

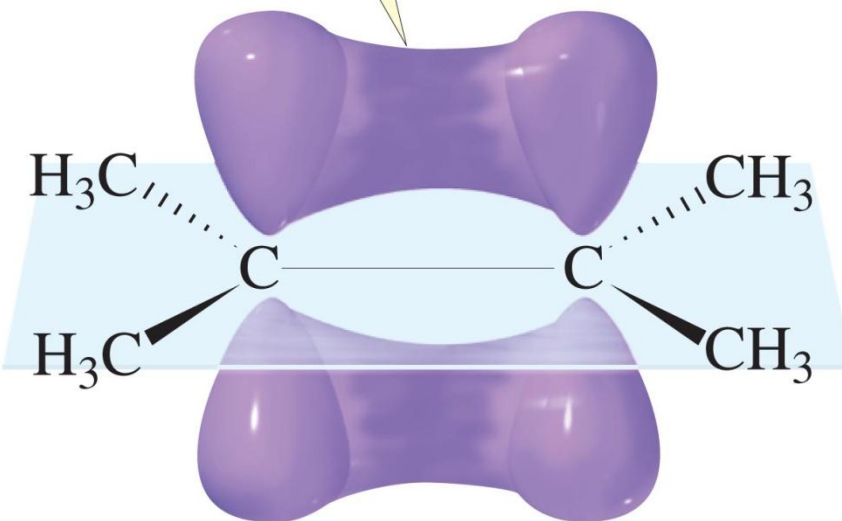
Organic Chemistry
2th Edition
Paula Yurkanis Bruice

Chapter 4

Alkenes:

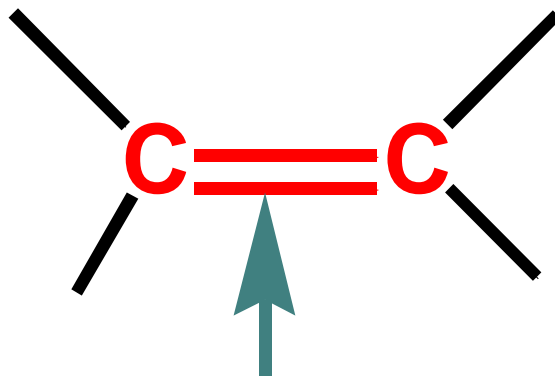
Structures, Nomenclature, and
an Introduction to Reactivity

p orbitals overlap to form
a π bond



Alkenes

Hydrocarbons containing double bonds



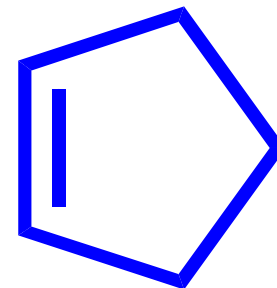
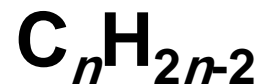
double bond
the functional group
center of reactivity

4.1 Molecular Formula of Alkene

Acyclic alkene:



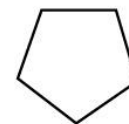
Cyclic alkene:



an alkane



an alkene



a cyclic alkane

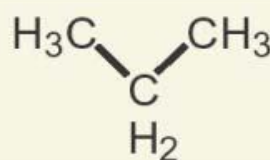
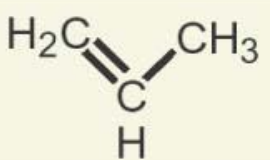
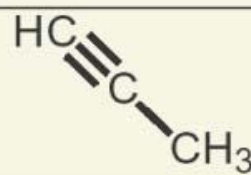
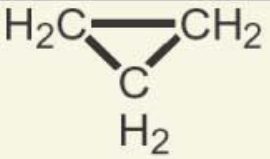
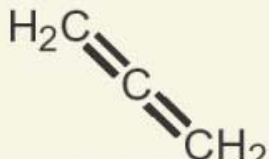


