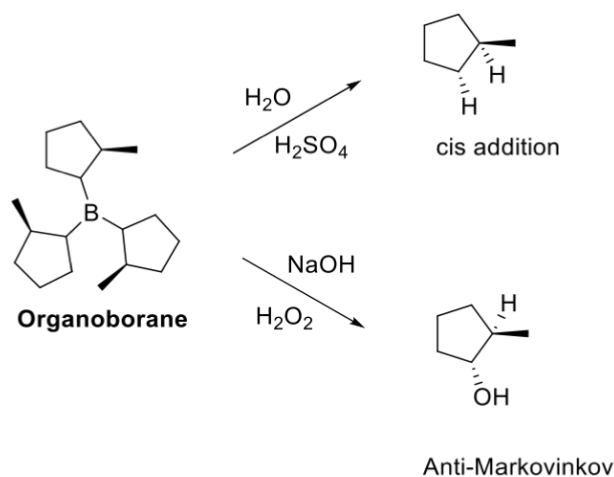
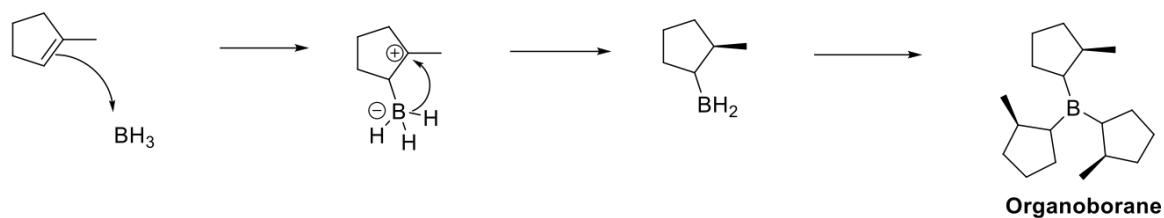
Structure of borane

Exists as Diborane (B₂H₆), but behaves like BH₃



Example

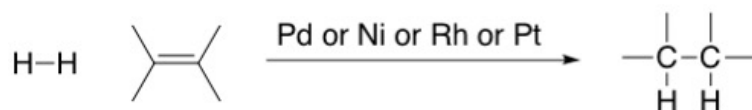
Syn addition, but
anti-Markovnikov
addition of OH

**Oxidation and Reduction**

Oxidation- removal of electron

Reduction- Addition of electron

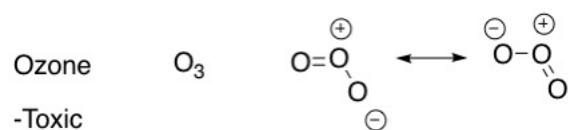
Example of Reduction (Hydrogenation)



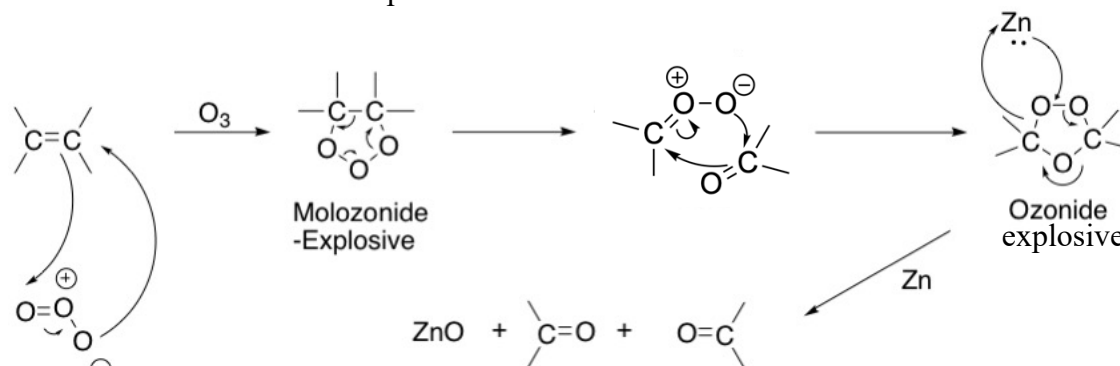
There are 12 electrons in the reagent side and 14 electrons in the product side. There is an addition of two electrons, therefore classified as **reduction**.

