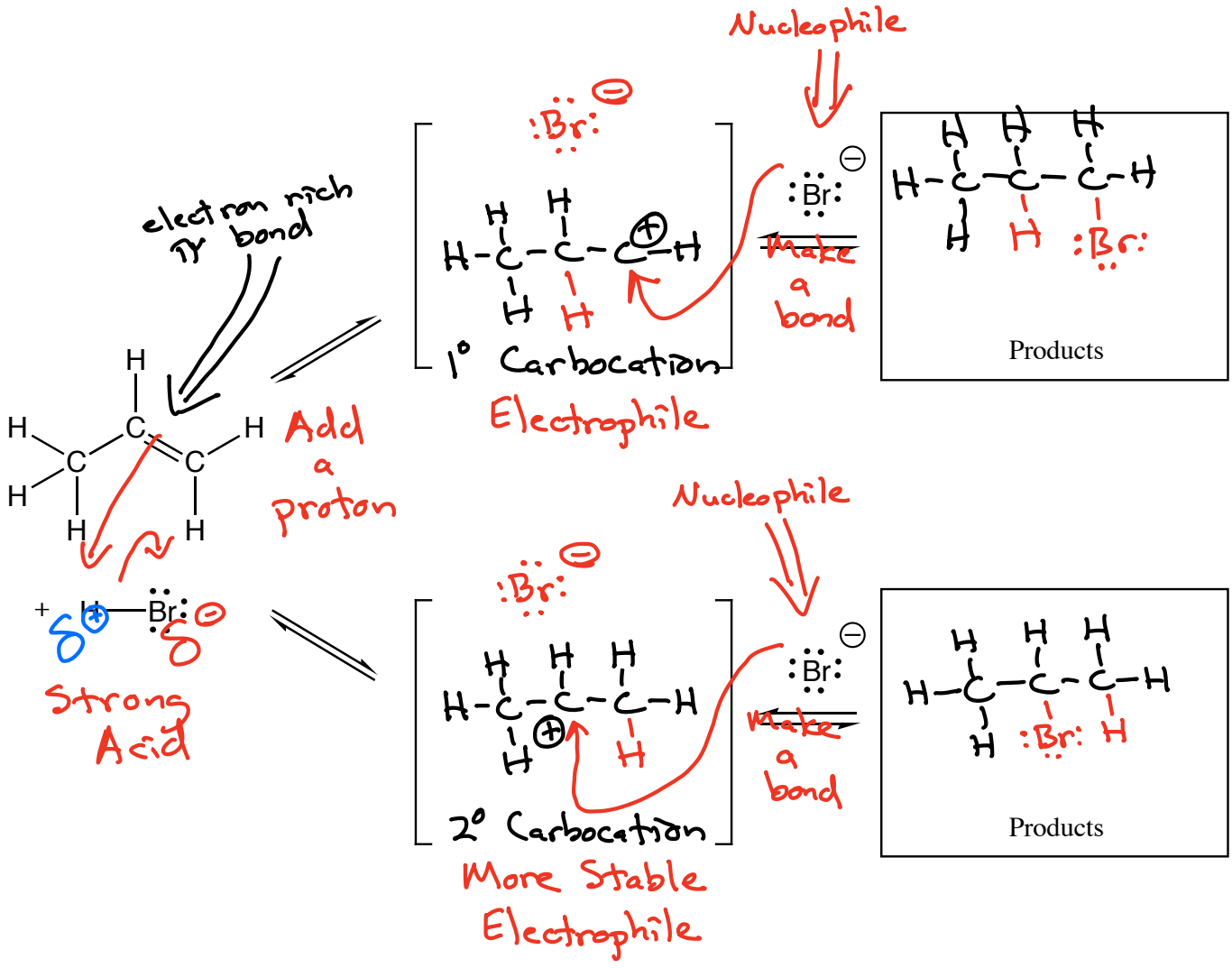
*Addition of H-X to an Alkene*

X = Cl, Br, I but not F

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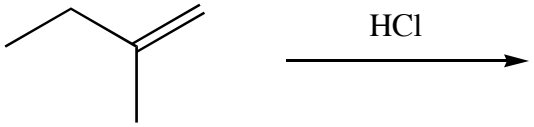
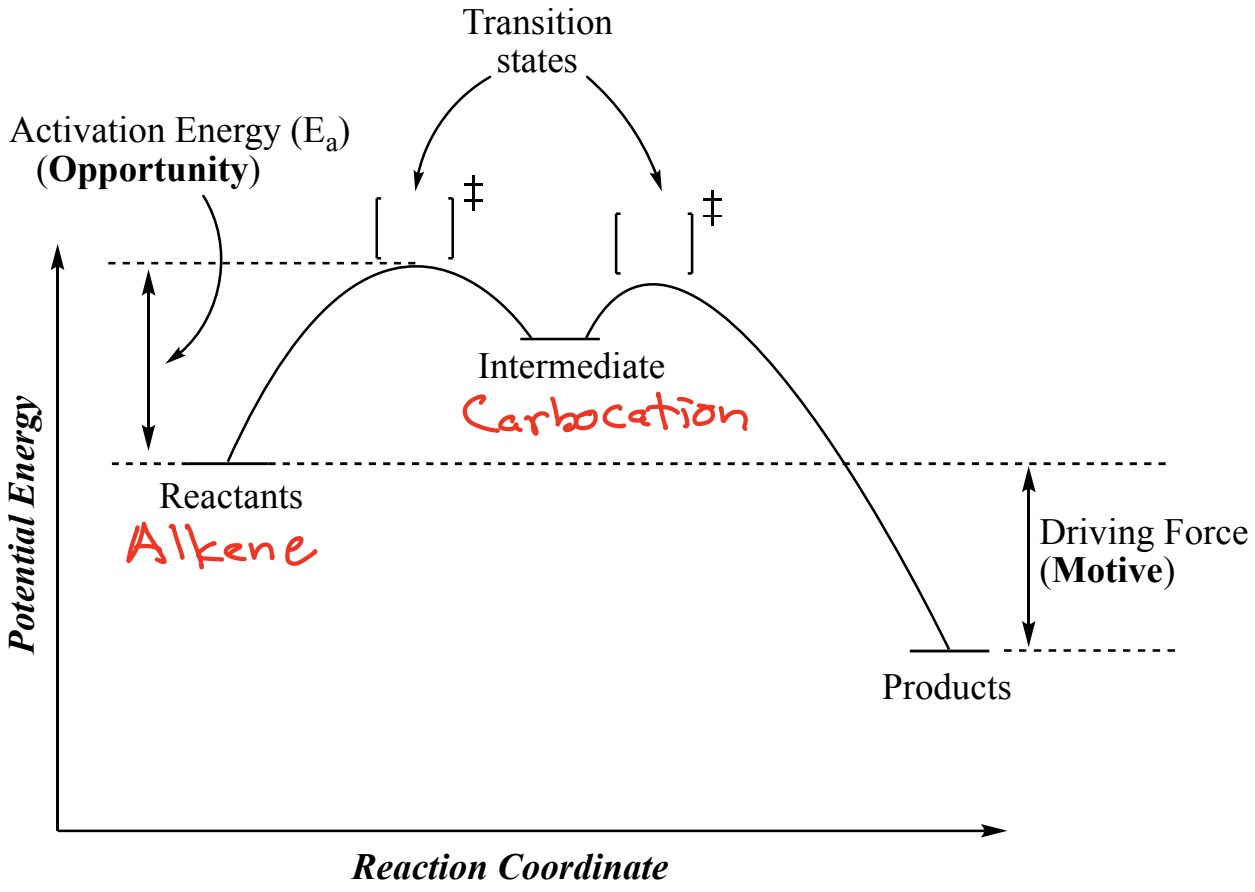
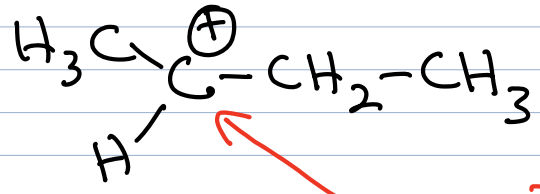
|---|
| Summary: |
| Regiochemistry: |
| Stereochemistry: |
| Example:   |




During reactions we often encounter intermediates → relatively high energy species that are formed between reactants and products

When alkenes react with H-X → carbocation intermediate

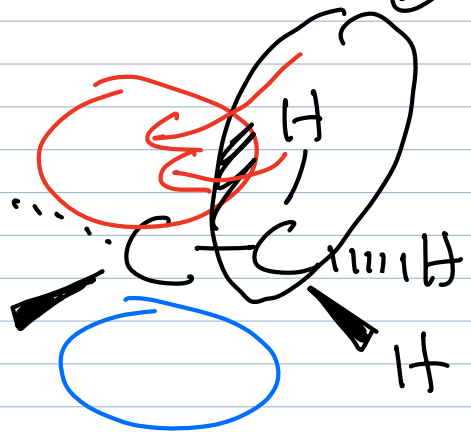
Carbocations ⇒ positive charge on a carbon atom




$sp^2$ hybridized with an empty 2p orbital

Alkyl groups stabilize carbocations by 2 different mechanisms

1) Hyperconjugation → overlap of adjacent σ bonding electron density with the empty 2p orbital of a carbocation



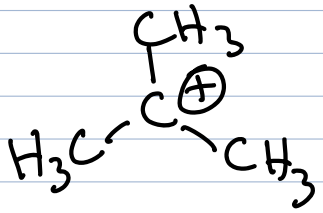

delocalizes the ⊕ charge

Some electron density of the C–H σ bond is pulled into the empty 2p orbital (red arrows in the figure)

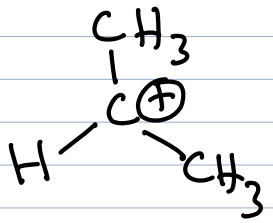
2) Inductive effect → the electron density is drawn through the σ bonds to the C⊕

↳ The C⊕ is very electronegative!

