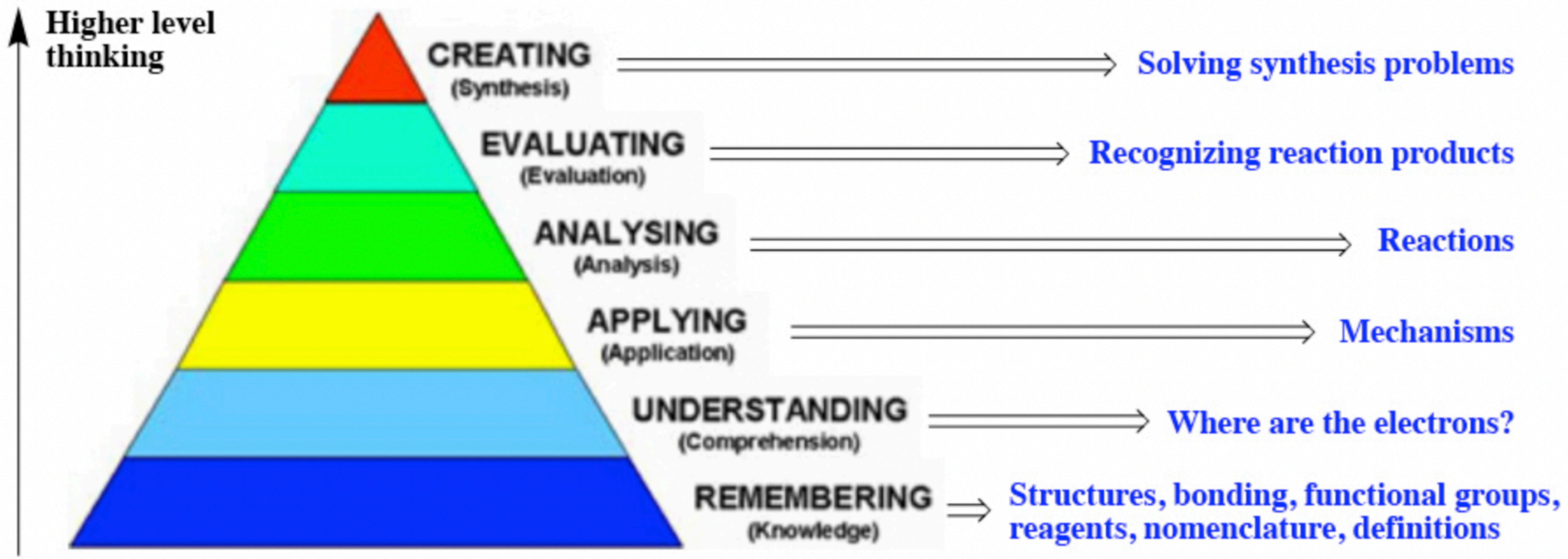
Bloom's Taxonomy of Learning

Organic Chemistry Analog

Tools we created to help you succeed:



- KRE Table
- Roadmaps
- The 4 mechanistic elements
- "Personalities of Molecules" Nucleophiles, electrophiles, acids, bases
- **Rules of the Day**

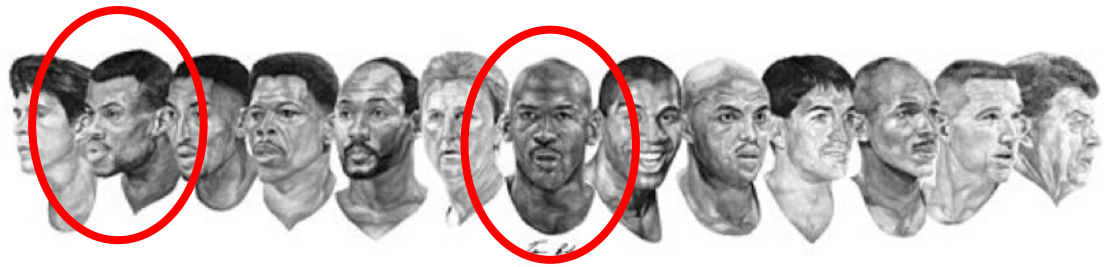
Organic chemistry is difficult because it requires higher order thinking. According to Bloom's taxonomy of learning, the lowest level of learning involves pure memorization ("Remembering") As one moves up the pyramid to higher learning, understanding, applying, analysing, evaluating and creating are reached. I believe there are Organic chemistry analogs of all of these, culminating in synthesis which inolves creativity along with all of the other levels of thinking. It is likely that many of you have never been challenged all the way to the top of the Bloom's taxonomy of learning pyramid before, explaining why this feels different and disorienting. DO NOT GIVE UP. As shown on the right, we have created tools to help you master each step up the ladder. On the above diagram you can cllick on the tools listed to go directly to them. Also, if you have any questions about how to study, click here to read about the way I learned to study. I never earned a grade lower than an A after I started using this method during my own college career.

I understand that most of you are headed to the health professions, so you may be wondering if mastering synthesis problems will be important for you. I assert that it is. Solving a synthesis problem involves the detailed evaluation of a complex molecule while looking for KREs, then working backwards to the starting materials by analyzying possible reactions involved by thinking through your roadmaps, possibly applying your understanding of mechanism to make sure you predict the correct product for each reaction. This is the exact type of thinking you will need to diagnose a patient. A patient will present various complex combinations of symptoms, then you must evaluate which of these are important, then analyze, apply and understand how the patient got that way and how to get them back to their starting state (healthy) again. In other words, you will learn the "KREs of diagnosis" then work backwards to understand what happened to the originally healthy patient! Therefore, learning how to solve synthesis problems will teach you how to use higher level thinking skills, exactly the kind you will need to develop as a health care professional!

File:Dream Team Basketball 1992 Olympic Games Barcelona.jpg

From Wikipedia, the free encyclopedia

File   File history   File usage

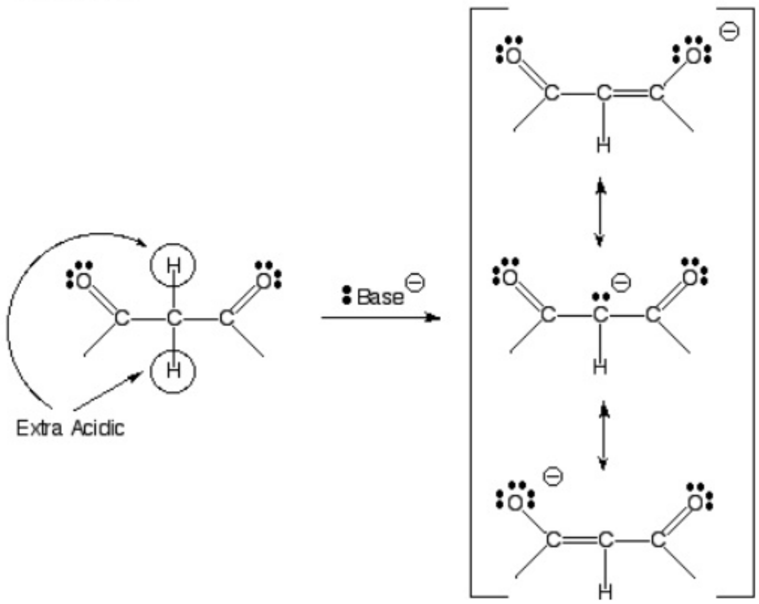


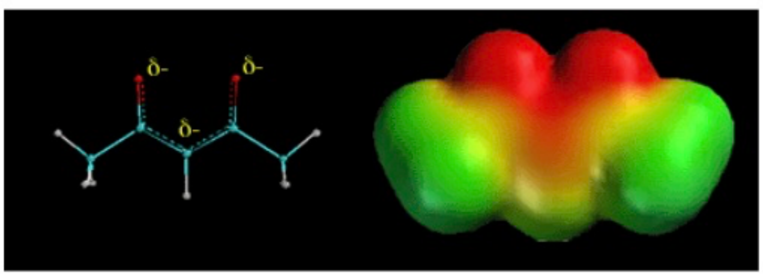
Michael

Robinson

Iverson

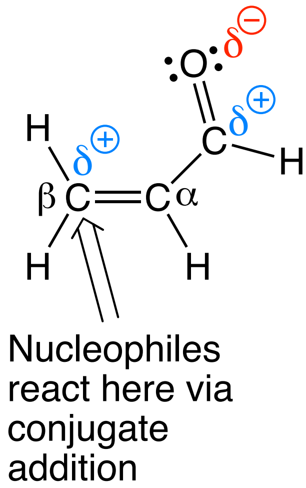
Beta-dicarbonyls have alpha-hydrogens that are extra acidic

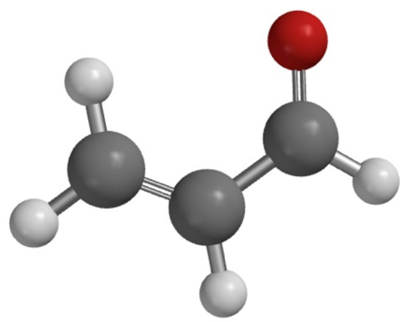


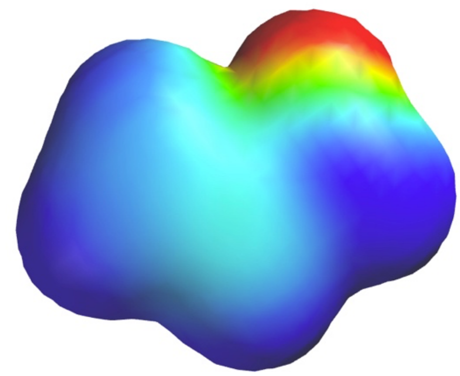


The C-H hydrogen atoms between two carbonyl groups are aven more acidic than normal a hydrogens because the resulting anion is double resonance stabilized. The above electrostatic potential surface shows how the negative charge (red color) is spread over all three atoms as predicted by the three resonance contributing structures.

