

Logan's

1

• Office hours as usual

SC 108 11-noon

• Review 3-5 pm
Sci Ctr C } Handouts in back

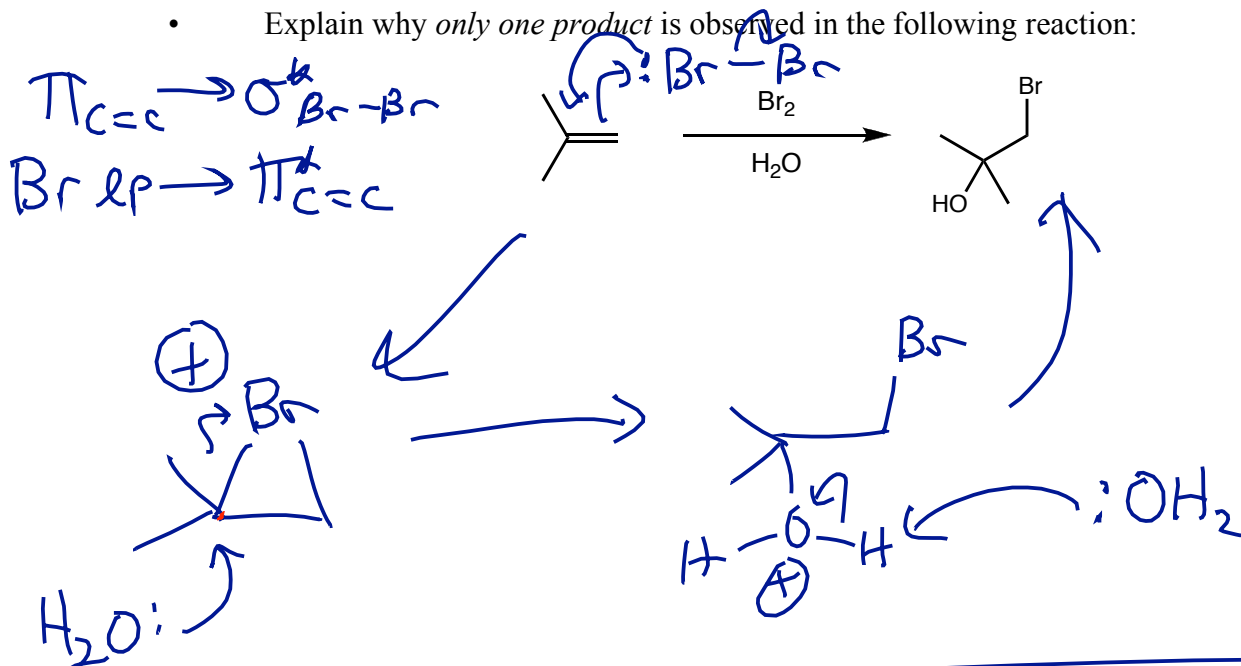
• Exam Monday

8:10 am sharp

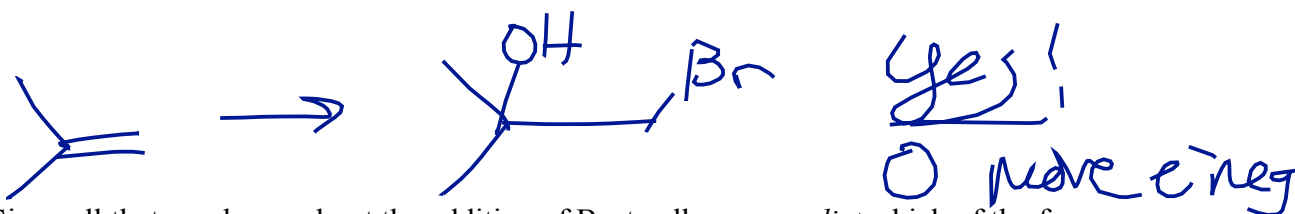
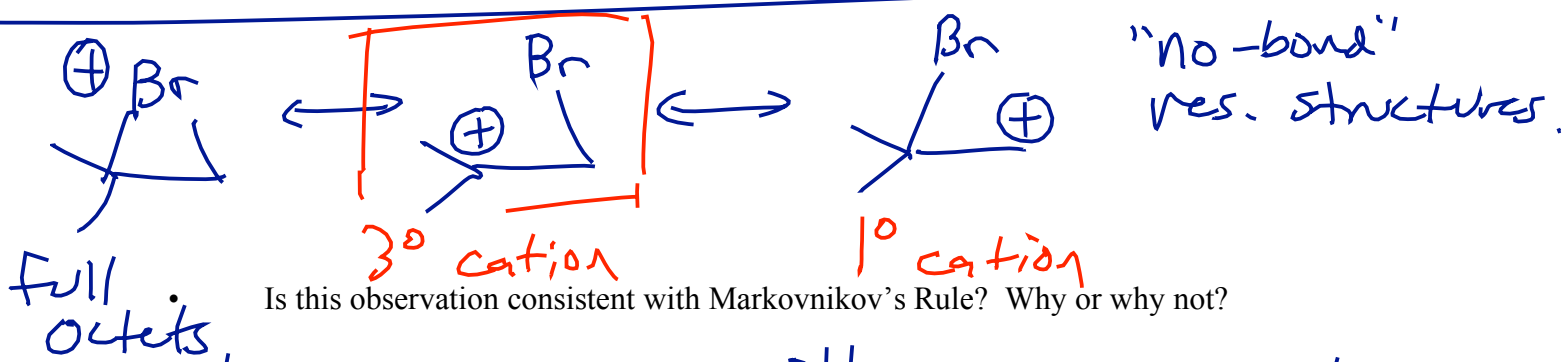
• Prac. exams on web.

(3 memb. ring, \oplus F.C. \rightarrow more subst. C) **The Structure of the Bromonium Ion**

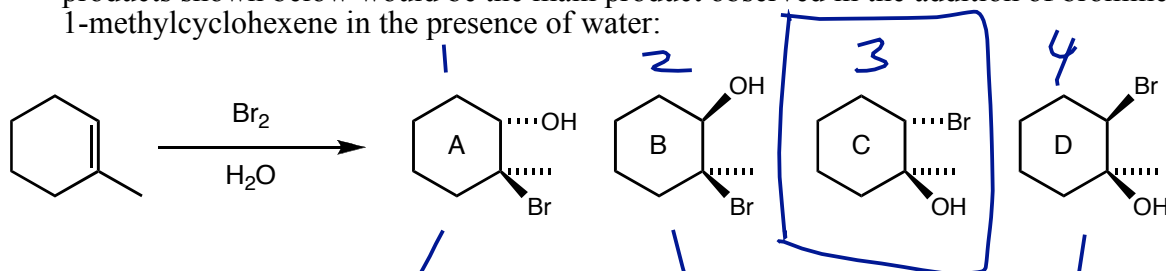
- Explain why *only one product* is observed in the following reaction:



$O^{\delta-} C-Br$
 better acceptor
 \oplus
 Br
 δ^+
 partial (+)
 on more
 subst. C.