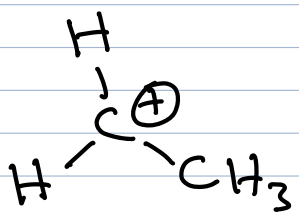
Carbocation stability → the more C atoms bonded to the C⊕ the more stable



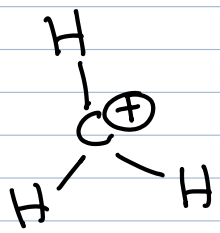
3° (tertiary)



2° (secondary)



1° (primary)



methyl

← Hyperconjugation stabilization

← Inductive effect stabilization

← Carbocation Stability

Markovnikov's Rule → For alkene reactions involving a carbocation intermediate the nucleophile (ex. $:\ddot{B}r:^{\ominus}$) will make a bond to the more substituted C atom → derived from the more stable carbocation

# *Addition of H-X to an Alkene*

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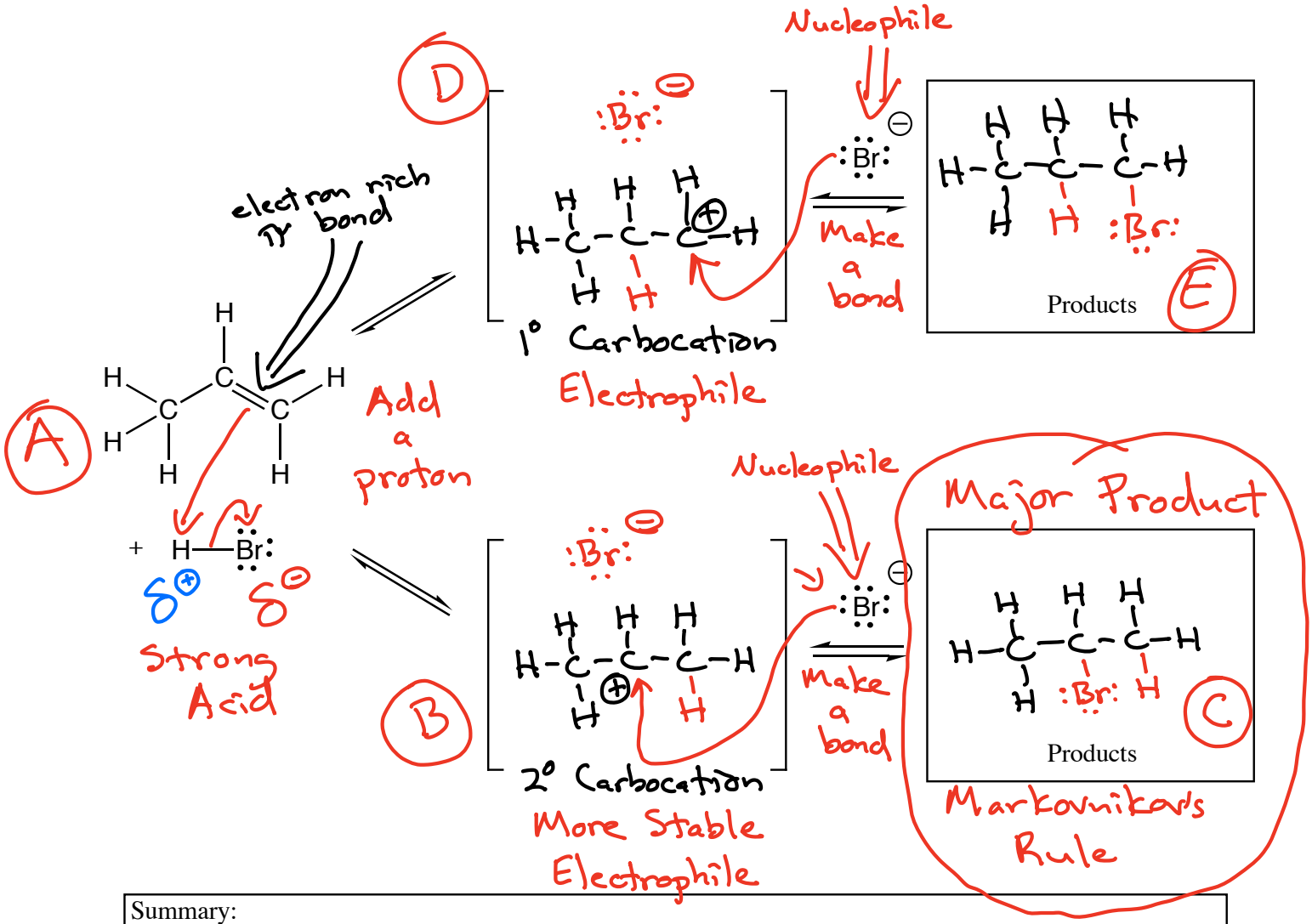
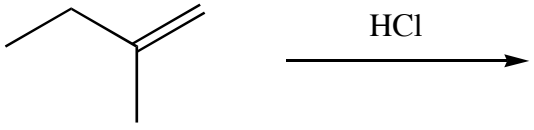