Conjugate Addition







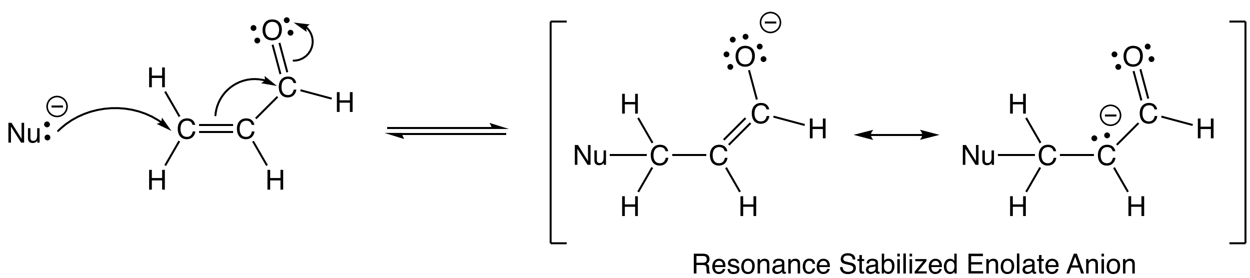
A) Alkenes adjacent to a carbonyl are conjugated and are therefore electrophilic.

B) These species are called α,β unsaturated carbonyl compounds.

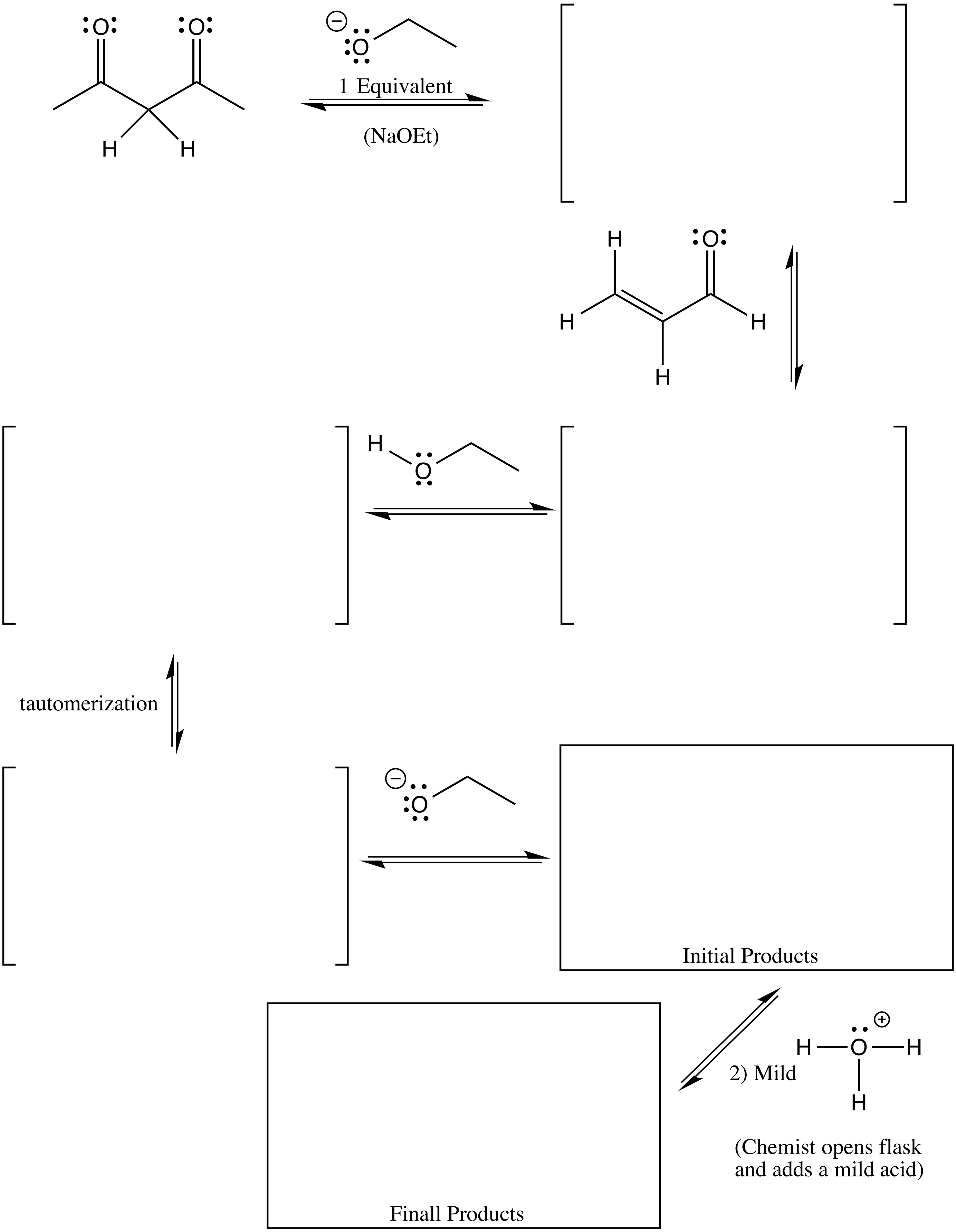
C) α,β unsaturated carbonyl compounds are conjugated, in that the pi electrons of the C=C and C=O bonds can delocalize over all four atoms. This lends some degree of extra stabilization to these species, because [pi electrons prefer to delocalize.]

D) Nucleophiles can, however, react at the β carbon atom in a process called conjugate addition.

E) Conjugate addition is favorable because the intermediate formed is a resonance stabilized enolate, thus relatively low energy.