a cyclic alkene



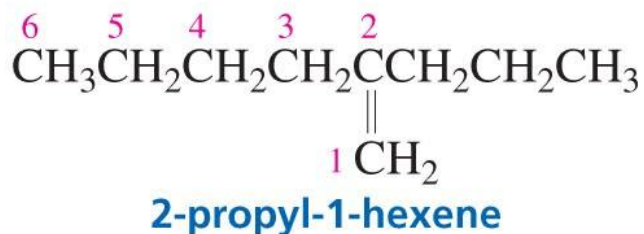
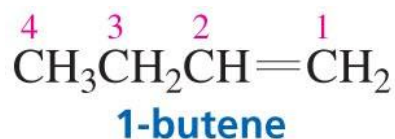
Degree of Unsaturation

- Relates molecular formula to possible structures
- Degree of unsaturation: number of multiple bonds or rings

0	1	2
		
		
C_3H_8	C_3H_6	C_3H_4

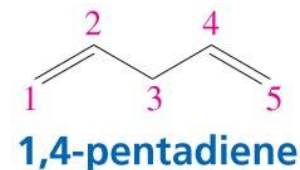
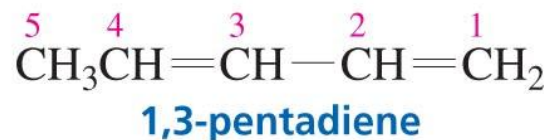
4.2 Systematic Nomenclature of Alkenes

1. Longest continuous chain containing the functional group:



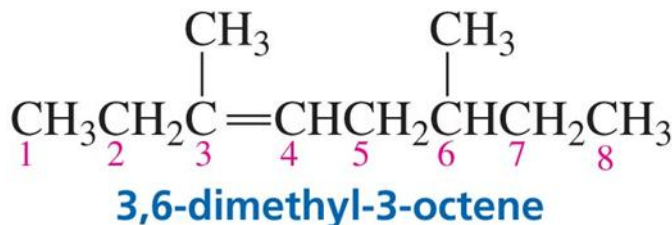
the longest continuous chain has eight carbons but the longest continuous chain containing the functional group has six carbons, so the parent name of the compound is hexene

2. For a compound with two double bonds, the suffix is “diene”:

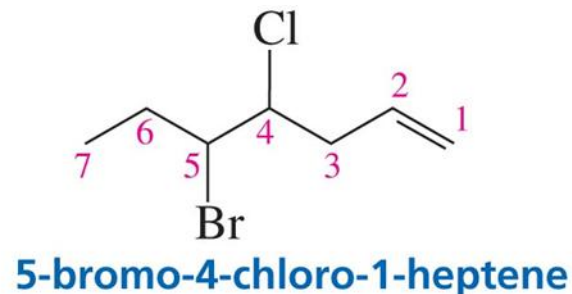


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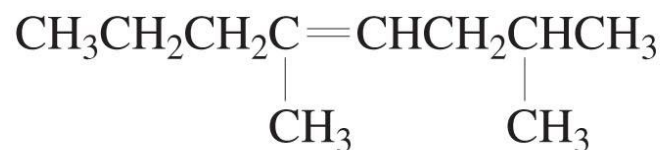
3. When there are both a functional group and a substituent, the functional group gets the lowest number:



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4. Name with the lowest functional group number and then the lowest substituent numbers:



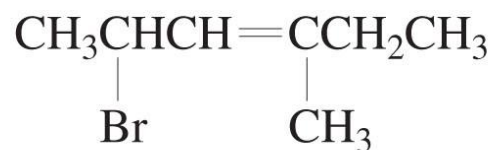
2,5-dimethyl-4-octene

not

4,7-dimethyl-4-octene

because $2 < 4$

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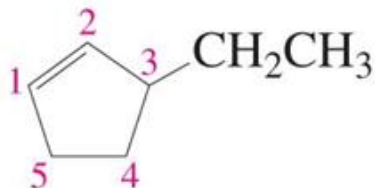
2-bromo-4-methyl-3-hexene

not

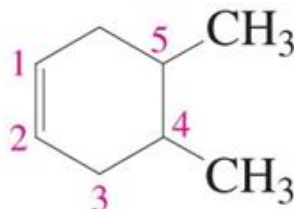
5-bromo-3-methyl-3-hexene

because $2 < 3$

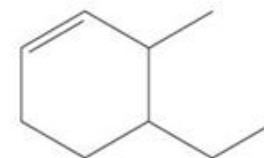
5. In a cyclic alkene, the alkene functional group is given the number 1, but the -1- is left out of the name:



3-ethylcyclopentene



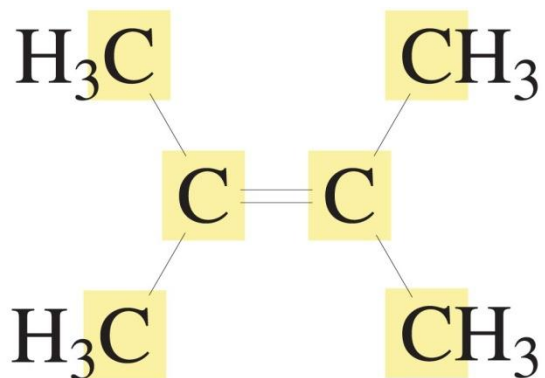
4,5-dimethylcyclohexene



4-ethyl-3-methylcyclohexene

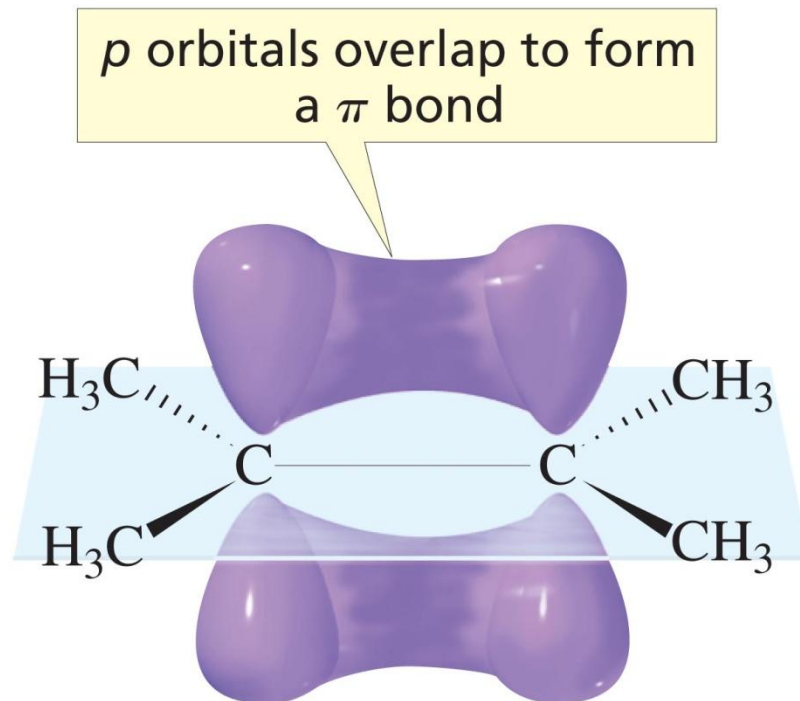
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4.3 Structure of Alkene



**the six carbon atoms
are in the same plane**

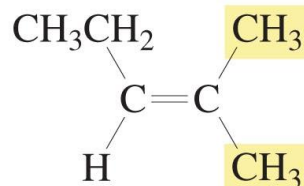
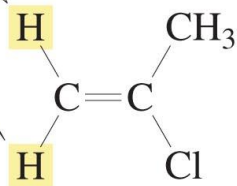
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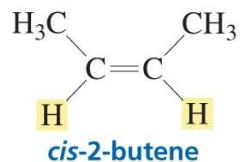
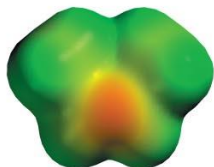
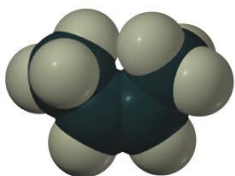
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4.4 Alkene Isomers