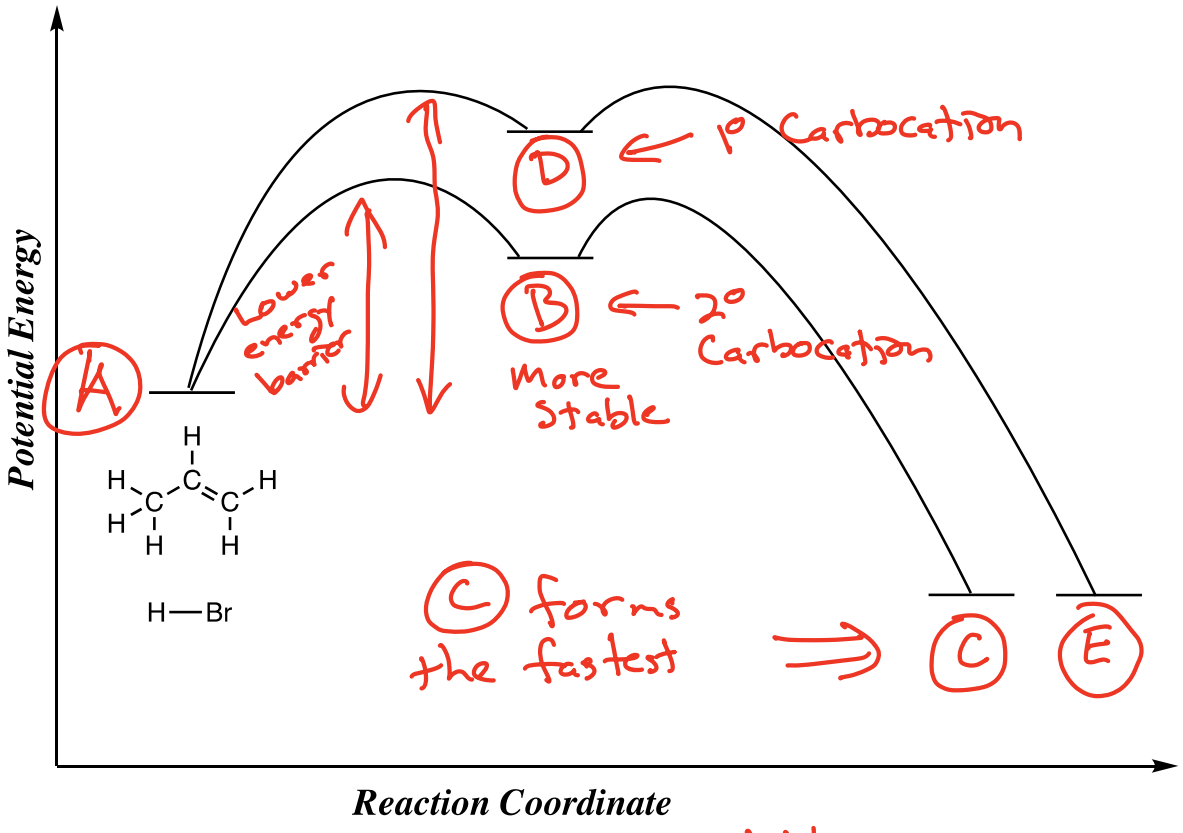

Summary:

Regiochemistry:

Stereochemistry:

Example:






More stable carbocation

Creation of (B) has a lower energy barrier and it forms faster → We get more (C) product

Regiochemistry → Which constitutional isomer is made in largest amounts in a reaction

→ For H-X addition this is explained by Markovnikov's Rule

Stereochemistry → Which of the possible stereoisomers are formed?

→ If a new chiral center is made from a molecule (the alkene) that itself is NOT chiral → You end up with a racemic mixture.

Time capsule → The stereochemistry of H-X addition to an alkene is MIXED as H and X can end up on both the same (cis, syn) and opposite (trans, anti) sides of the original double bond