Michael Reaction



Michael Reaction

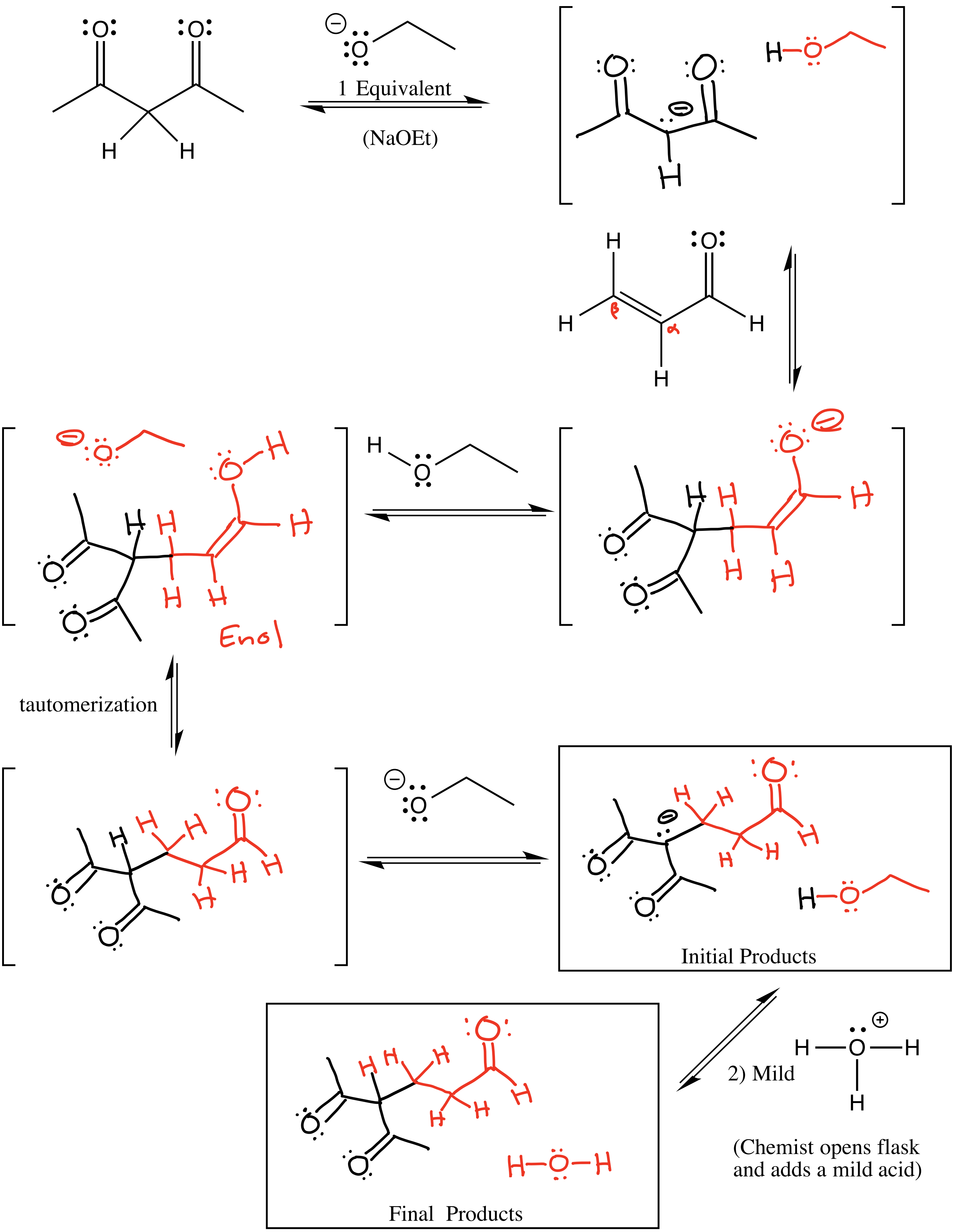
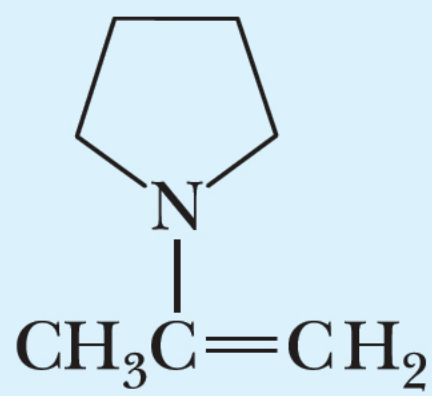
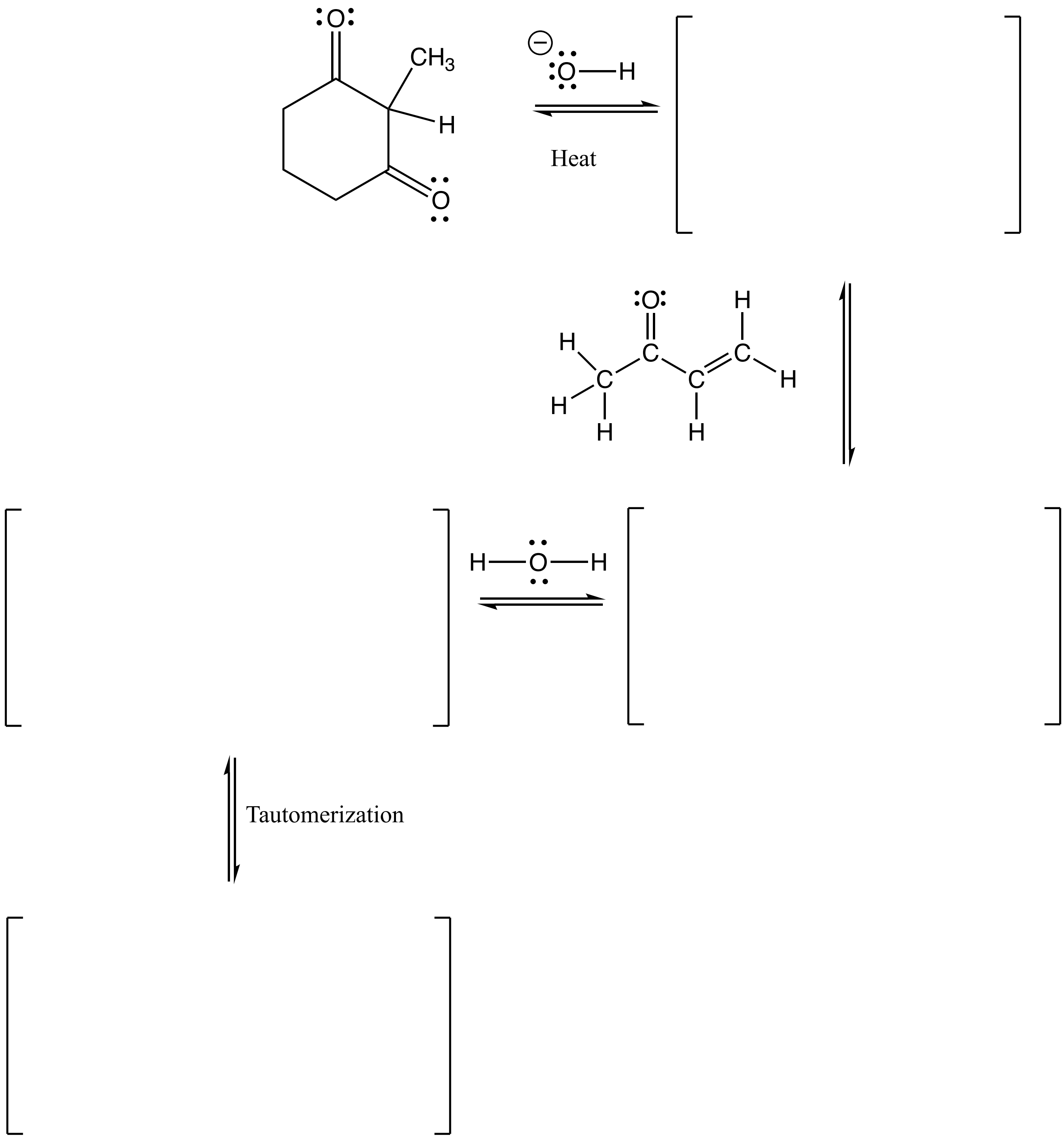


