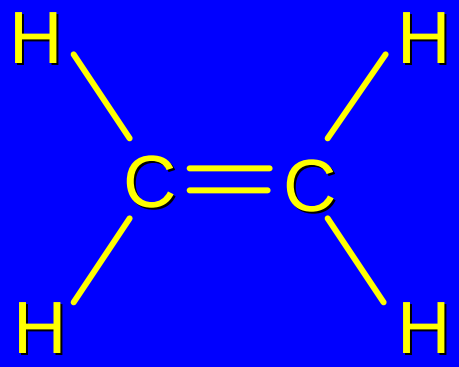
5.5
Physical Properties of Alkenes

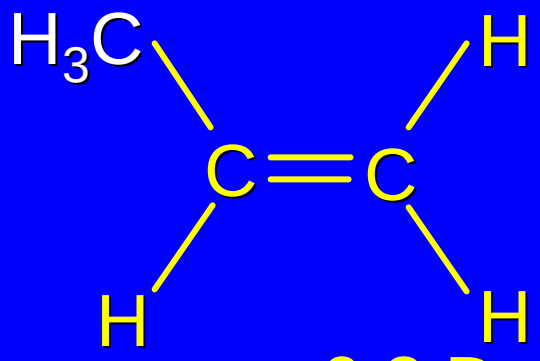
Dipole moments

What is direction of dipole moment?

Does a methyl group donate electrons to the double bond, or does it withdraw them?

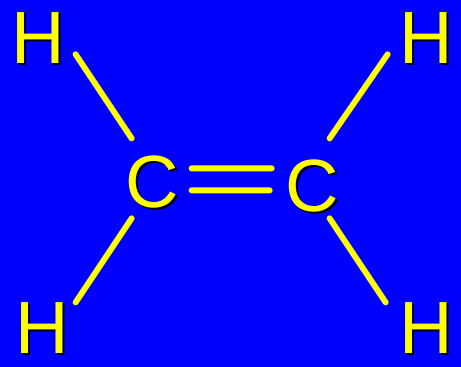


m = 0 D



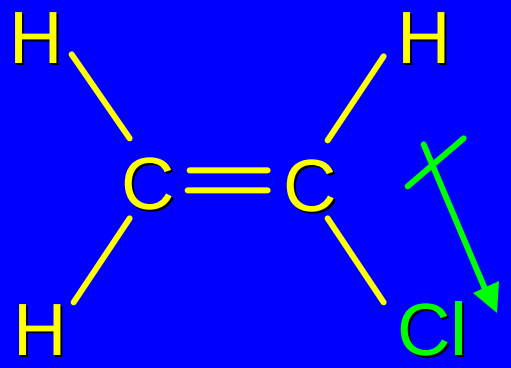
m = 0.3 D

Dipole moments

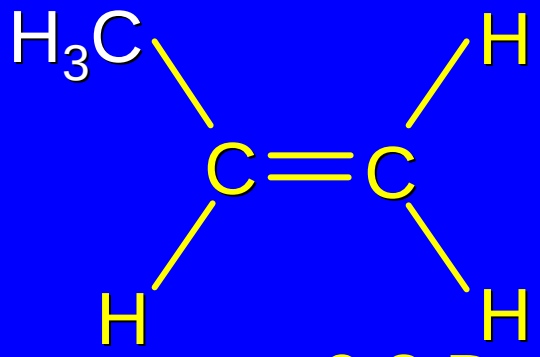


m = 0 D

m = 1.4 D



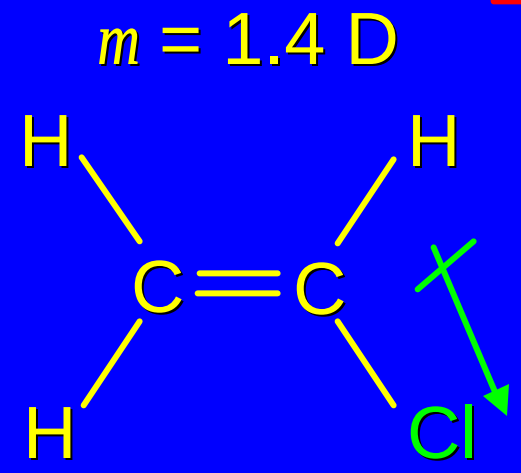
Chlorine is electronegative and attracts electrons.