- Given all that you know about the addition of Br_2 to alkenes, *predict* which of the four products shown below would be the main product observed in the addition of bromine to 1-methylcyclohexene in the presence of water:



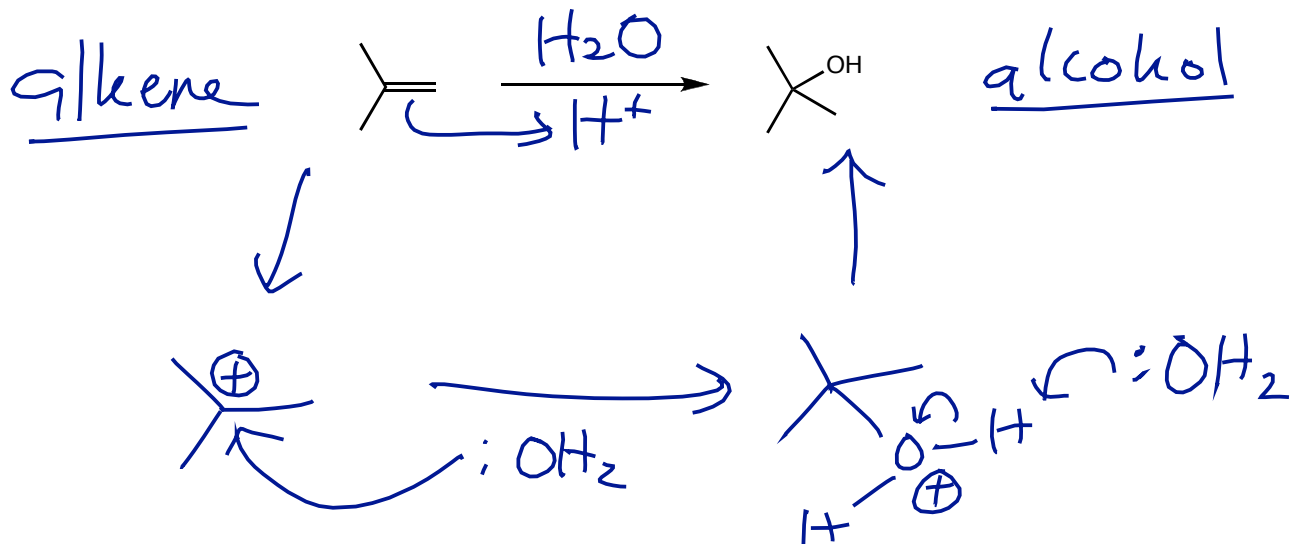
anti
 Markovnikov

Reading: Section 5.1

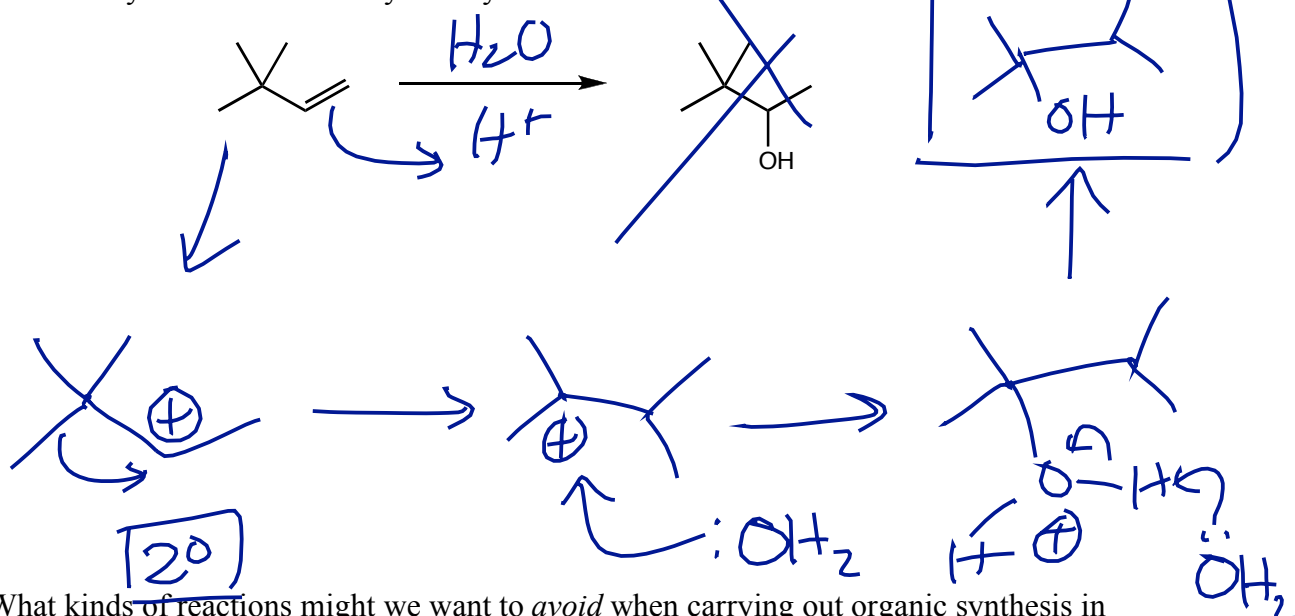
67 Stereochem syn

Conversions of Alkenes into Alcohols: Review of Alkene Hydration

- You already know one method for accomplishing the following transformation. What is that method? What is its mechanism?



- Now suppose you want to carry out the following transformation. Can you use the same method as you did above? Why or why not?



- What kinds of reactions might we want to *avoid* when carrying out organic synthesis in the laboratory?