Table 19.1 Combinations of Reagents for Effective Michael Reactions

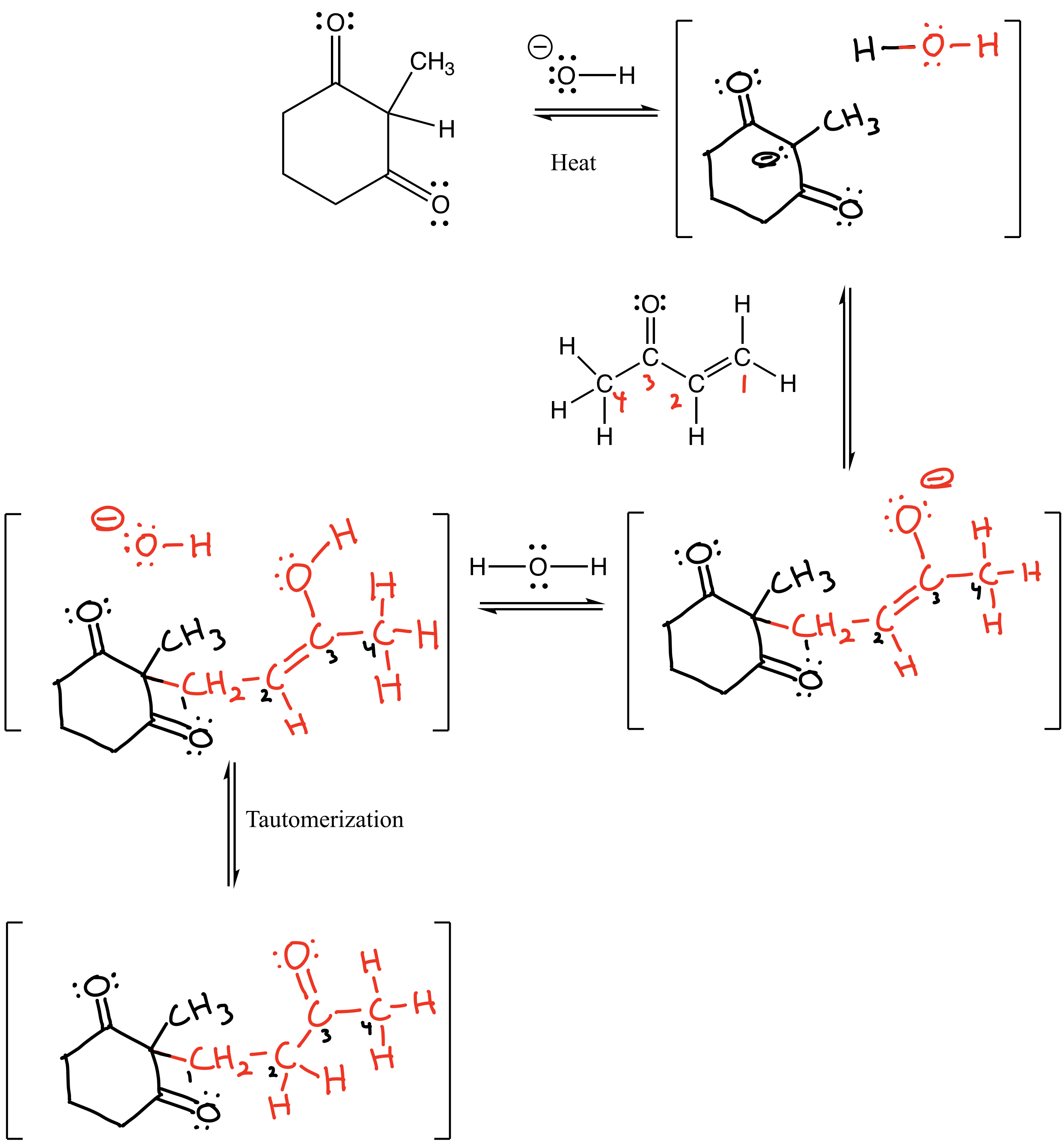
These Types of α,β-Unsaturated Compounds Are Nucleophile Acceptors in Michael Reactions		These Types of Compounds Provide Effective Nucleophiles for Michael Reactions	
$CH_2{=}CH\overset{\overset{O}{\|}}{C}H$	Aldehyde	$CH_3\overset{\overset{O}{\|}}{C}CH_2\overset{\overset{O}{\|}}{C}CH_3$	β-Diketone
$CH_2{=}CH\overset{\overset{O}{\|}}{C}CH_3$	Ketone	$CH_3\overset{\overset{O}{\|}}{C}CH_2\overset{\overset{O}{\|}}{C}OEt$	β-Ketoester
$CH_2{=}CH\overset{\overset{O}{\|}}{C}OEt$	Ester	$CH_3\overset{\overset{O}{\|}}{C}CH_2CN$	β-Ketonitrile
$CH_2{=}CH\overset{\overset{O}{\|}}{C}NH_2$	Amide	$EtO\overset{\overset{O}{\|}}{C}CH_2\overset{\overset{O}{\|}}{C}OEt$	β-Diester
$CH_2{=}CHC{\equiv}N$	Nitrile		Enamine
$CH_2{=}CHNO_2$	Nitro compound	NH_3, RNH_2, R_2NH	Amine