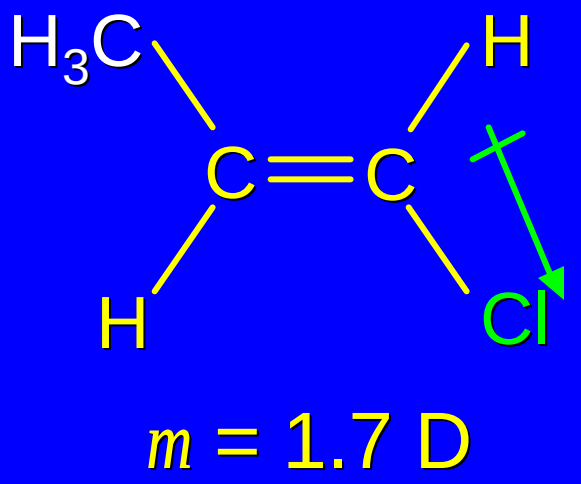


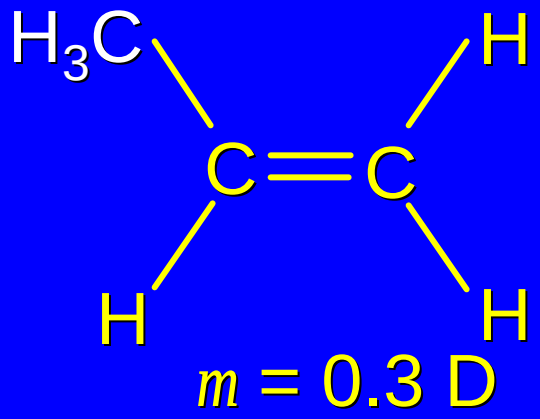
m = 0.3 D

Dipole moments

Dipole moment of 1-chloropropene is equal to the sum of the dipole moments of vinyl chloride and propene.

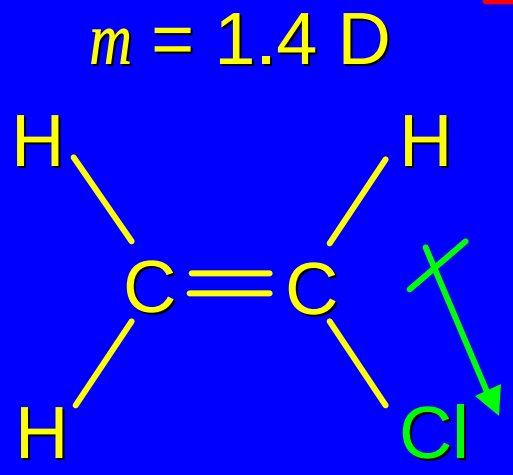


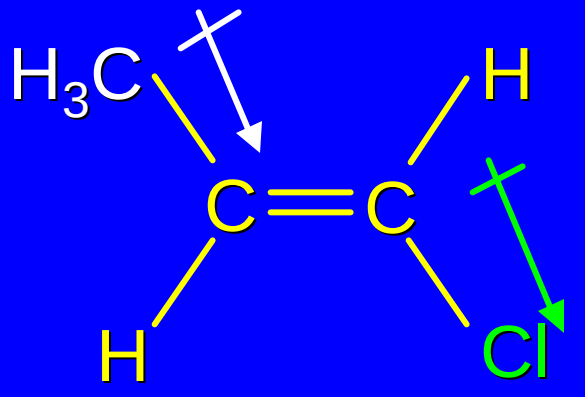




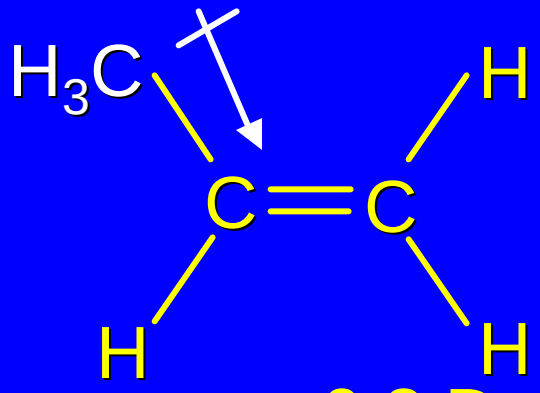
Dipole moments

Therefore, a methyl group donates electrons to the double bond.