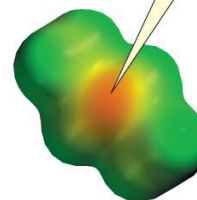
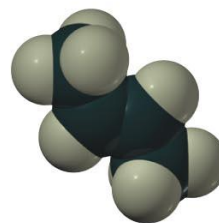
cis and trans isomers are not possible for these compounds because two substituents on an sp^2 carbon are the same



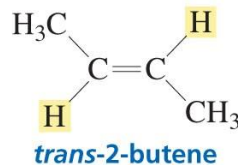
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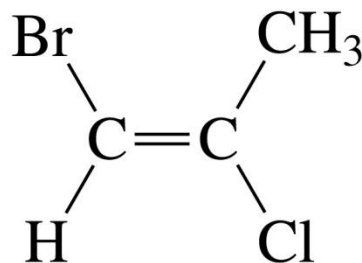
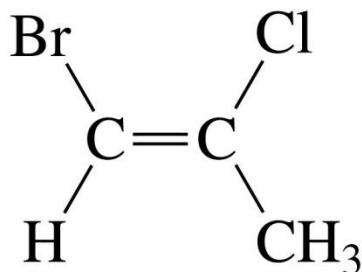
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electron-rich region, signaling the presence of a double bond

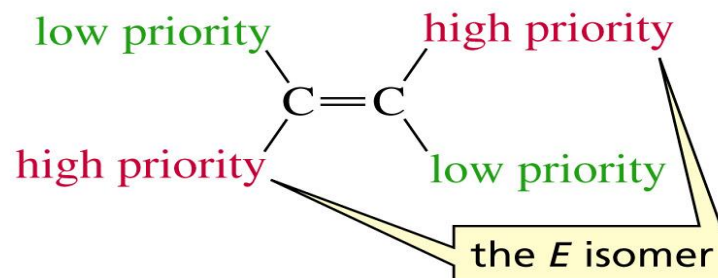
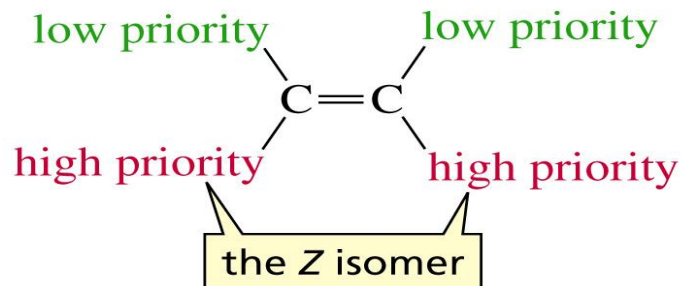


4.5 Sequence Rules: The *E,Z* Designation



Which isomer is cis and which is trans?

E and *Z* Isomers

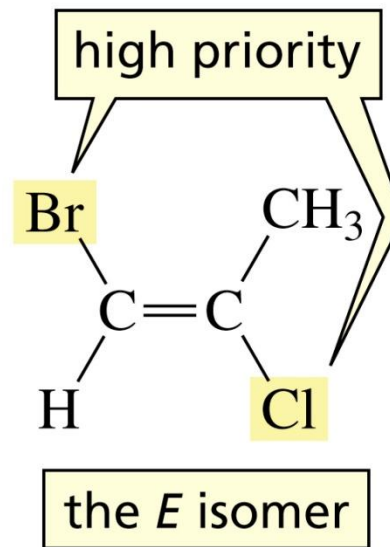
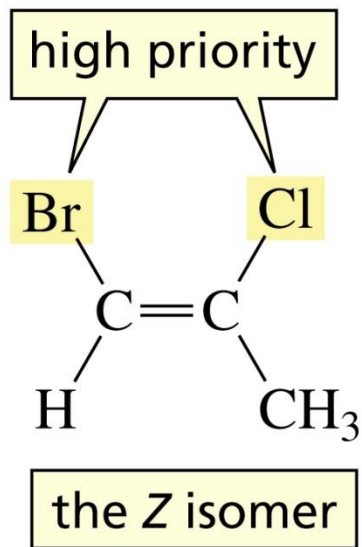