Robinson Annulation Part 1 - Michael Reaction Steps



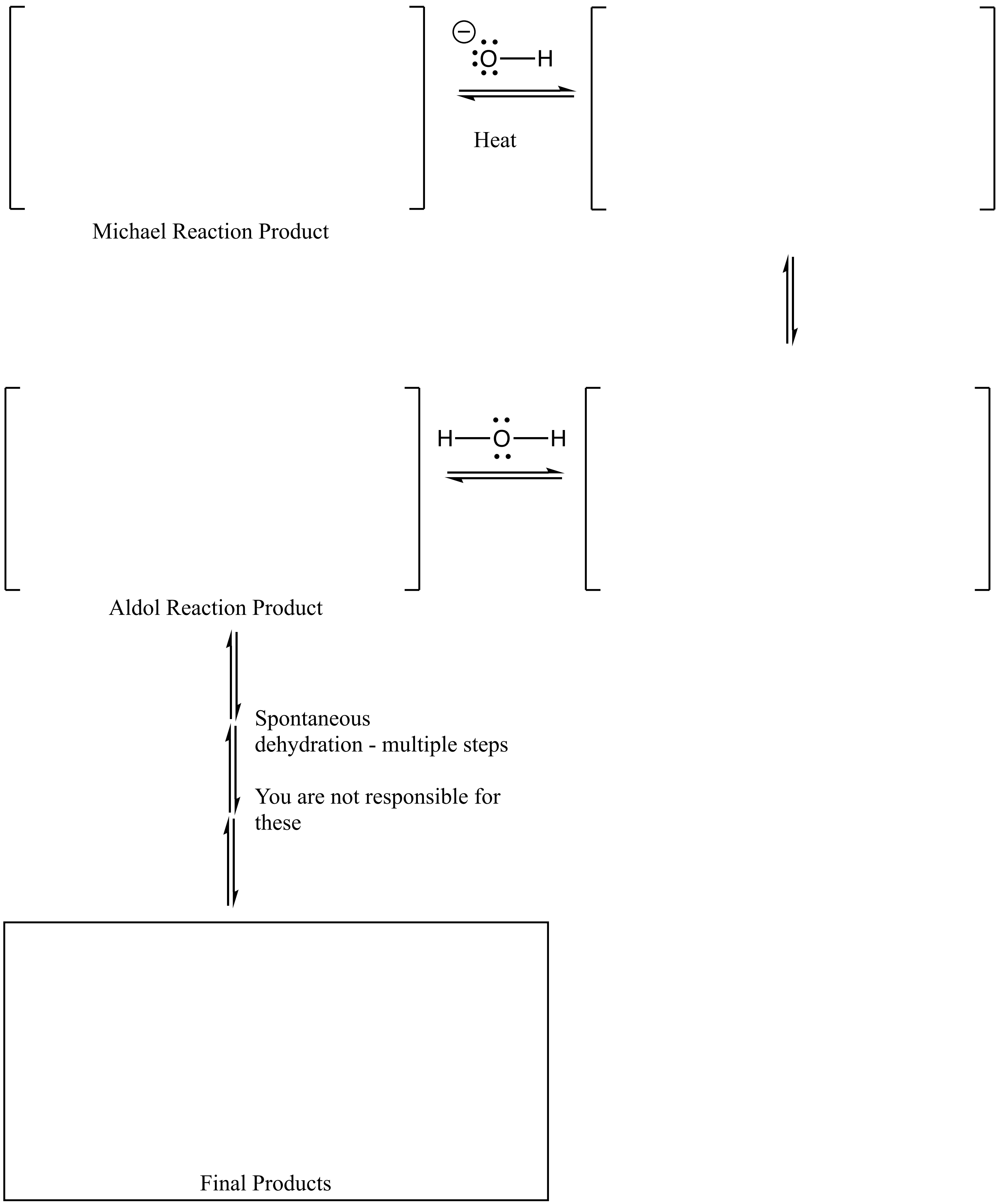
Michael Reaction Product

Robinson Annulation Part 1 - Michael Reaction Steps

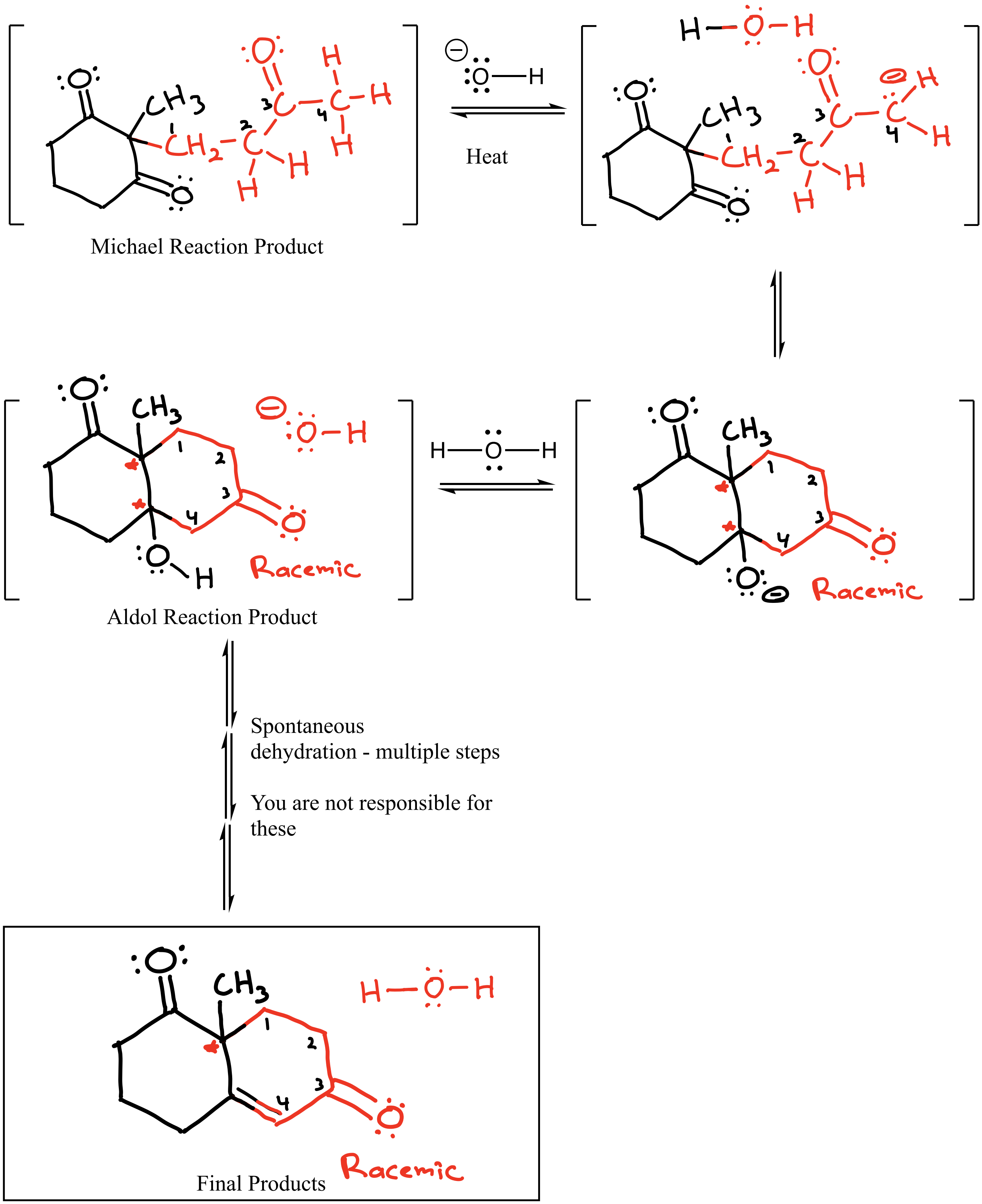


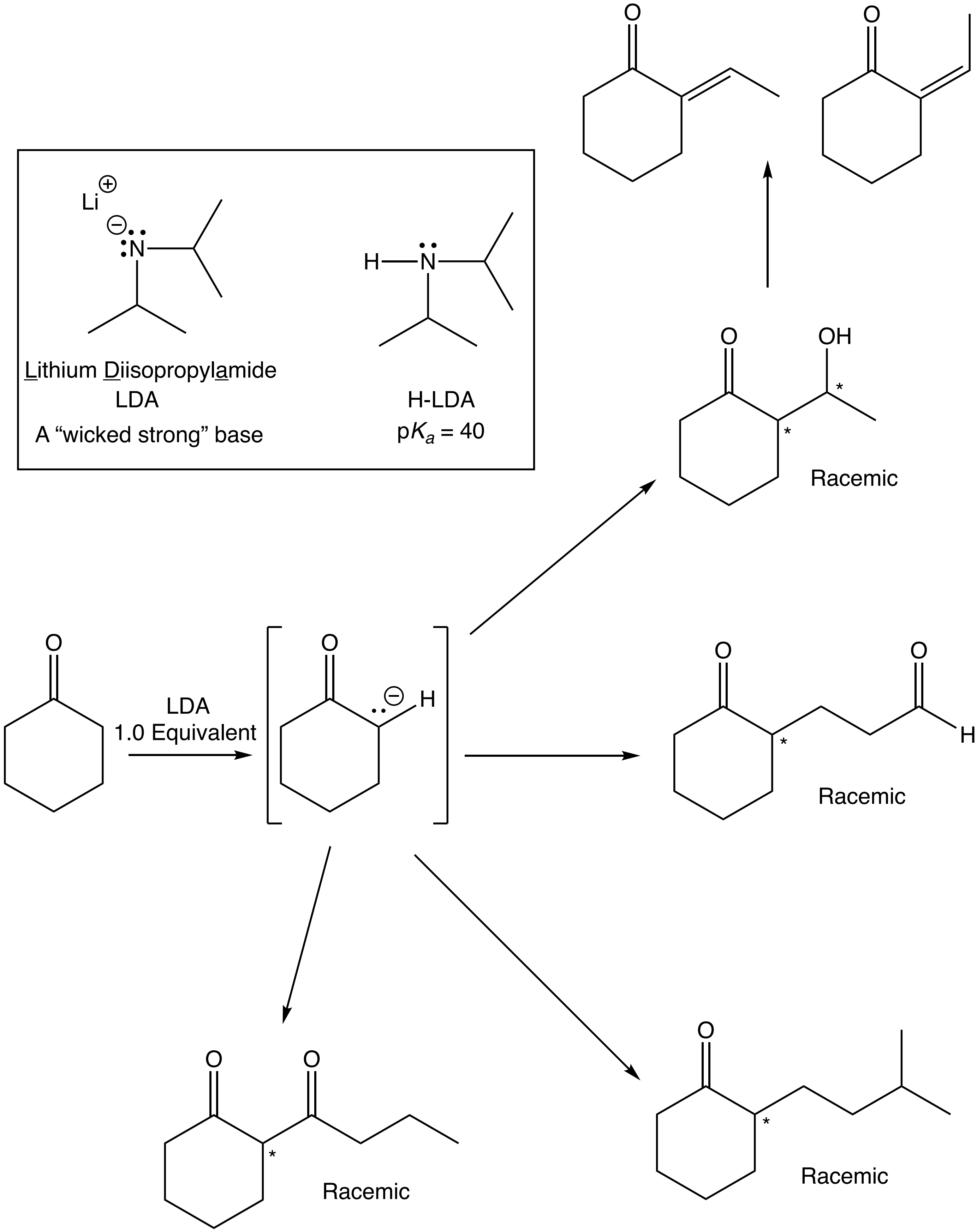
Michael Reaction Product

Robinson Annulation Part 2 - Aldol and Dehydration Steps



Robinson Annulation Part 2 - Aldol and Dehydration Steps





Li
N
H
N
Lithium Diisopropylamide
LDA
A “wicked strong” base
H-LDA
pK_a = 40
O
LDA
1.0 Equivalent
O
H
O
OH
Racemic
O
O
H
Racemic
O
O
Racemic
O
Racemic
O
O

β-Substituted aldehydes, nitriles, ketones, or esters

α,β-Unsaturated, nitriles, ketones, or esters

β-Keto esters

α,β-Unsaturated aldehydes

Acid Chlorides

β-Hydroxy aldehydes

Aldehydes

Ketones

Carboxylic esters

β-Ketoaldehyde

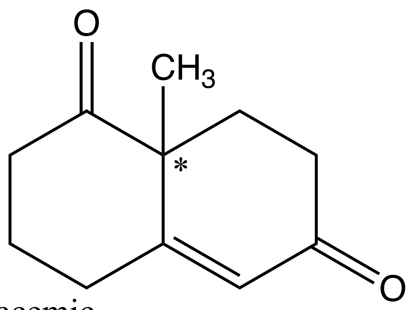
β-Diketone

Carboxylic acids

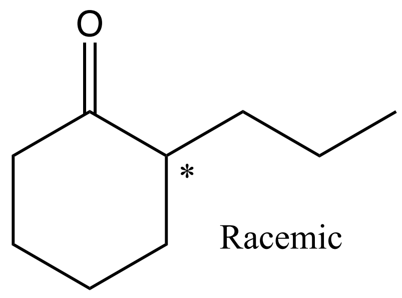
Substituted aldehyde

Substituted ketone

β-Diester



Racemic



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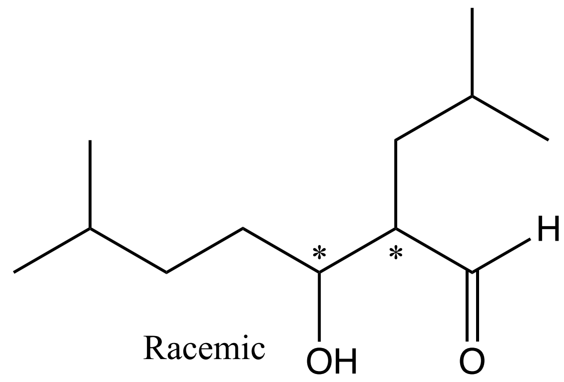

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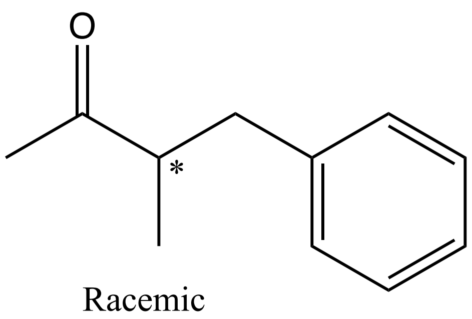