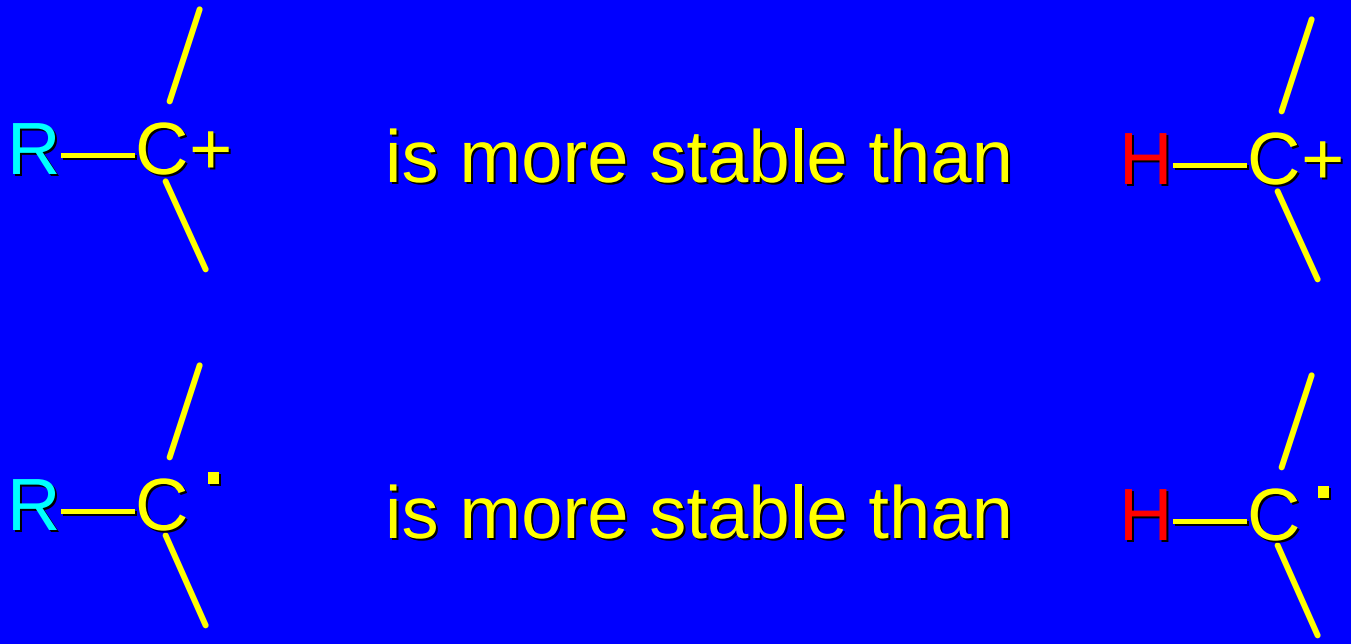


m = 1.7 D

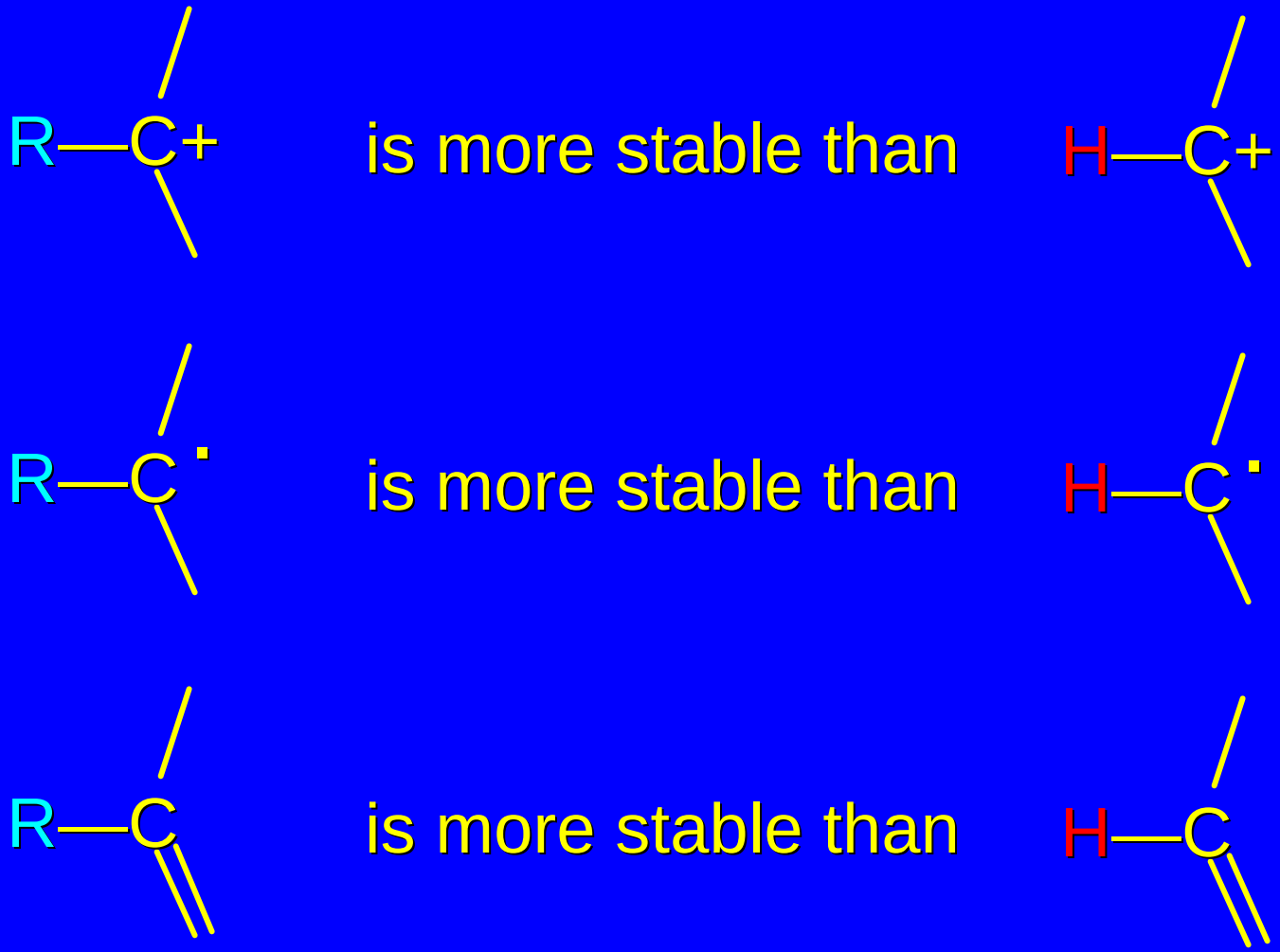


m = 0.3 D

Alkyl groups stabilize sp^2 hybridized carbon by releasing electrons

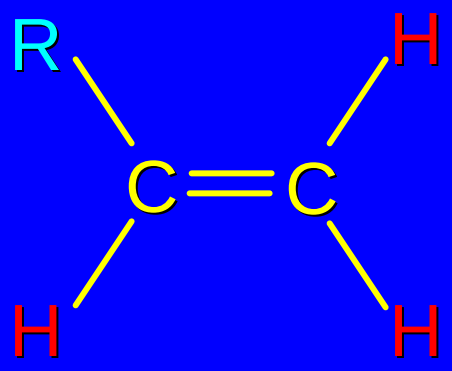


Alkyl groups stabilize sp^2 hybridized carbon by releasing electrons

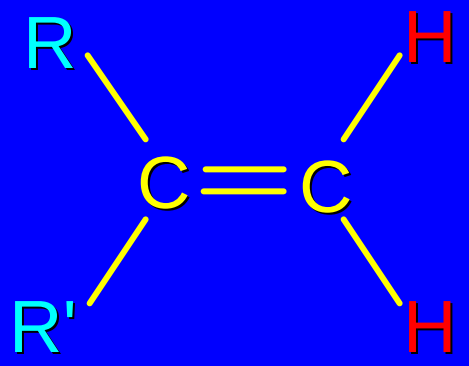


5.6
Relative Stabilities of Alkenes