• avoid carbocation intermediates that can rearrange

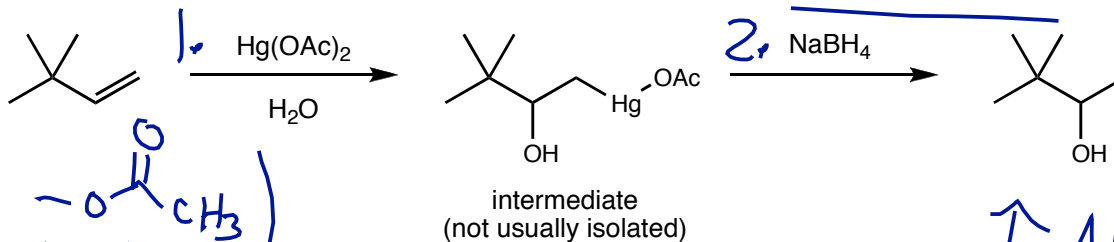
Reading: Section 4.9

Avoid Carbocations

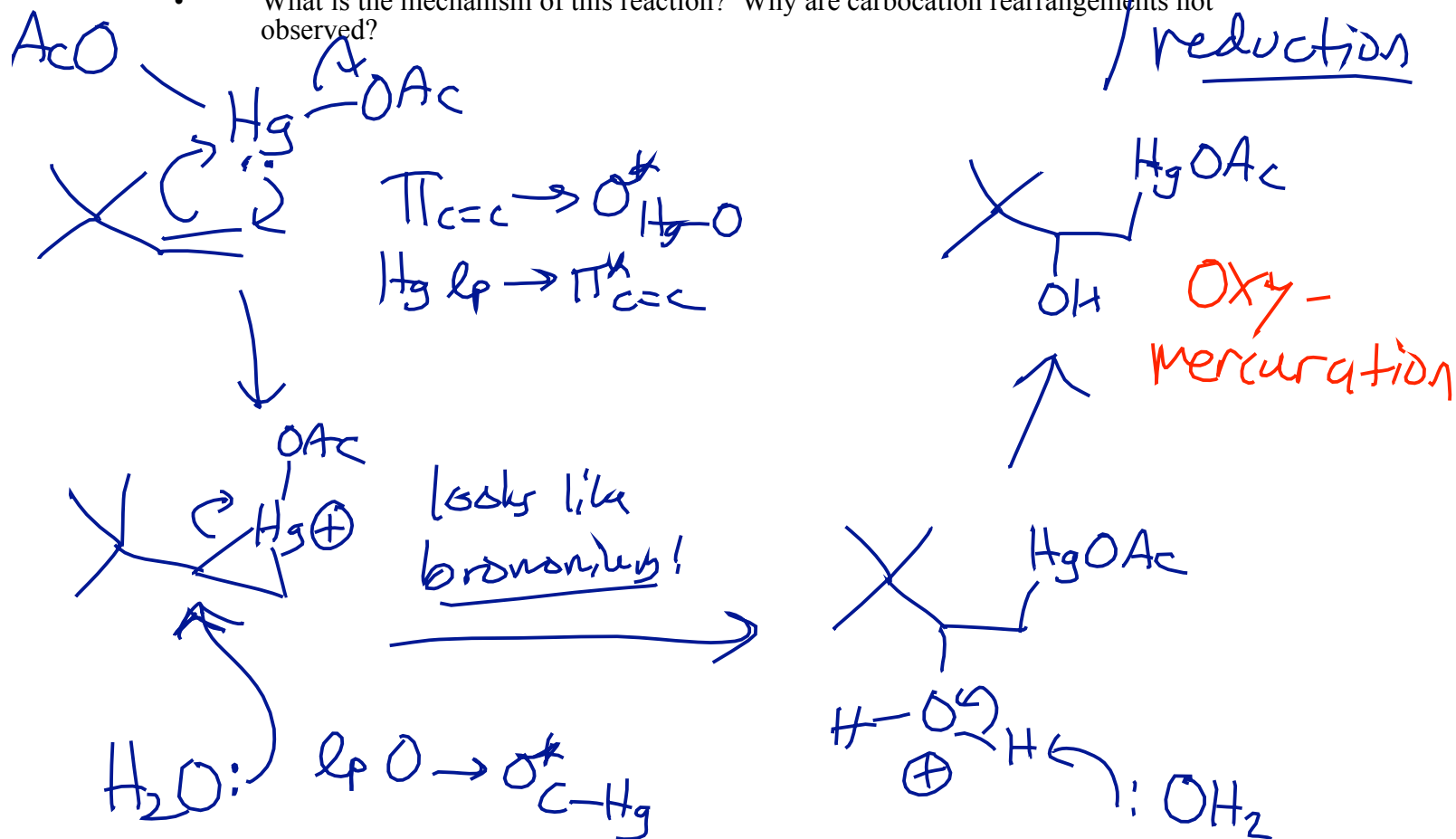
Conversions of Alkenes into Alcohols: Oxymercuration-Reduction

get rid of "OAc"

- We can convert an alkene into an alcohol with the following *two-step* process:



- What is the mechanism of this reaction? Why are carbocation rearrangements not observed?



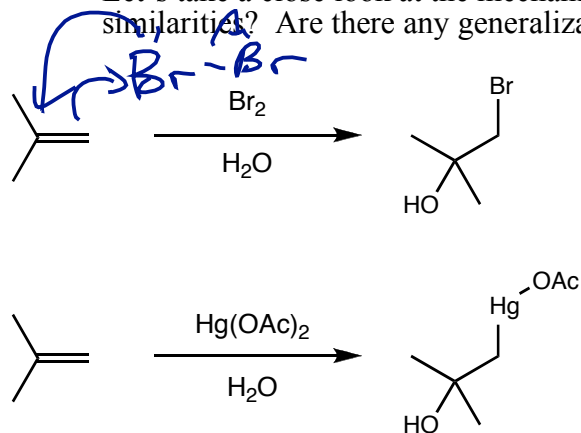
- Why might we say that this two-step sequence results in the "Markovnikov addition of water to an alkene"?

Overall Markovnikov addition of H₂O to alkene

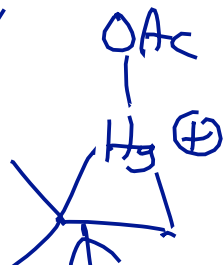
But No carbocations!

Forming and Opening 3-Membered Rings

- Let's take a close look at the mechanisms of the following reactions. Do you notice any similarities? Are there any generalizations you can make?