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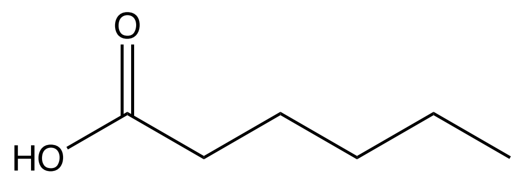

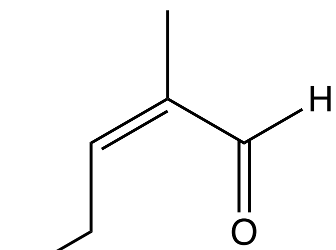

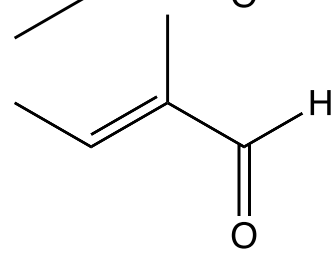

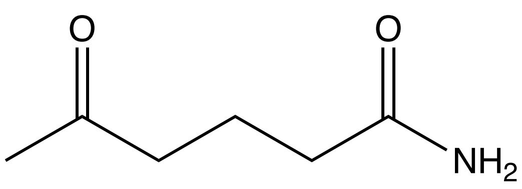

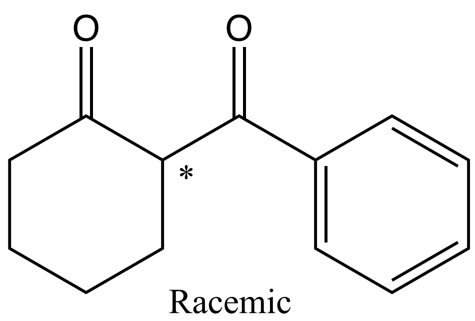

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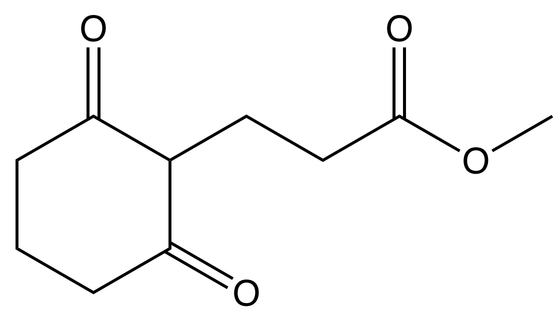

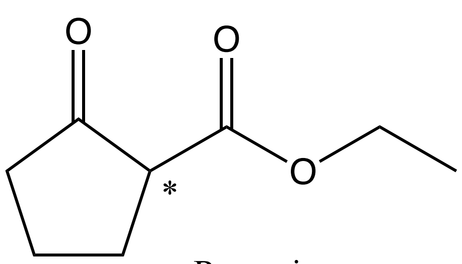

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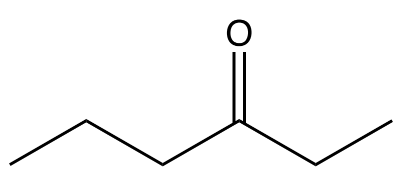

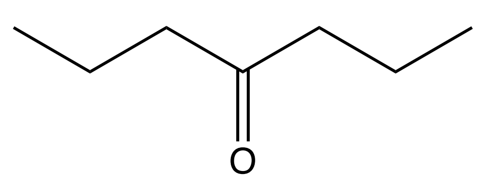

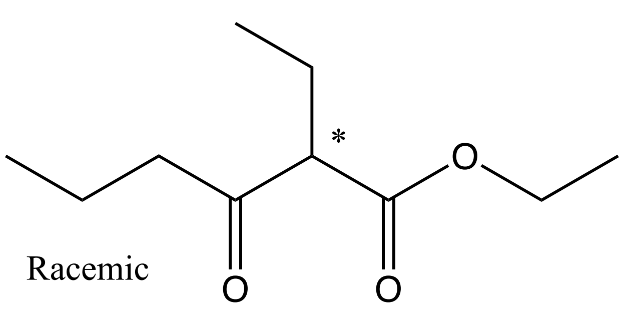

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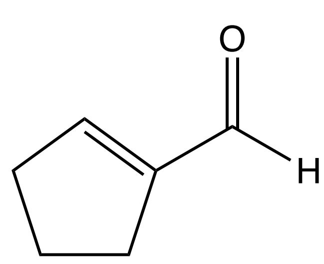
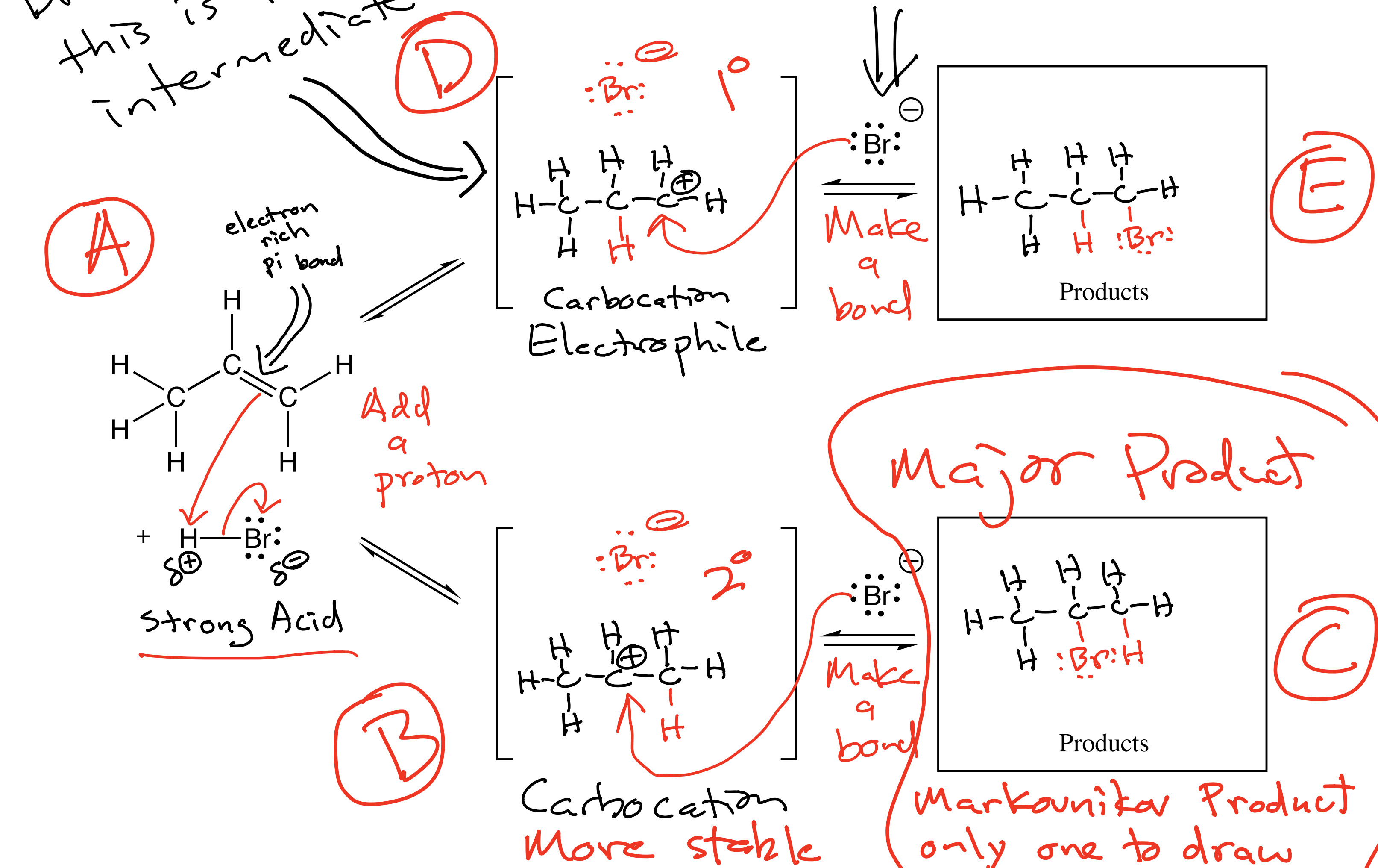


"X" can be Cl, Br, I
Not F

Addition of H-X to an Alkene



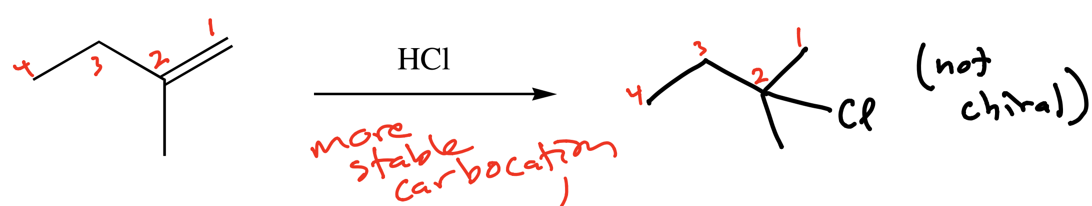
Which constitutional isomer is formed?