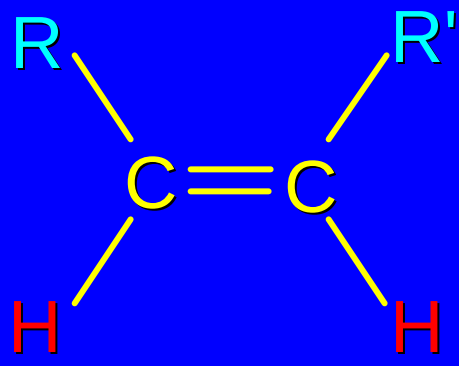
Double bonds are classified according to the number of carbons attached to them.



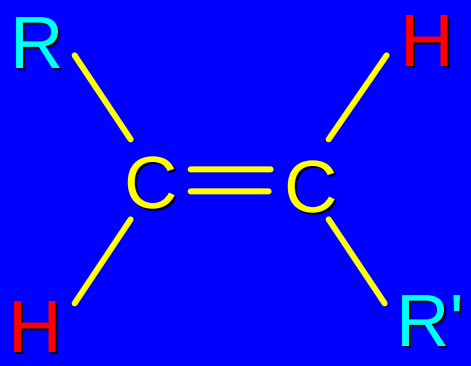
monosubstituted



disubstituted

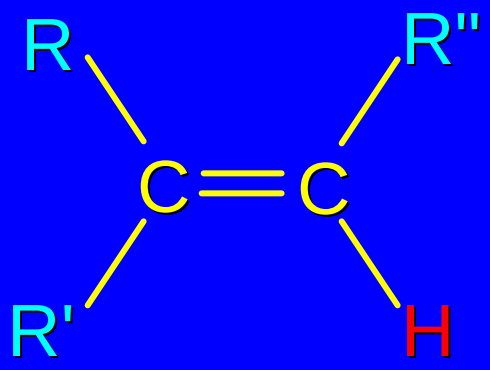


disubstituted

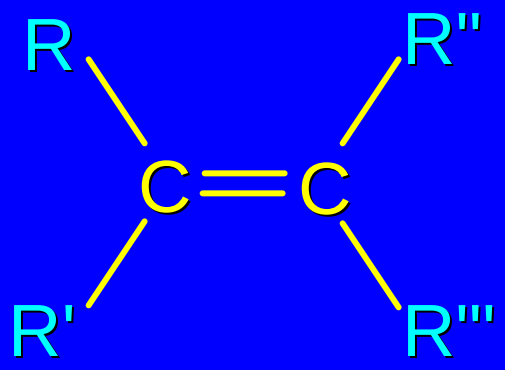


disubstituted

Double bonds are classified according to the number of carbons attached to them.