# *Addition of H-X to an Alkene*

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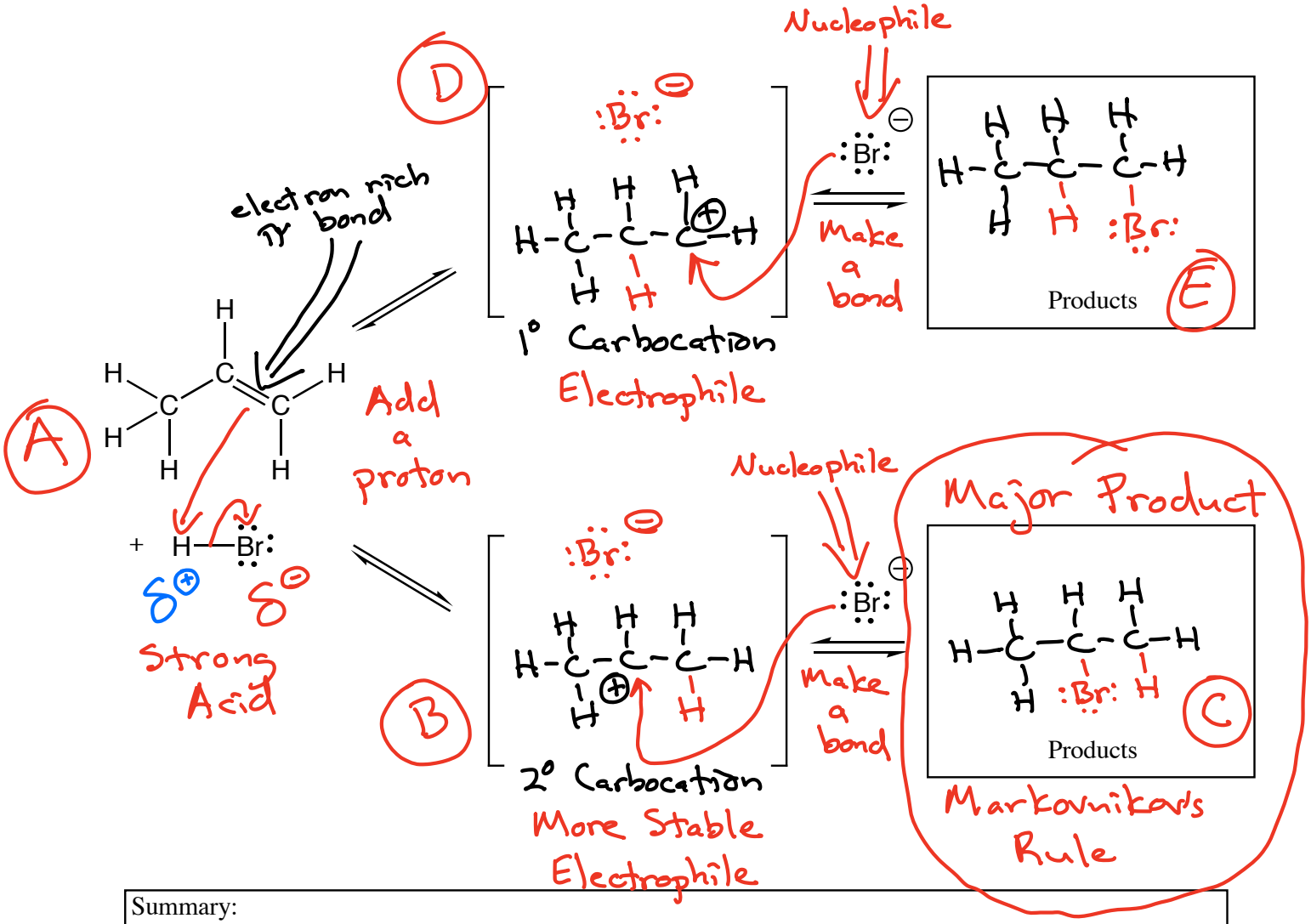


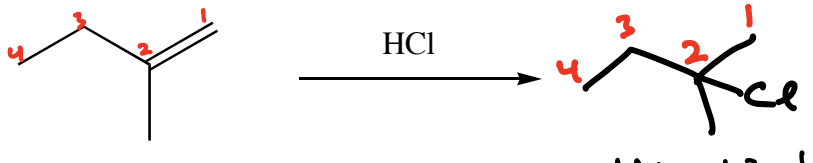

Summary:

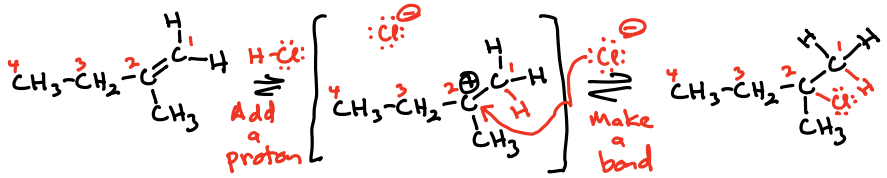
The alkene pi bond reacts with H-X to add a proton to create a carbocation intermediate that makes a bond with $X^{\ominus}$ to give the product

Regiochemistry: Markovnikov's Rule

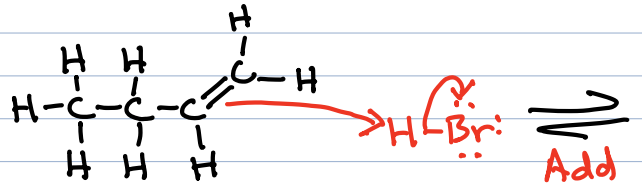
Stereochemistry: Mixed (time capsule) → Racemic Product

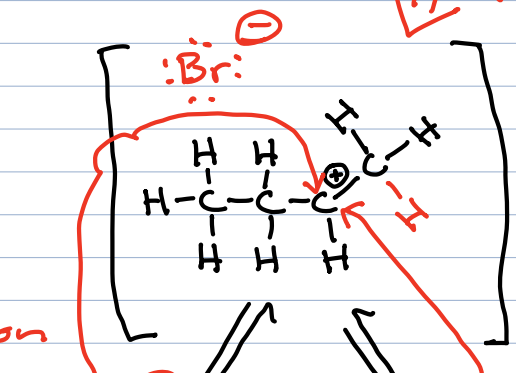
Example:



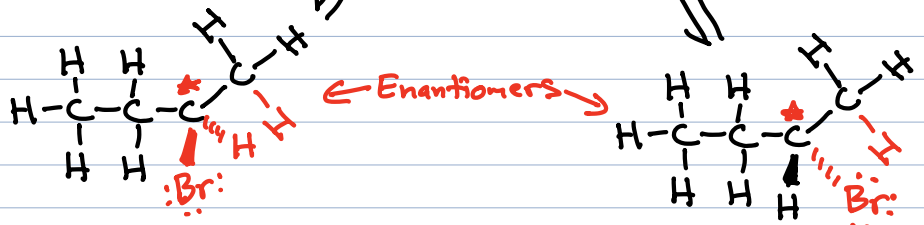
Example:






C⊕ atom is sp² and planer



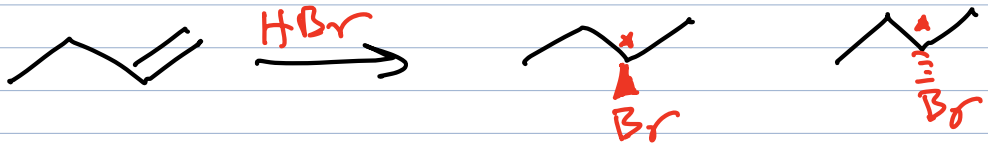




I added this after lecture to better explain

Racemic Mixture

It is equally likely to make either enantiomer

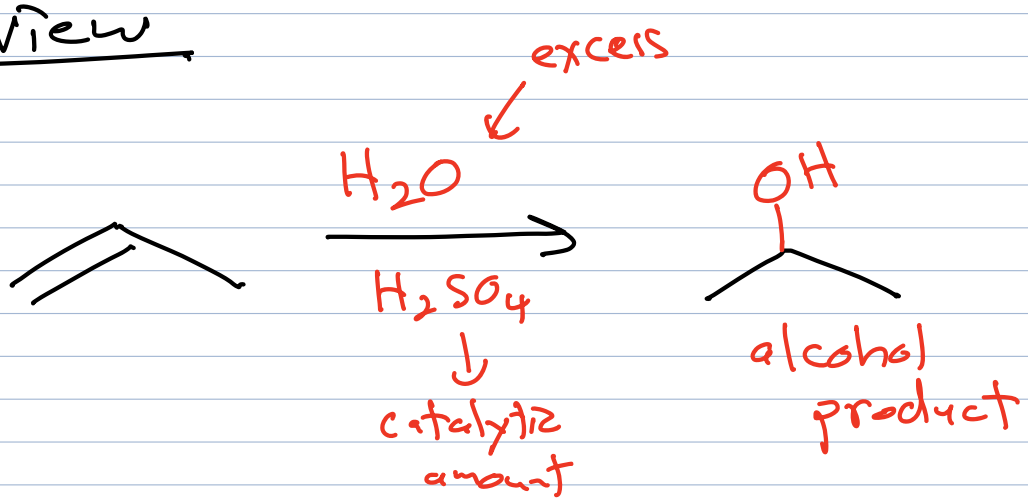
Also written as




Racemic Mixture

New Reaction: → "same song, different verse"

Overview



# The 4 Most Important Mechanistic Elements

The following are expressed from the point of view of the carbon-containing molecule taking part in a reaction

1) **Make a bond** between a nucleophile and electrophile.
   ⇒ A nucleophile and electrophile are both present and a bond can be made.

2) **Break a bond** to give stable molecules or ions.
   ⇒ None of the other possibilities are likely and the fragments produced are relatively stable