Both cases:

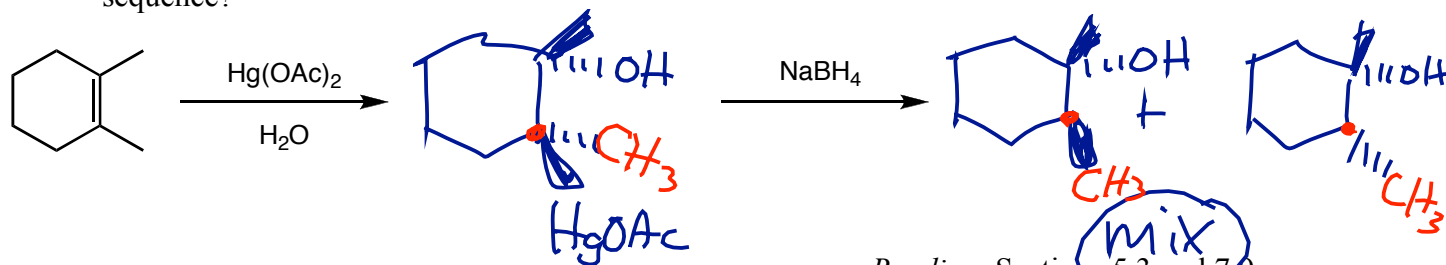


3-member ring
with \oplus F.C.

Nucleophile: Nu attack

more subst. carbon

- What is the stereochemistry of the intermediate and product in the following reaction sequence?



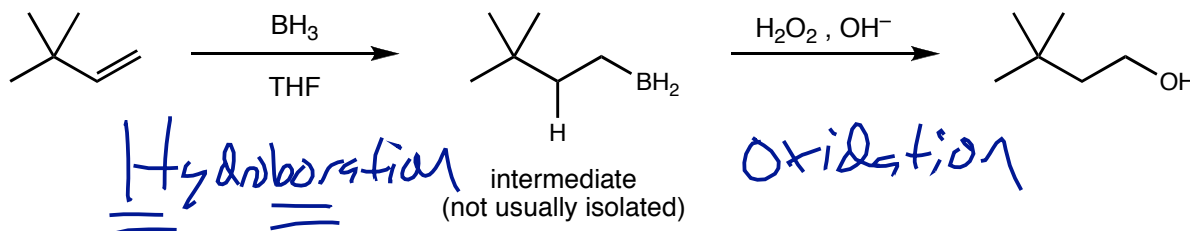
Reading: Sections 5.3 and 7.9

anti
 oxymercuration - (radical intermediate)

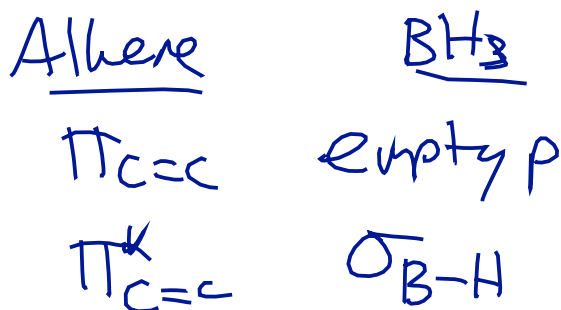
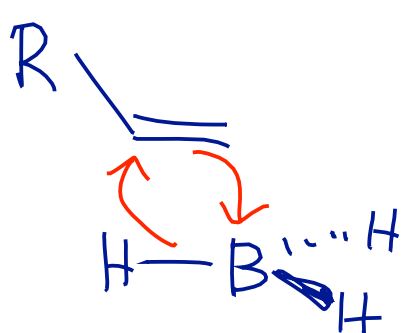
Conversions of Alkenes into Alcohols: Hydroboration-Oxidation

less
subst.
C!

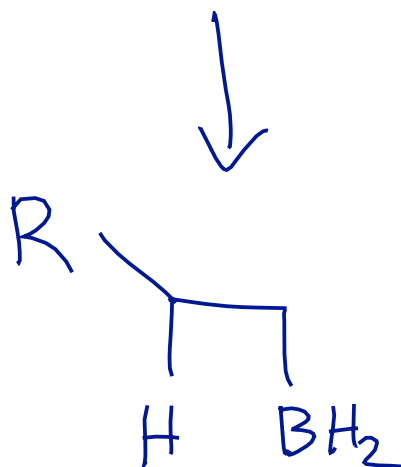
- We can accomplish the “anti-Markovnikov” addition of water to an alkene with the following *two-step* process:



- Let's take a closer look at the first step of this reaction:



H is more e-neg than B!
Follows Markovnikov.



Hydroboration.

- Would you say that the first step of this reaction obeys “Markovnikov’s Rule”?

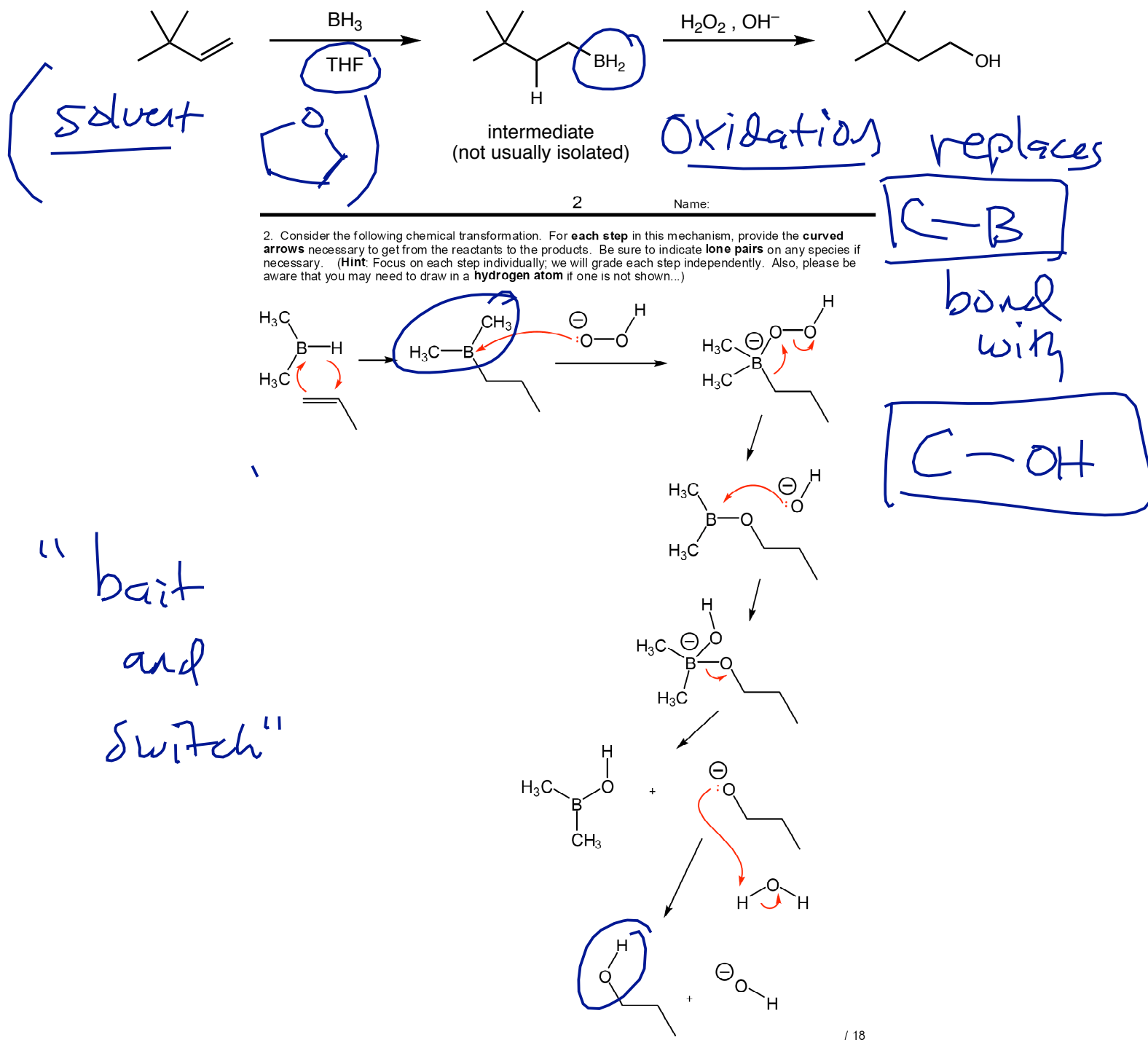
yes.