trisubstituted



tetrasubstituted

Substituent Effects on Alkene Stability

Electronic

disubstituted alkenes are more stable than monosubstituted alkenes

Steric

trans alkenes are more stable than *cis* alkenes

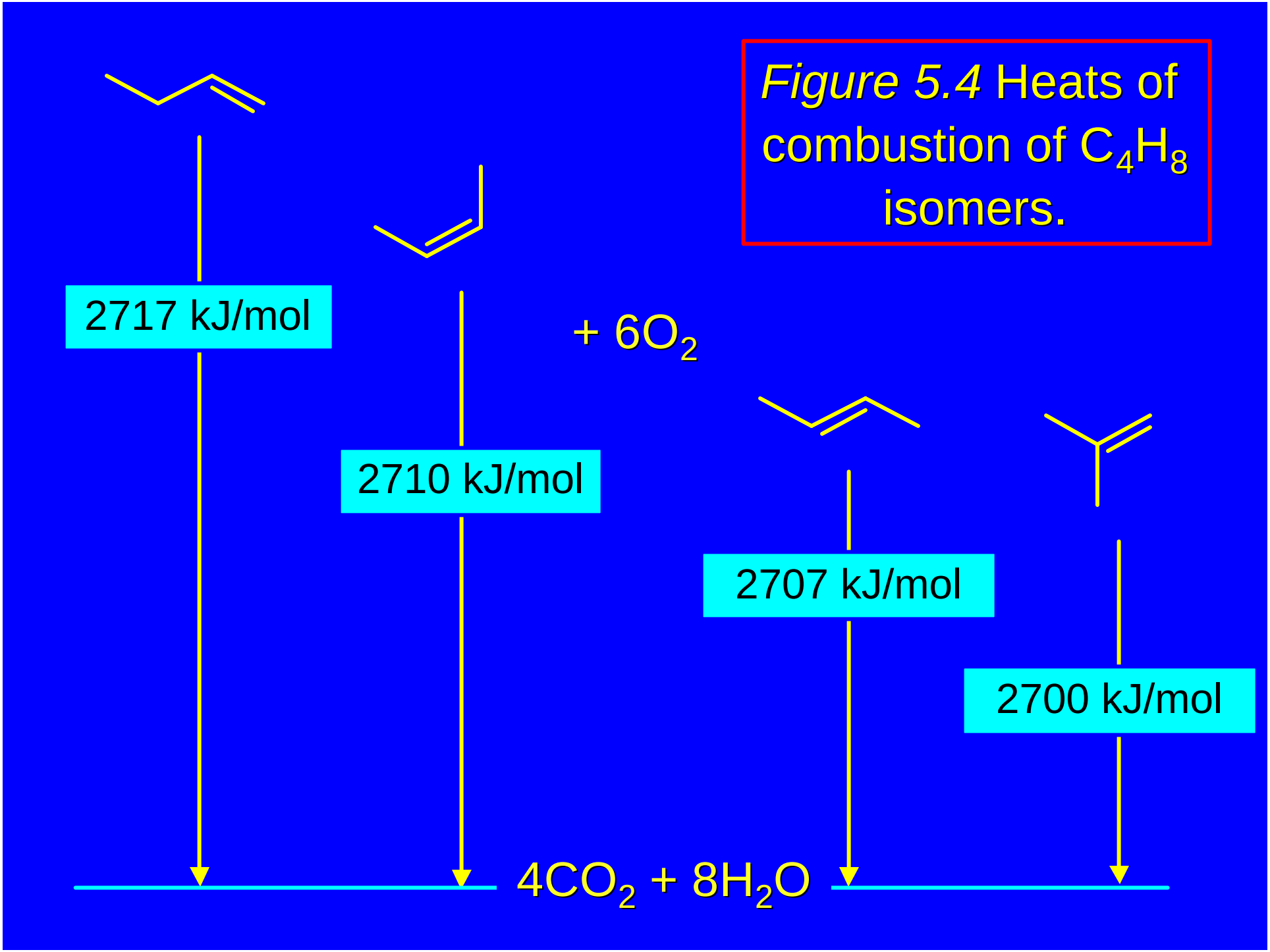


Figure 5.4 Heats of combustion of C_4H_8 isomers.