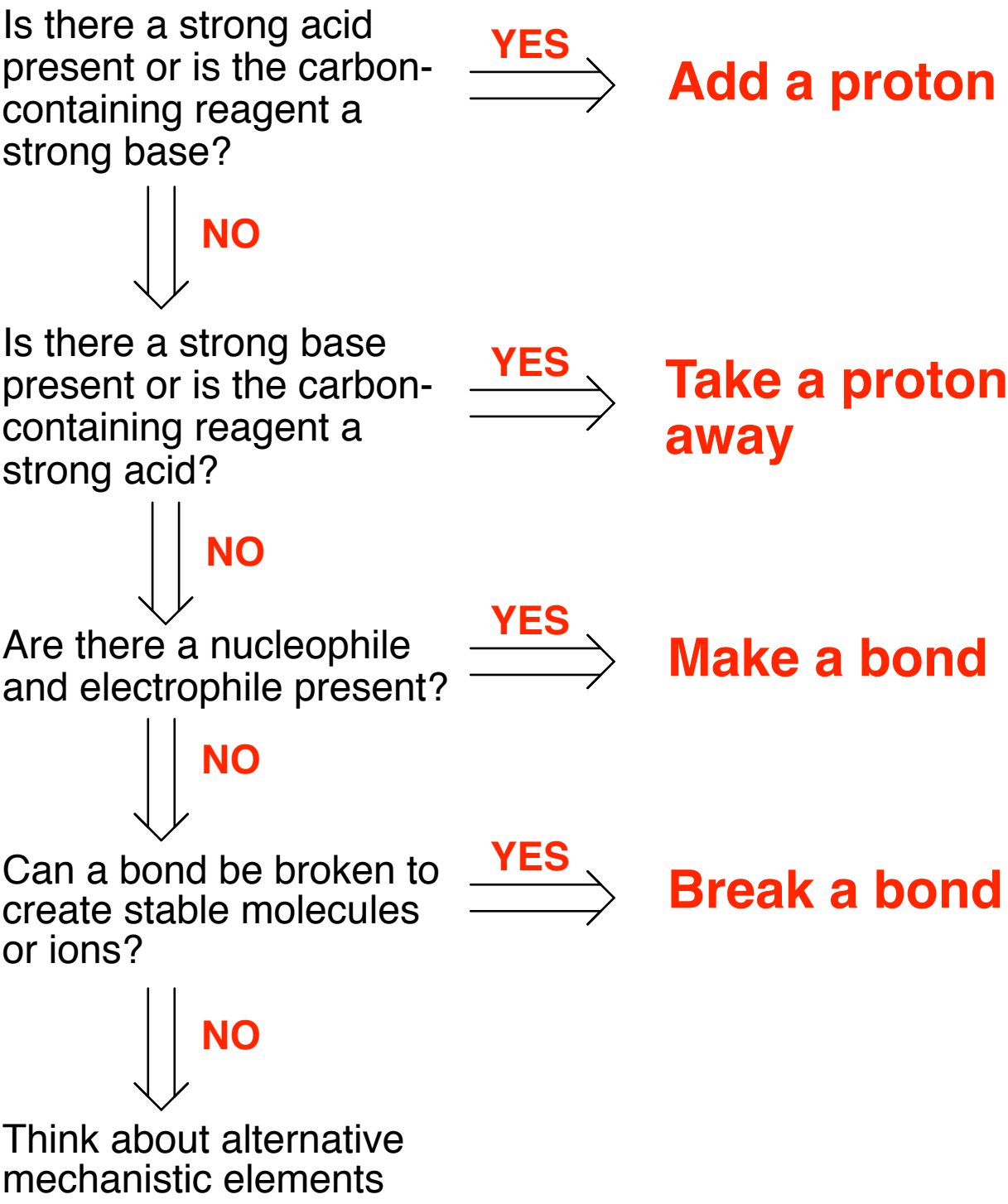
3) **Add a proton**
   ⇒ Acid is present or the molecule is a strong base.

4) **Take a proton away**
   ⇒ Base is present or the molecule is a strong acid.

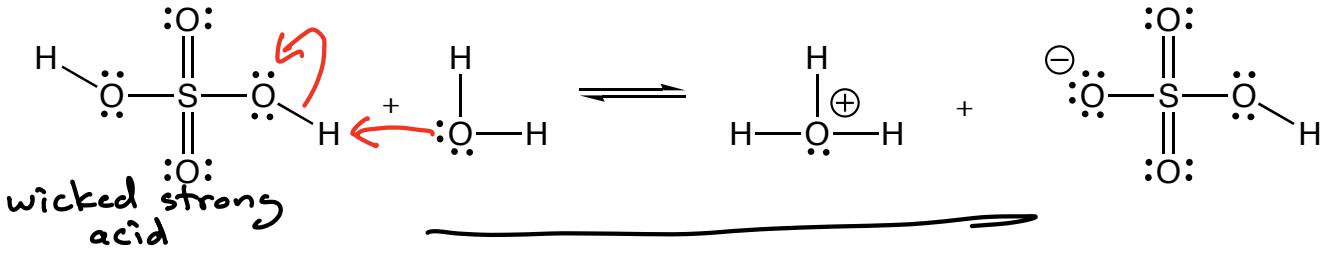
Notice → 1) is the reverse of 2) and 3) is the reverse of 4) .... and vice versa