Reading: Section 5.3

Overly alkene \longrightarrow alcohol

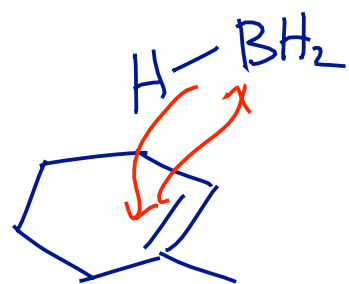
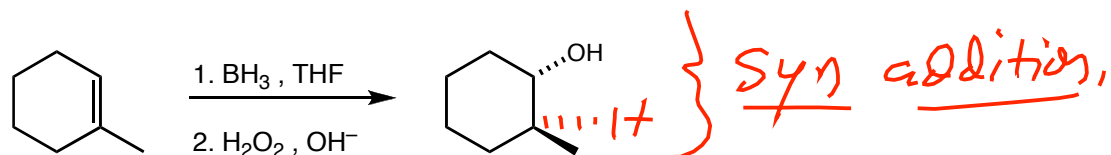
Conversions of Alkenes into Alcohols: on less subst Carbon. Hydroboration-Oxidation

- Now, let's look at the mechanism of the *second* step of the hydroboration-oxidation sequence:



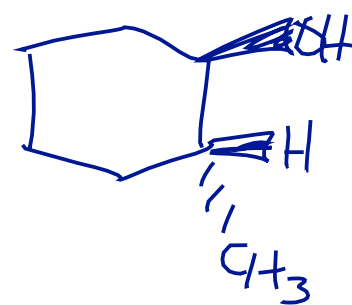
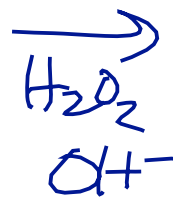
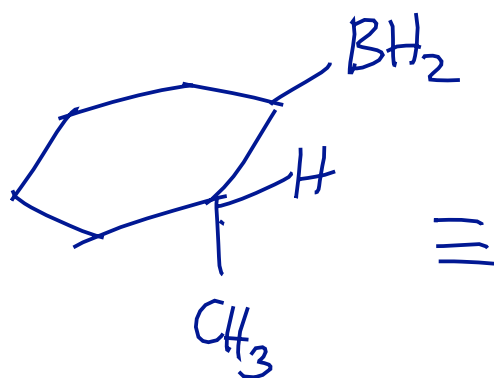
Stereochemistry of Hydroboration-Oxidation

- Explain why hydroboration-oxidation of 1-methylcyclohexene gives only the product shown below:



Overall adding H
and OH
to across C=C

Specifically



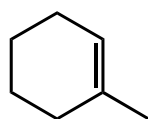
Oxidation step replace $-\text{BH}_2$ with $-\text{OH}$
and preserve stereochemistry

Reading: Section 7.9

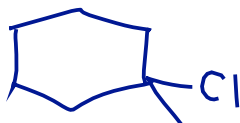
Summary of Alkene Addition Reactions

- Show the product of each of the following alkene addition reactions, and include some brief notes about the mechanism of each reaction.

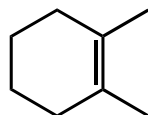
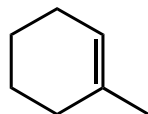
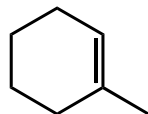
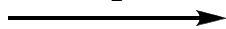
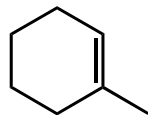
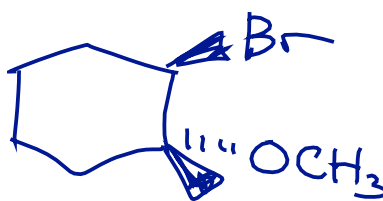
alkene



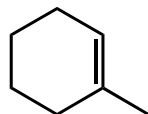
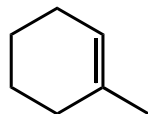
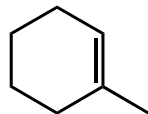
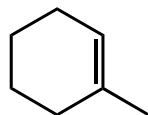
HCl



- Markovnikov
- Carbocation intermediate
- mix of syn/anti

 H_2 , Pt Cl_2  Br_2 , H_2O *
alkene Br_2 , CH_3OH 

- Markovnikov
- Bromonium
- Anti addition

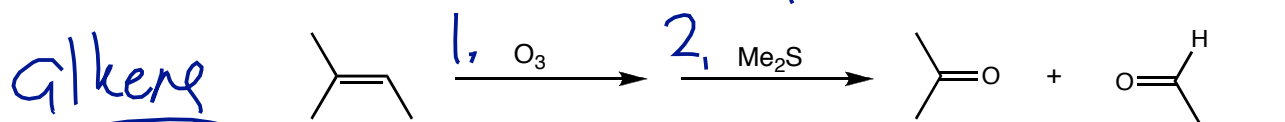
 H_2O , H^+ 1. $Hg(OAc)_2$, H_2O 2. $NaBH_4$ 1. $Hg(OAc)_2$, CH_3OH 2. $NaBH_4$ 1. BH_3 , THF2. H_2O_2 , OH^-