Substituent Effects on Alkene Stability

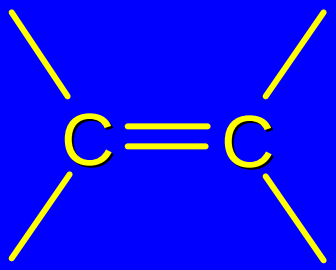
Electronic

alkyl groups stabilize double bonds more than H

more highly substituted double bonds are more stable than less highly substituted ones.

Problem 5.8

Give the structure or make a molecular model of the most stable C_6H_{12} alkene.



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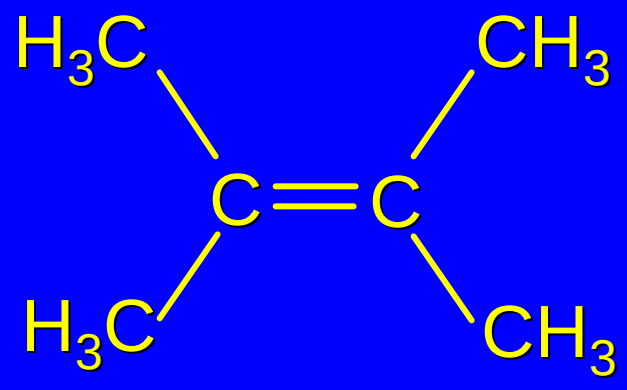
Give the structure or make a molecular model of the most stable C_6H_{12} alkene.