***Z* - *zusammen*,**
together on the same side

***E* - *entgegen*,**
opposite sides

Ranking Priorities: Cahn-Ingold-Prelog Rules

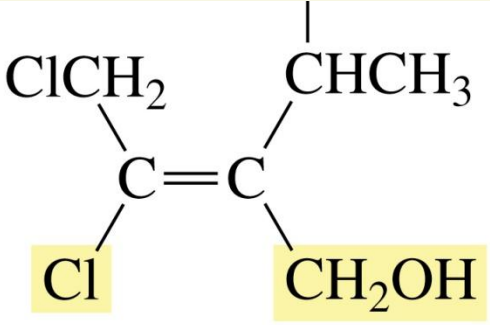
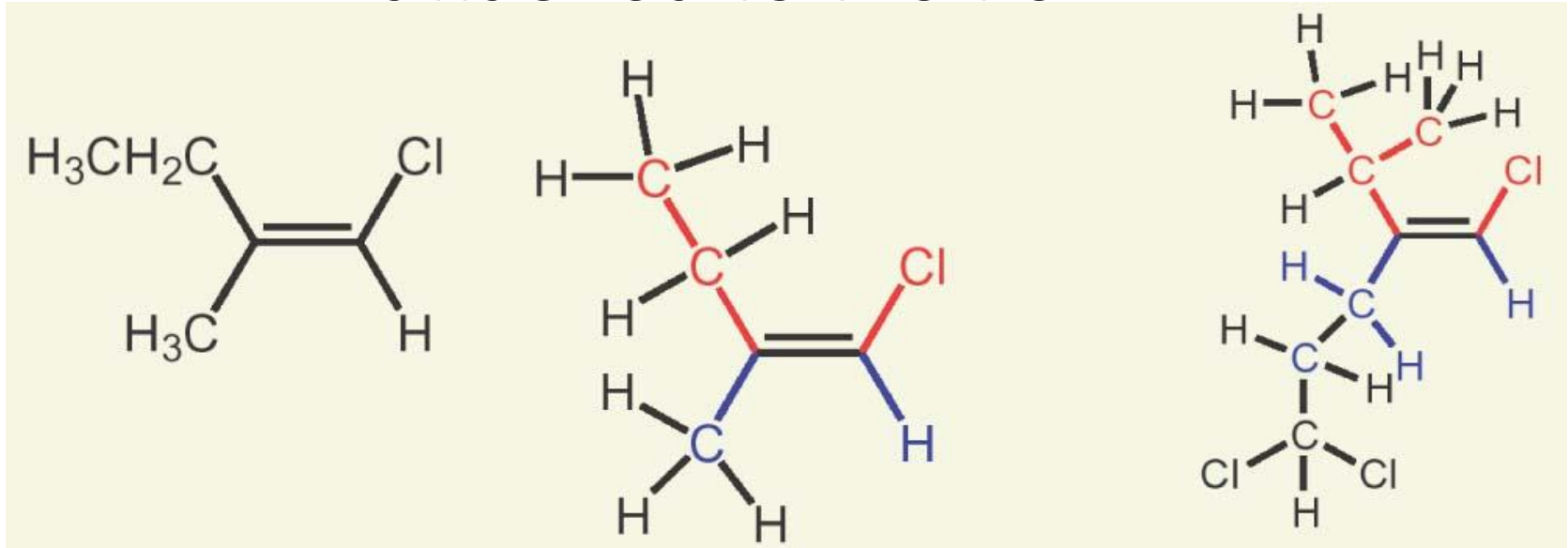
Rule 1: Consider the atomic number of the atoms bonded directly to a specific sp^2 carbon