Ozonolysis of Alkenes

dimethyl sulfide

reductive
"workup"

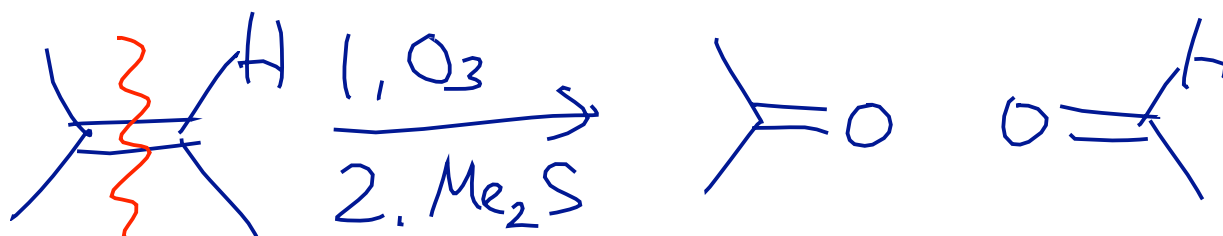
- Consider the following very interesting reaction sequence:



- What are the functional groups of the products of this reaction sequence?

ketone aldehyde

- We won't worry (for now) about the *real* mechanism for this reaction, but we can write a *fake* mechanism:



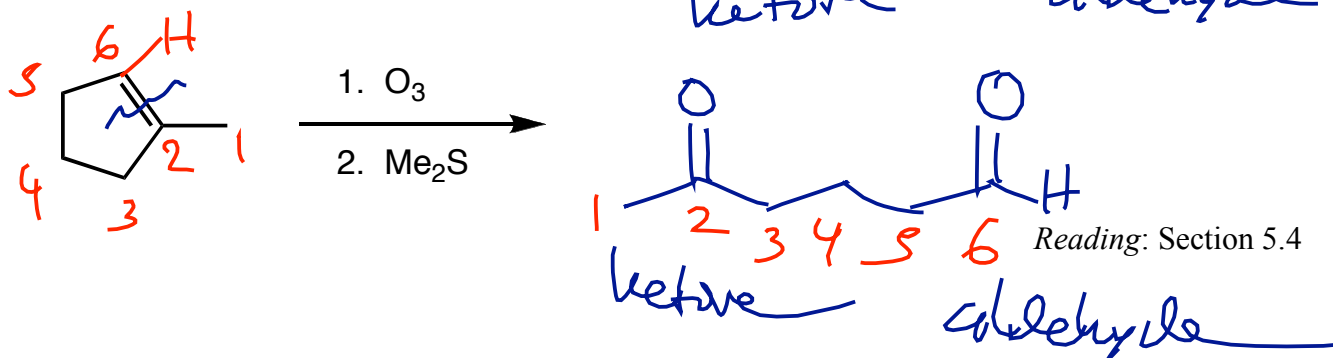
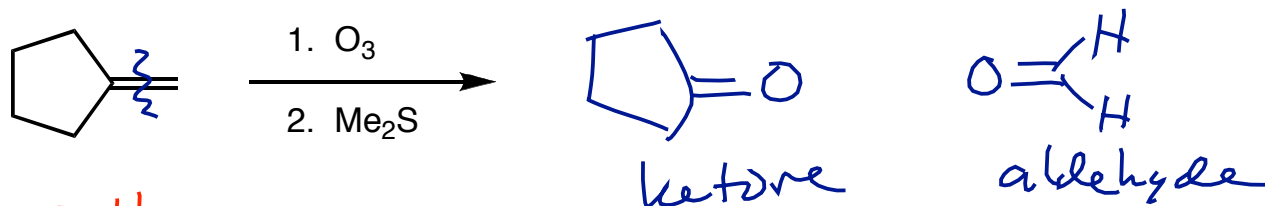
break C-C

replace the

C=C

with 2 C=O

- Using that fake mechanism, predict the product(s) of the following reactions:

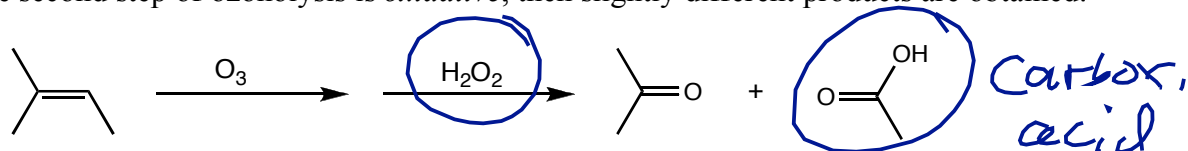


Reading: Section 5.4

Oxidative workup,

Ozonolysis of Alkenes, With Oxidation

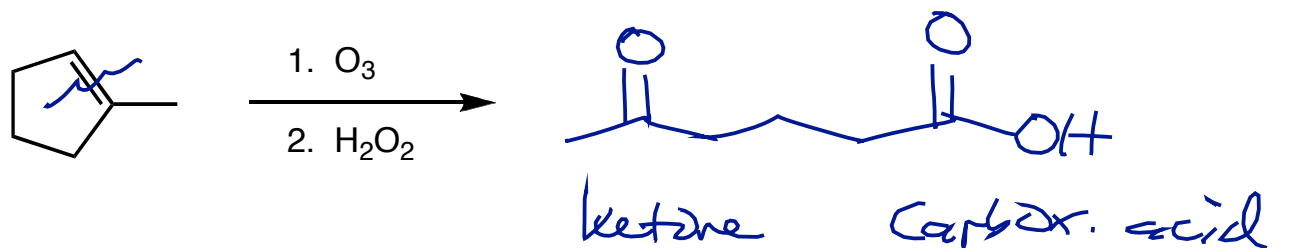
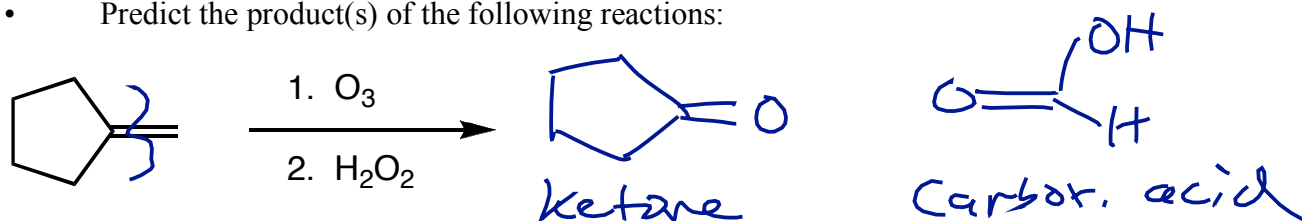
- If the second step of ozonolysis is *oxidative*, then slightly different products are obtained:



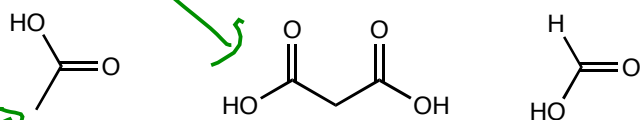
- What are the functional groups of the products of this reaction sequence? How is this different from the reductive "workup" (with Me_2S)?

in product, aldehyde H \rightarrow $-\text{OH}$ of Carbox. acid.

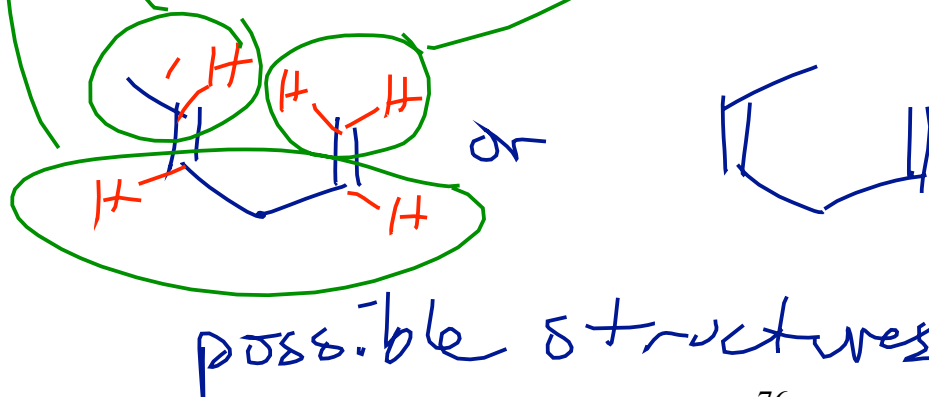
- Predict the product(s) of the following reactions:



- Ozonolysis of a hydrocarbon (with oxidative workup) gave the following products. What are some possible structures for the original hydrocarbon?



(1 : 1 : 1 molar ratio)



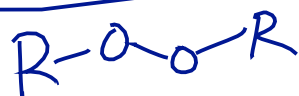
Reading: Section 5.4

"region"

Regiochemistry**Anti-Markovnikov Addition of HBr to Alkenes:**
Free-Radical Addition

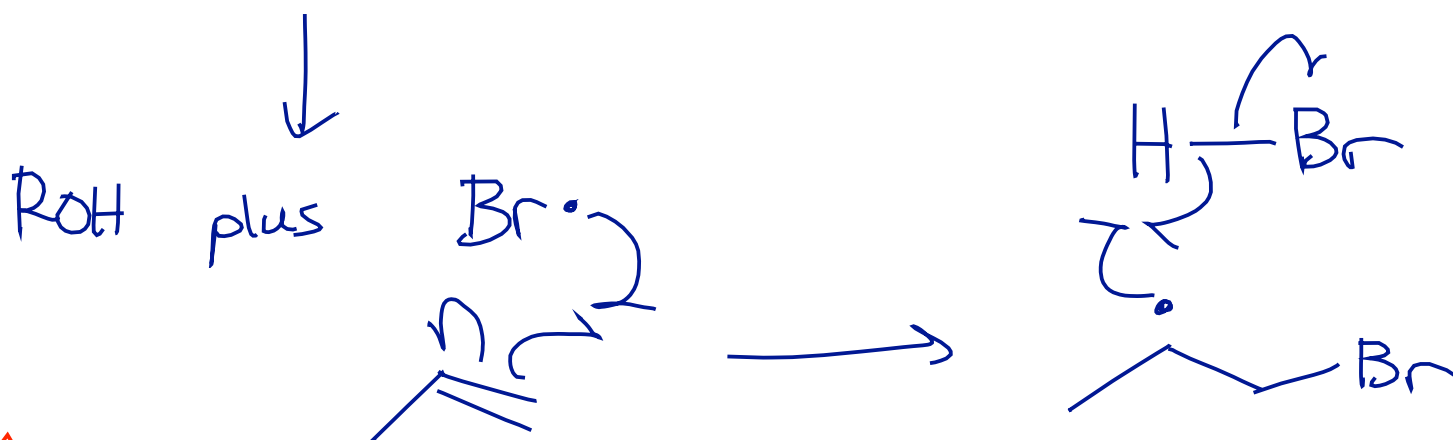
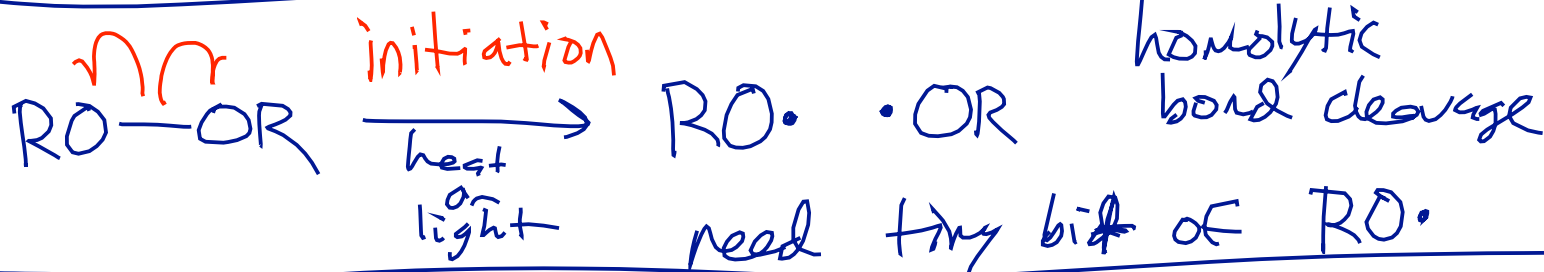
"fishhook" arrows

