

ORGANIC CHEMISTRY 1 LECTURE GUIDE 2019

BY RHETT C. SMITH

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# Organic Chemistry 1 Lecture Guide 2019

By Rhett C. Smith, Ph.D.

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Companion Books from the Proton Guru:

*Organic Chemistry 1 Reactions and Practice Problems 2019*

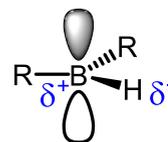
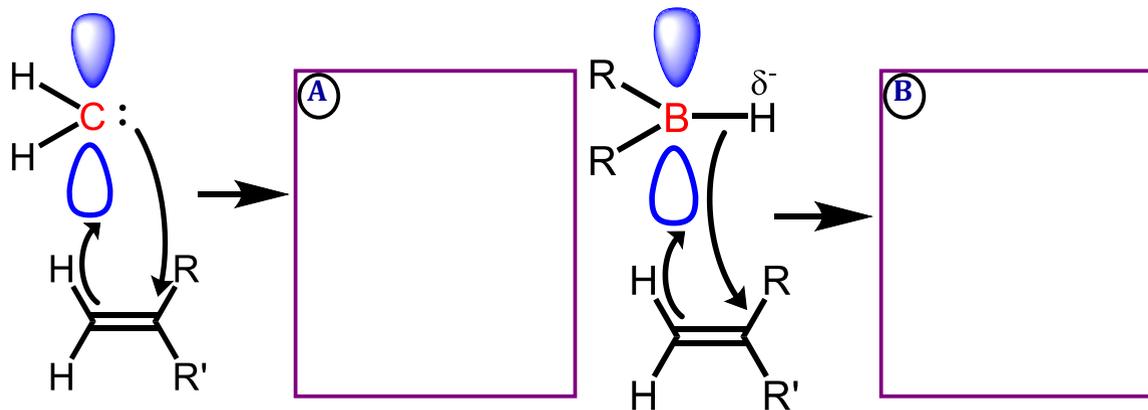
by Rhett C. Smith

*Organic Chemistry 1 Primer 2019,*

by Rhett C. Smith, Andrew G. Tennyson, and Tania Houjeiry

Like a carbene, a **borane** ( $\text{BH}_3$ ,  $\text{RBH}_2$  or  $\text{R}_2\text{BH}$ ) has an empty  $p$  orbital, allowing it to accept a pair of electrons from an alkene. Unlike a carbene, borane does not have a lone pair, so it donates a bonding pair from its B-H bond, leading to **hydroboration** of the alkene:

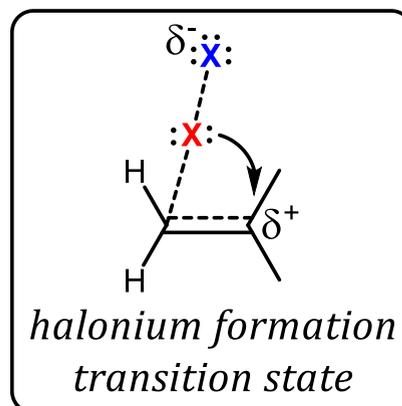
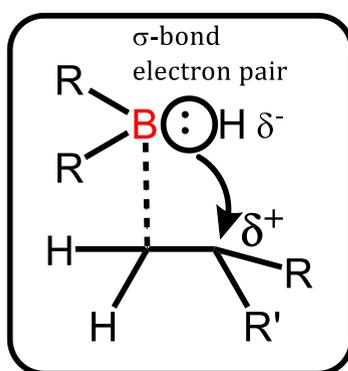
(empty p orbital)

*A Borane*Notes

The **hydroboration step** is concerted and it leads to a **Markovnikov product** (H is more electronegative than B, so it ends up on the more substituted side). Because both B and H add at the same time, this is also a **syn-addition** step.

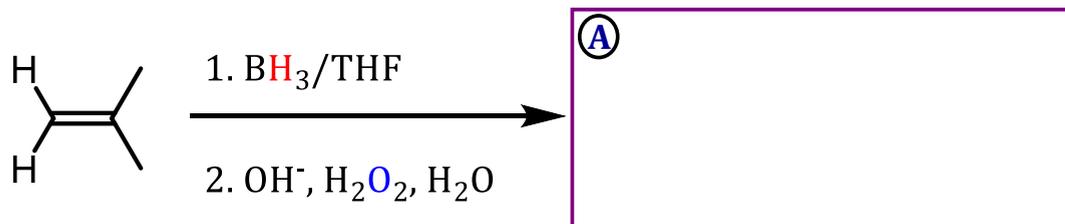
We can understand why H adds to the more substituted side if we examine the transition state and compare it to what we know about halonium formation (**Lecture Topic III.6**)

The more substituted C of the C=C bond better stabilizes positive charge, so the negative charge is attracted to that site



Notes

The only application of hydroboration in this course is as part of a two-step process called **hydroboration-oxidation**. In this process the hydroboration is followed by an oxidation step in which the borane unit on the carbon is replaced with an OH without changing stereochemistry of attachment:



You may see " $\text{B}_2\text{H}_6$ " or " $\text{R}_2\text{BH}$ " (such as disiamylborane) in place of " $\text{BH}_3/\text{THF}$ "; these are alternative hydroboration agents and the net result is the same. The mechanism of the oxidation is complex, but a proposed mechanism is provided in the Reaction Guide.

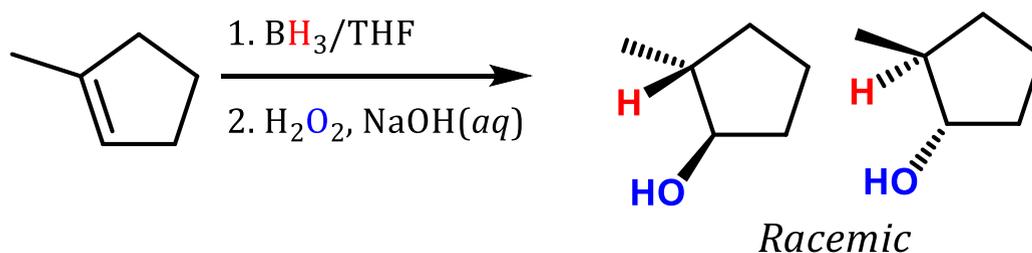
Notes

Because hydroboration places the B on the less substituted C and the B is replaced by an OH in the oxidation, the **net result after both steps** is formation of:

Ⓐ

Because hydroboration is syn- and OH replaces the B without a change of stereochemistry of attachment, the H and OH in the alcohol are:

Ⓑ



Notes