Oxidation Reactions

Ozonolysis (lysis = cleavage) – cleavage by ozone (O_3)



- Use double-headed arrow to indicate resonance (\leftrightarrow)
- Highly reactive (always looking for negative charge such as the negative charge in a double bond)
- Concerted and stereospecific



- Reaction is irreversible

Examples of carbonyl groups

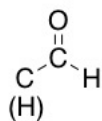
Carbonyl



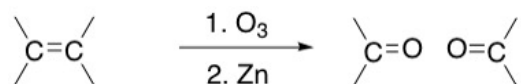
Ketone



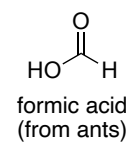
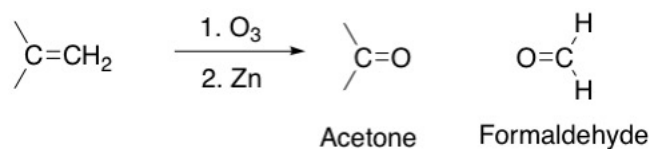
Aldehyde



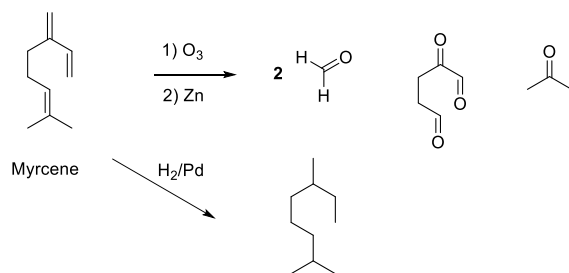
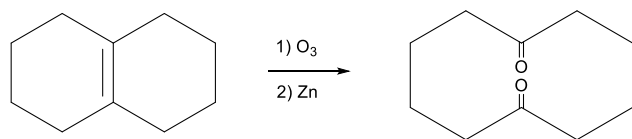
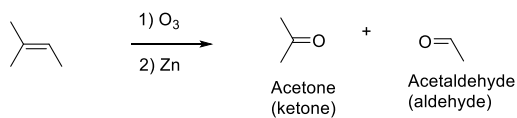
Reaction scheme of ozone

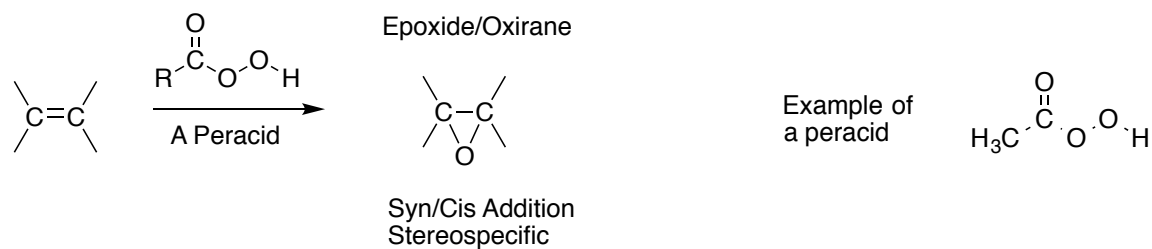


Example

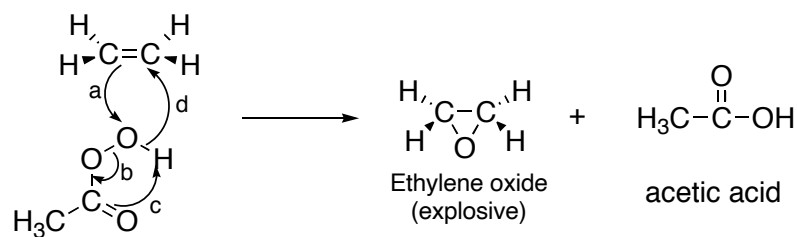


More examples

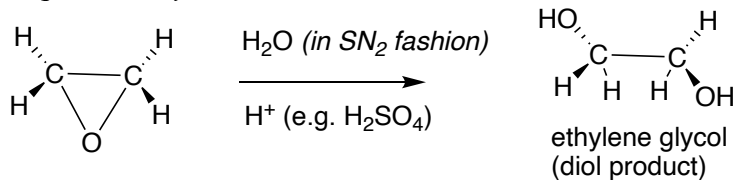
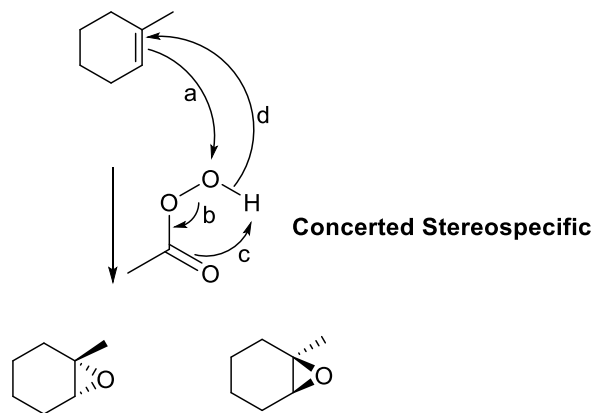


Epoxidation:

Concerted (bonds break and form at the same time)

Mechanism:

to quench ethylene oxide:

**Example: 1-methyl-1-cyclohexene**

Racemic mixture (1:1)
cis/syn addition