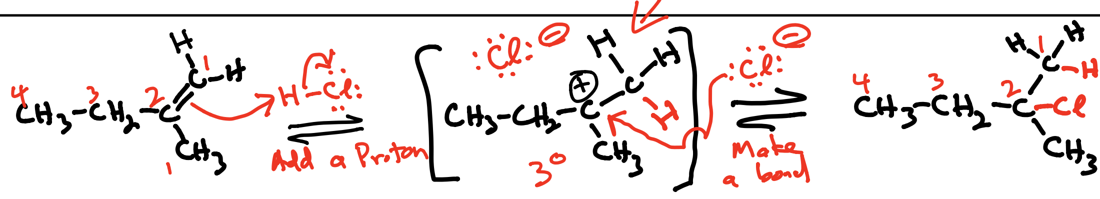
Summary: Alkene pi bond reacts with H-X to add a proton to create a carbocation intermediate that makes a bond with X⊖ to give the product

Regiochemistry: Markovnikov's Rule

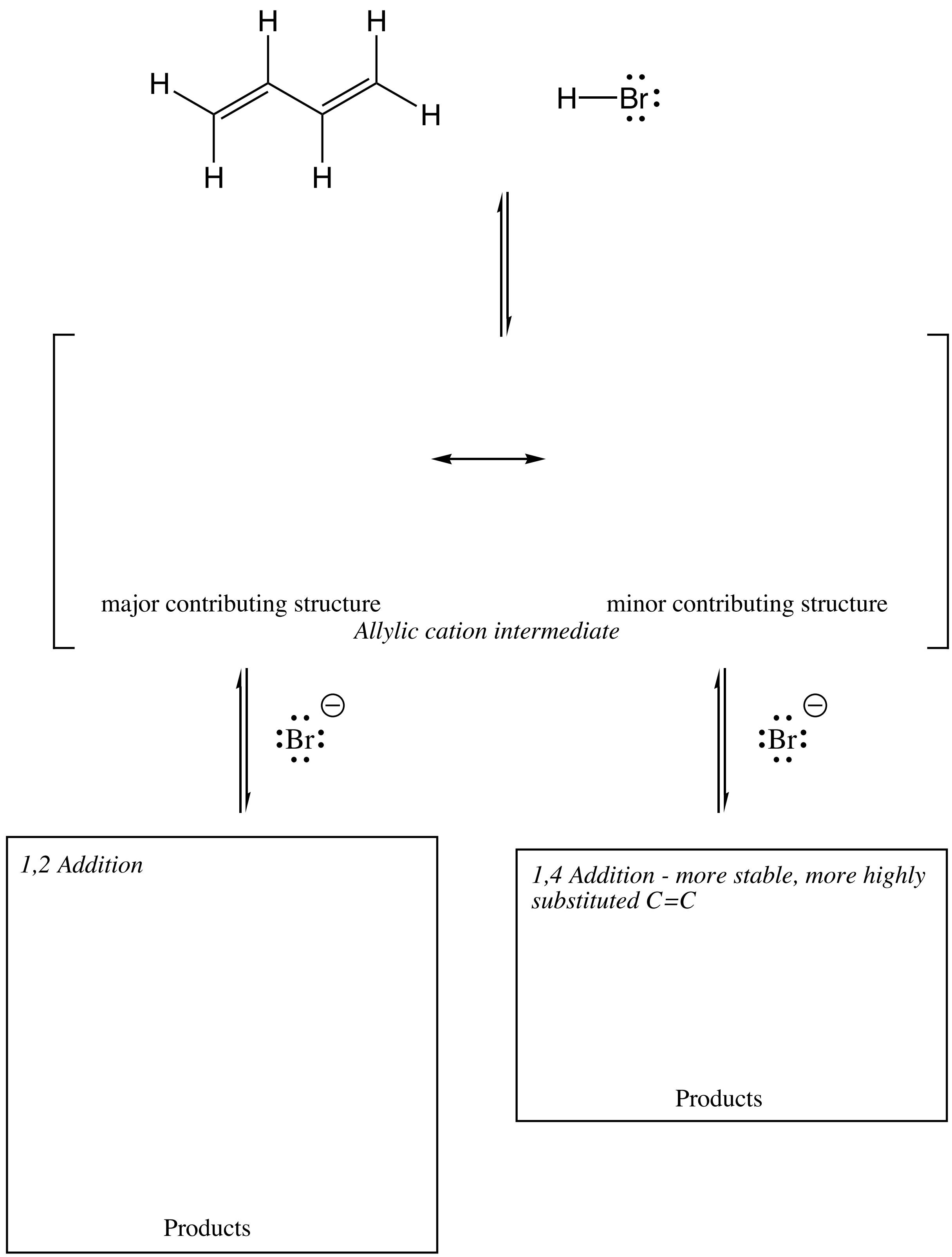
Stereochemistry: Mixed (time capsule) → Racemic Product

Example:

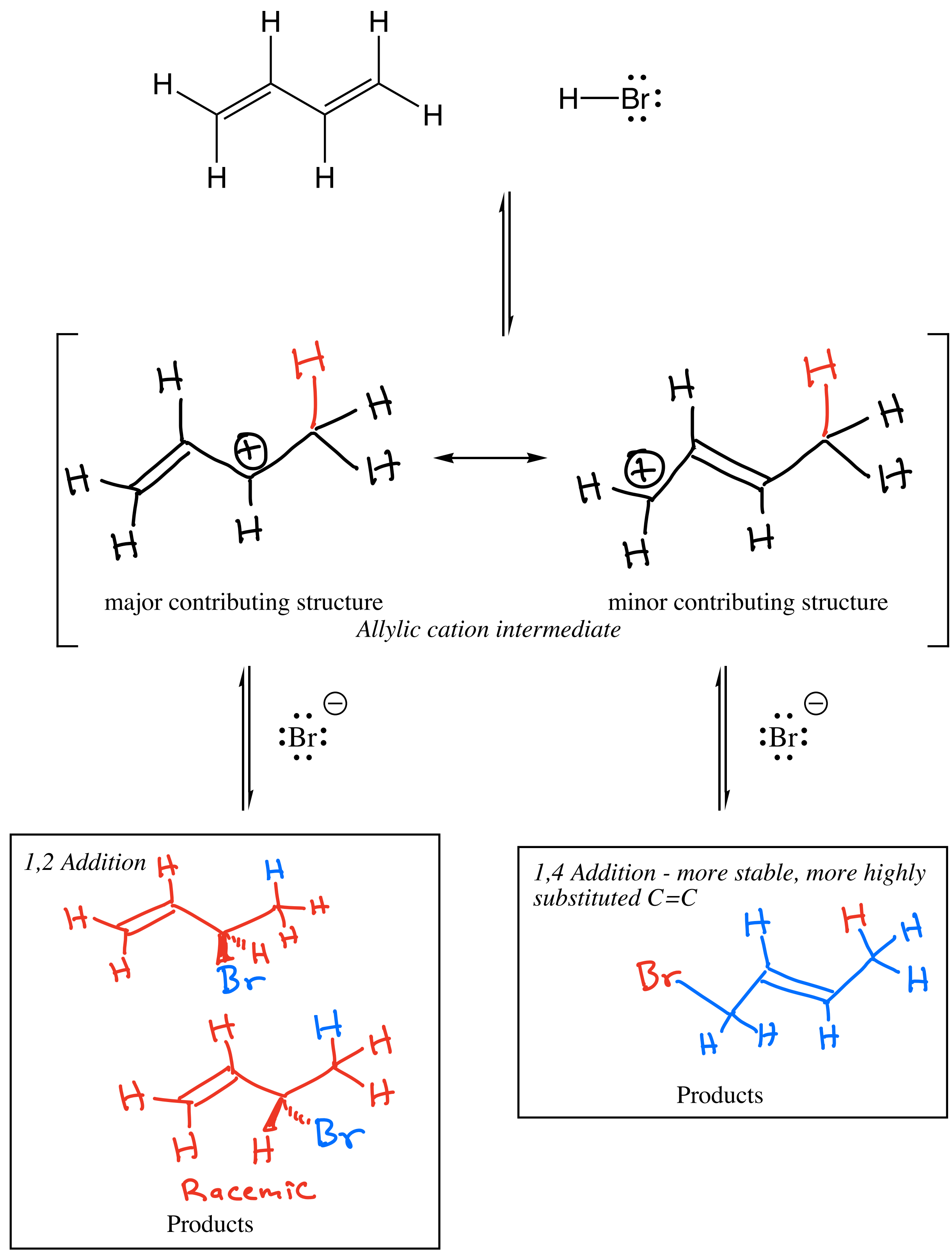


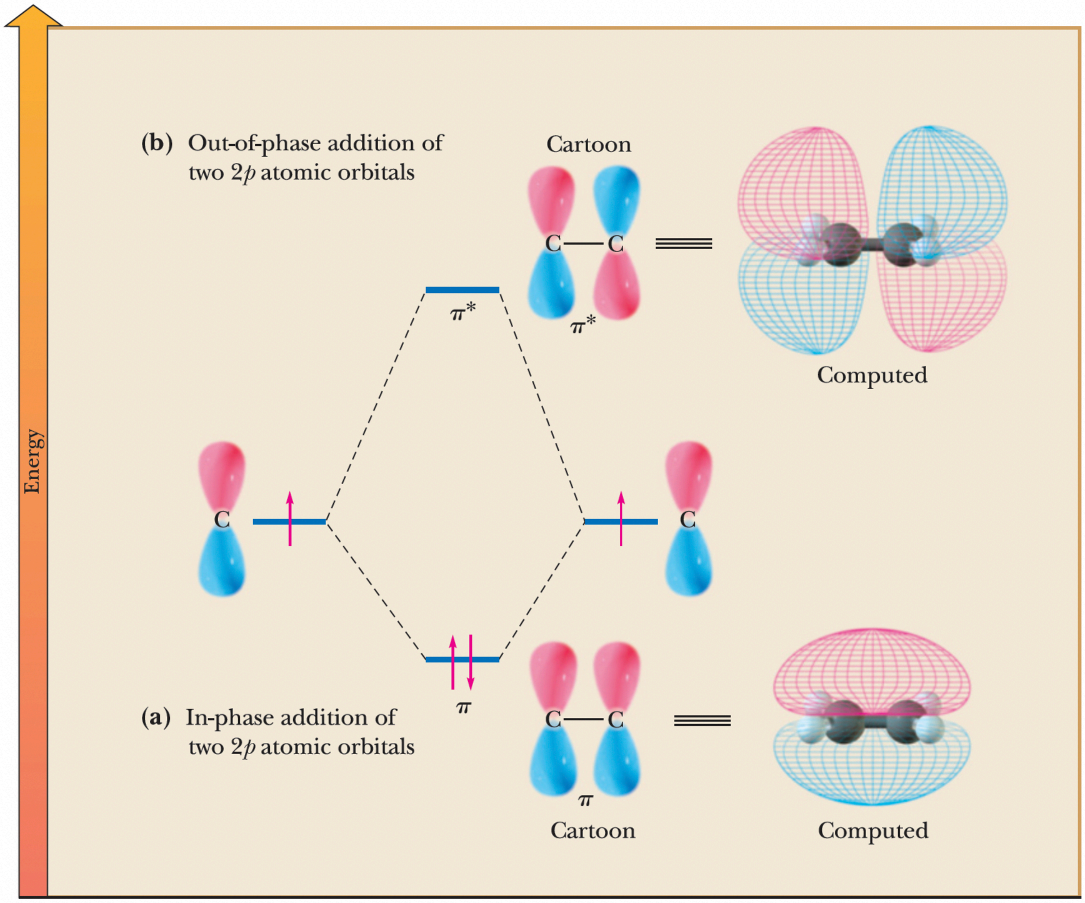


H-X reacting with conjugated dienes



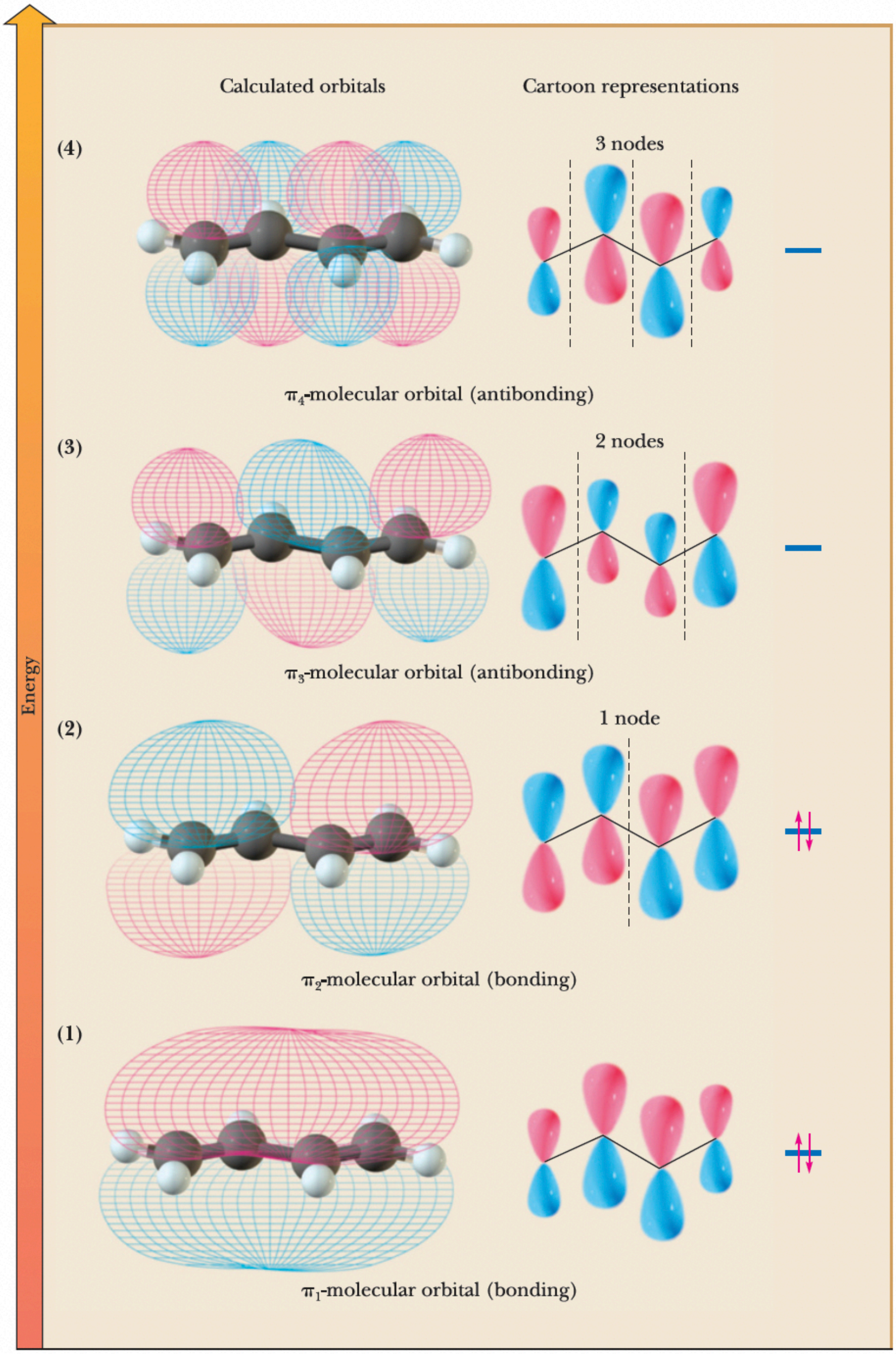
H-X reacting with conjugated dienes





Watch a video explanation

FIGURE 1.21 Molecular orbital mixing diagram for the creation of any C—C π bond. (a) Addition of two p atomic orbitals in phase leads to a π orbital that is lower in energy than the two separate starting orbitals. When populated with two electrons, the π orbital gives a π bond. (b) Addition of the p orbitals in an out-of-phase manner (meaning a reversal of phasing in one of the starting orbitals) leads to a π^* orbital. Population of this orbital with one or two electrons leads to weakening or cleavage of the π bond, respectively.



Watch a video explanation

FIGURE 20.2 Structure of 1,3-butadiene—molecular orbital model. Combination of four parallel 2*p* atomic orbitals gives two *π*-bonding MOs and two *π*-antibonding MOs. In the ground state, each *π*-bonding MO is filled with two spin-paired electrons. The *π*-antibonding MOs are unoccupied.