- In the presence of certain compounds, notably *peroxides* ($R-O-O-R$), the addition of HBr (but not HCl or HI) takes place with anti-Markovnikov regiochemistry:

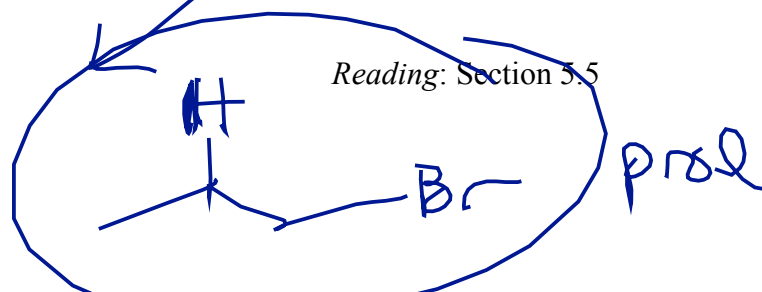
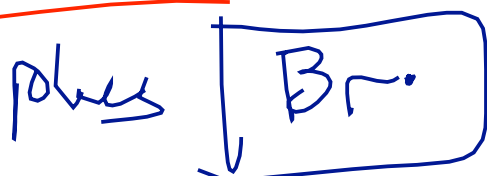
peroxidesMotion of one electron.

- Let's see if we can understand why this is so. First, we need to see the mechanism for HBr addition under these conditions. Note that this is not a mechanism that I would expect you to be able to guess or predict!

In presence of peroxides, $\text{HBr} + \text{alkene} \rightarrow$ anti-Mark



Radical chain reaction

propagation

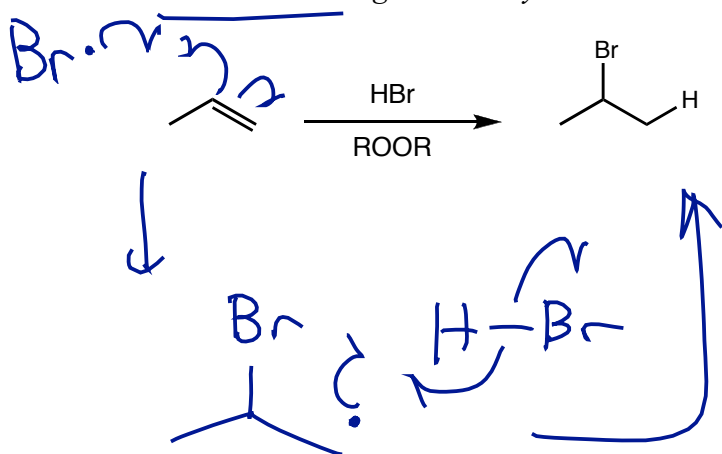
Radicals involve cases with peroxides!

Anti-Markovnikov Addition of HBr to Alkenes: Relative Stability of Free-Radical Intermediates

ROOR

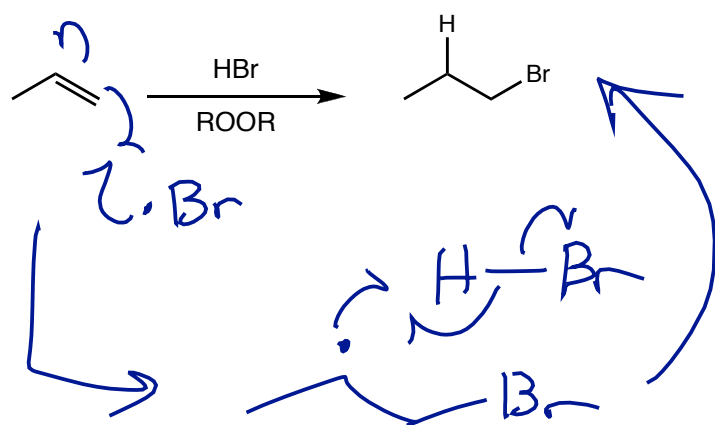
- Now let's see if we can explain why the addition of HBr under *free-radical* conditions gives the "anti-Markovnikov" product. Consider the mechanisms for forming the Markovnikov and anti-Markovnikov products. What intermediates are formed in each case?

Markovnikov Regiochemistry:



Br on more subst.
means radical
is on
less subst carbon.

Anti-Markovnikov Regiochemistry:



Br on less subst.
means
radical
is on
more subst carbon.

- How can we explain why the anti-Markovnikov product is preferred?

Radical on more subst. carbon
is more stable.

Reading: Section 5.5

(e⁻ deficient) $3^\circ > 2^\circ > 1^\circ > \cdot\text{CH}_3$
most stable

How Can I Possibly Learn All of These Reactions?

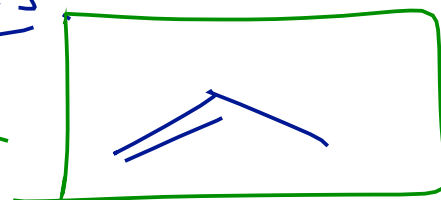
<u>React</u>	<u>Reagent</u>	<u>Product</u>	<u>Comments</u>
alkene	1. O_3 2. Me_2S	ketones aldehydes	break $C=C$
alkene	1. O_3 2. H_2O_2	ketones carbox. acids	break $C=C$
alkene	$HBr, ROOR$	alkyl bromide	Anti-Markov, radical mech.

An Introduction to Organic Synthesis

- Propose a synthesis of the following product, starting with only hydrocarbons and inorganic reagents:

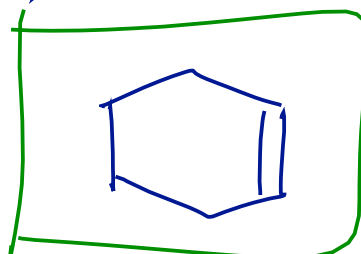
Retrosynthetic analysis

S.M.



Anti-
markovnik
addition of
 H_2O to alkene

1. BH_3, THF
2. H_2O_2, OH^-



S.M.

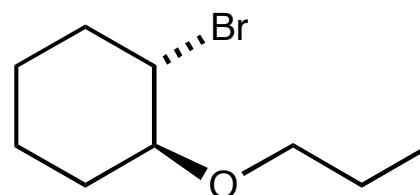
plus $HO-CH_2CH_2CH_3$

Br_2

Vicinal bromoether

Functional groups:

- Alkyl bromide
 - Ether
- } Anti!
Vicinal.



target