Substituent Effects on Alkene Stability

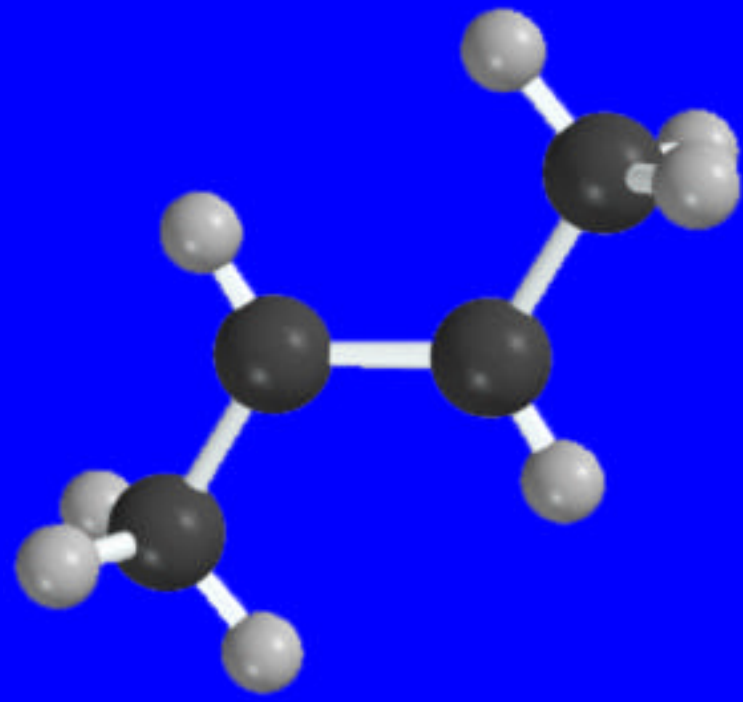
Steric effects

trans alkenes are more stable than *cis* alkenes

cis alkenes are destabilized by van der Waals strain

Figure 5.5
cis and trans-2-Butene

van der Waals strain due to crowding of cis-methyl groups

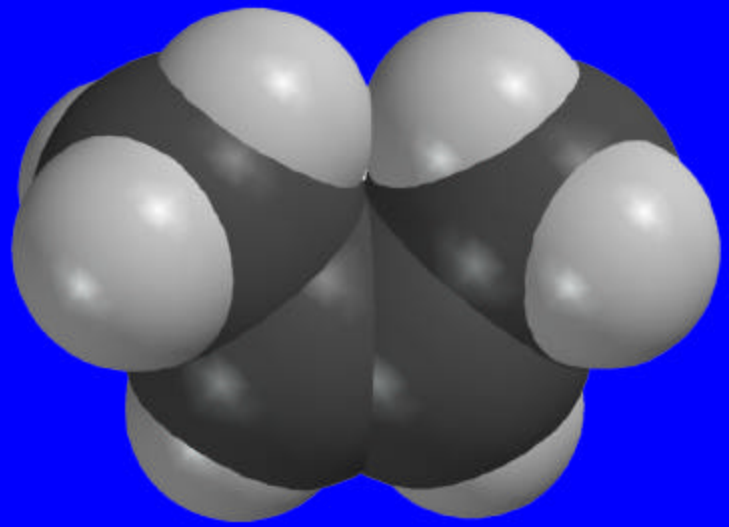


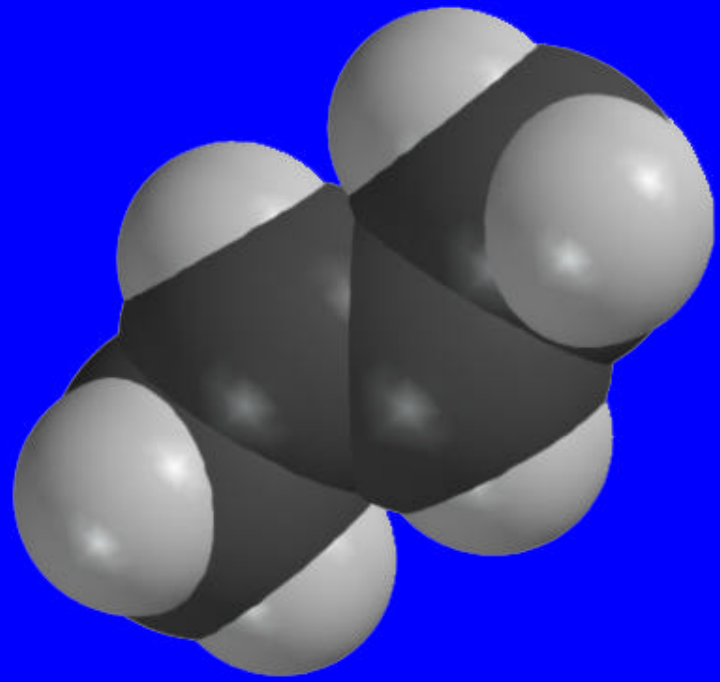
cis-2-butene

trans-2-butene

Figure 5.5
cis and trans-2-Butene

van der Waals strain due to crowding of cis-methyl groups





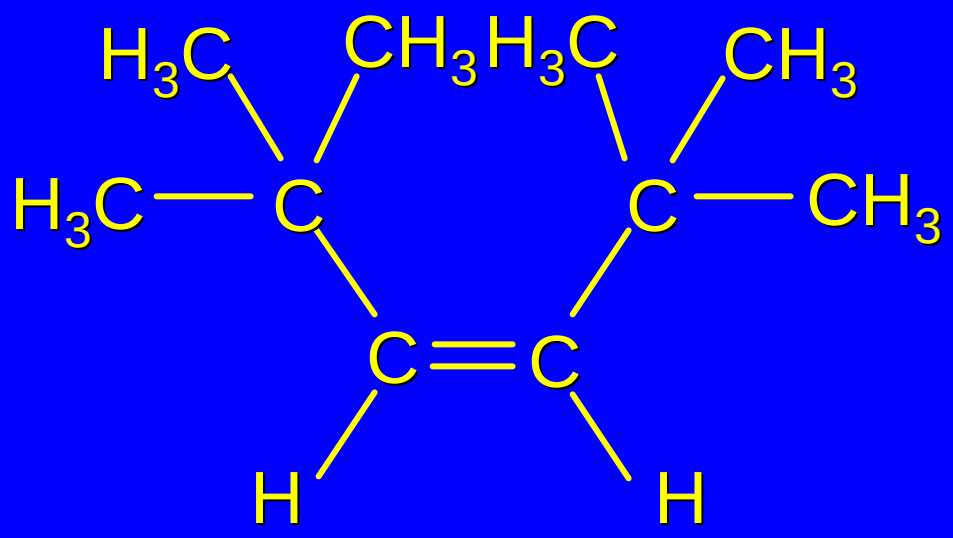
cis-2-butene

trans-2-butene

van der Waals Strain

Steric effect causes a large difference in stability between *cis* and *trans*-$(CH_3)_3CCH{=}CHC(CH_3)_3$

cis is 44 kJ/mol less stable than *trans*

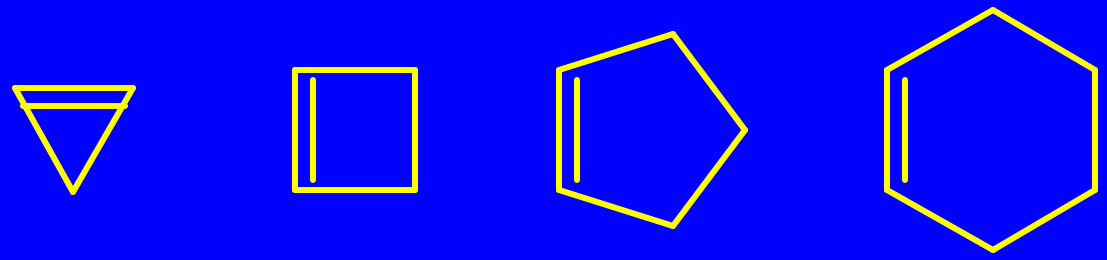


5.7
Cycloalkenes

Cycloalkenes

Cyclopropene and cyclobutene have angle strain.