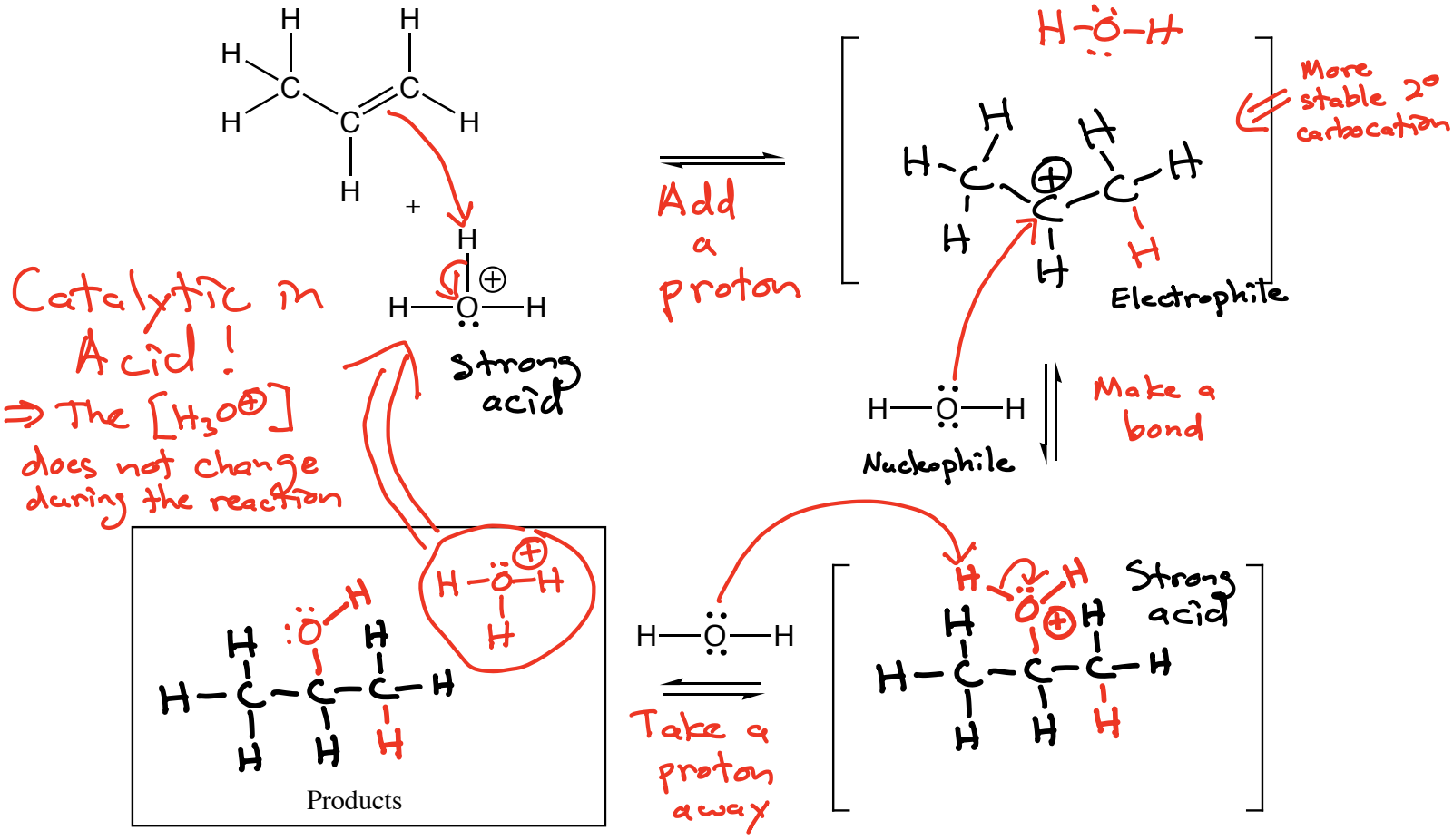
# Mechanism Summary

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.



*Acid-catalyzed Hydration of an Alkene*

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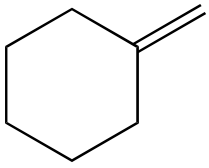

$H_2O$

$H_2SO_4$ (catalytic amount)

**<u>Organic Chemistry</u> is the study of carbon-containing molecules.**

**This class has two points.**

***The first point of the class is to understand the organic chemistry of living systems. We will teach you how to think about and understand the most amazing things on the planet!!***

Water is essential for life, you will learn why water has such special properties. 8/28/24

You will learn the secret structural reason proteins, the most important molecular machines in our bodies, can support the chemistry of life. 9/11/24

You will learn why when you take Advil for pain, exactly half of what you take works, and the other half does nothing. 9/25/24

You will learn how toothpaste works. 10/7/24

You will learn how a single chlorofluorocarbon refrigerant molecule released into the atmosphere can destroy many, many ozone molecules, leading to an enlargement of the ozone hole.

You will learn how medicines like Benadryl, Seldane, and Lipitor work.

You will learn how Naloxone is an antidote for an opioid overdose.

You will learn why Magic Johnson is still alive, decades after contracting HIV.

You will learn how MRI scans work.

***The second point of organic chemistry is the synthesis of complex molecules from simpler ones by making and breaking specific bonds.***

You will learn how to understand movies of reaction mechanisms like alkene hydration. 10/9/24

You will learn reactions that once begun, will continue reacting such that each product molecule created starts a new reaction until all the starting material is used up.

You will learn reactions that can make antifreeze from vodka.

You will learn a reaction that can make nail polish remover from rubbing alcohol.

You will learn how to look at a molecule and accurately predict which atoms will react to make new bonds, and which bonds will break during reactions.

You will learn how to analyze a complex molecule's structure so that you can predict ways to make it via multiple reactions starting with less complex starting molecules.