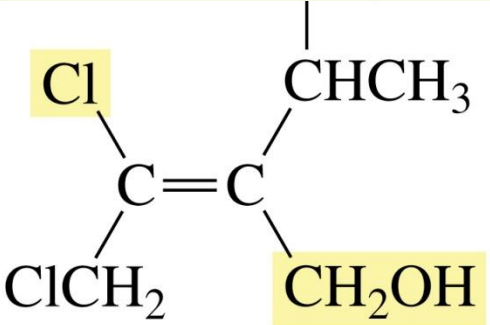
Higher atomic number has higher priority



Rule 2: If there is a tie, consider the atoms attached to the tie

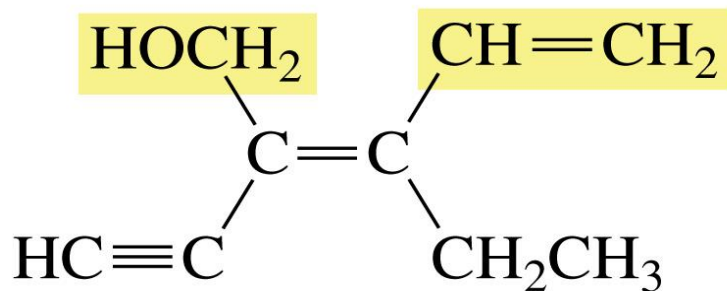
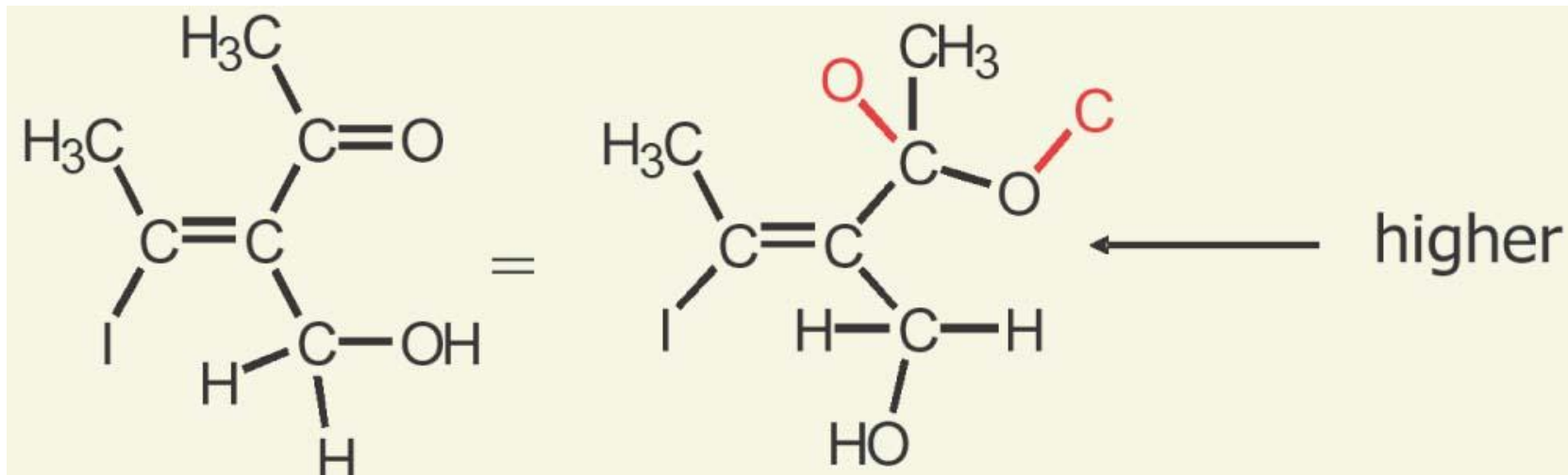


the Z isomer

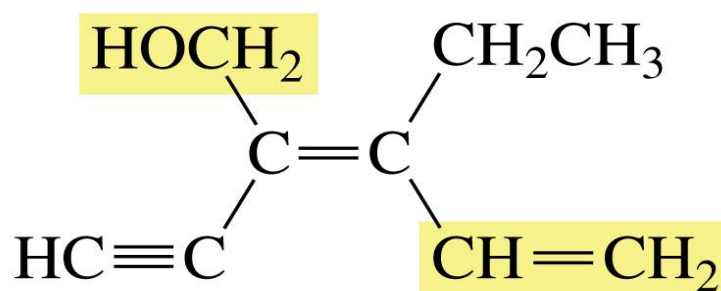


the E isomer

Rule 3: Multiple bonds are treated as attachment of multiple single bonds



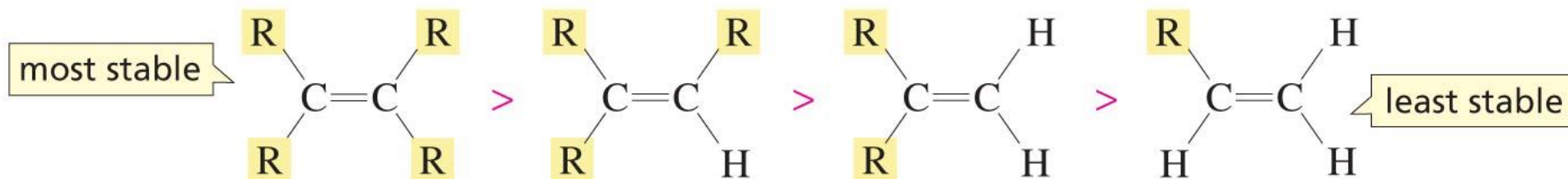
the *Z* isomer



the *E* isomer

4.6 Relative Stabilities of Alkyl-Substituted Alkenes

relative stabilities of alkyl-substituted alkenes

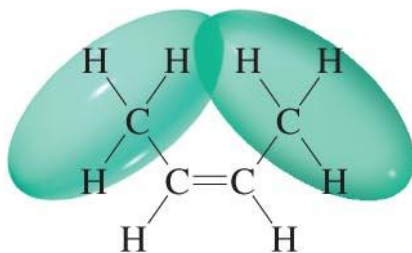


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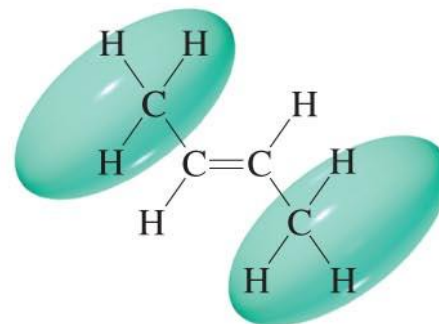
- Alkyl substituents stabilize alkenes
- The most stable alkene has the greatest number of alkyl groups bonded to its sp^2 carbon.

Steric Strain in Alkenes

the cis isomer has steric strain



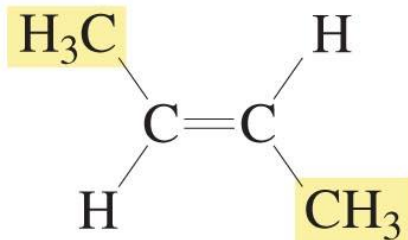
the trans isomer does not have steric strain



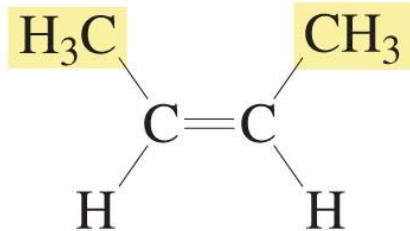
cis-2-butene

trans-2-butene

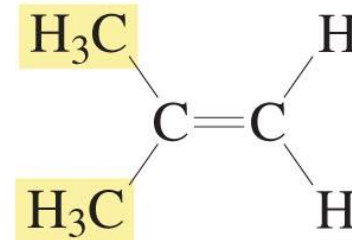
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alkyl substituents
are trans



alkyl substituents
are cis



alkyl substituents
are on the same sp^2 carbon

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