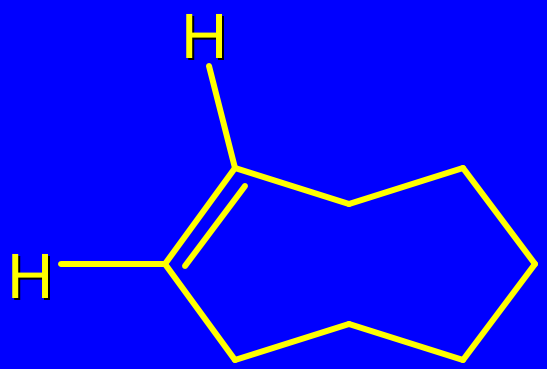
Larger cycloalkenes, such as cyclopentene and cyclohexene, can incorporate a double bond into the ring with little or no angle strain.



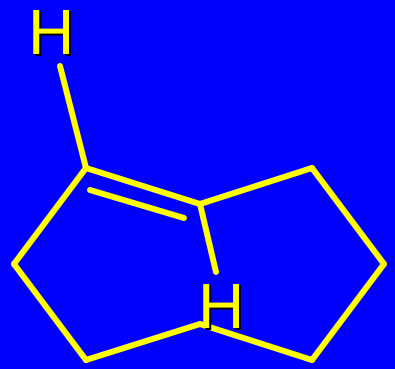
Stereoisomeric cycloalkenes

cis-cyclooctene and *trans*-cyclooctene are stereoisomers

cis-cyclooctene is 39 kJ/ molmore stable than *trans*-cyclooctene



cis-Cyclooctene

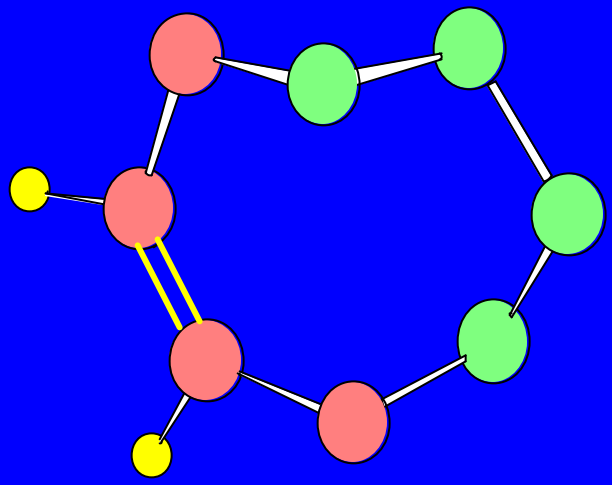


trans-Cyclooctene

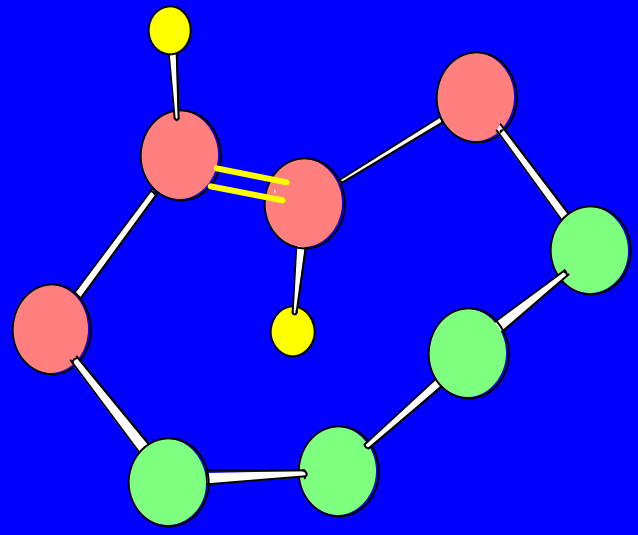
Stereoisomeric cycloalkenes

cis-cyclooctene and *trans*-cyclooctene are stereoisomers

cis-cyclooctene is 39 kJ/ molmore stable than *trans*-cyclooctene



cis-Cyclooctene



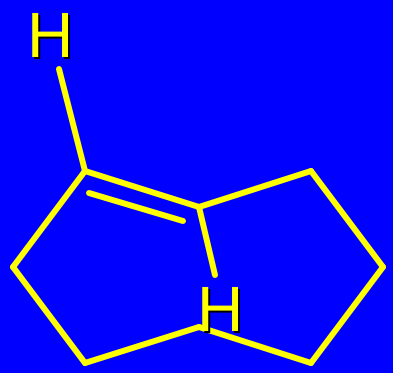
trans-Cyclooctene

Stereoisomeric cycloalkenes

trans-cyclooctene is smallest *trans*-cycloalkene that is stable at room temperature

cis stereoisomer is more stable than *trans* through C_{11} cycloalkenes

cis and *trans*-cyclododecene are approximately equal in stability



trans-Cyclooctene

Stereoisomeric cycloalkenes

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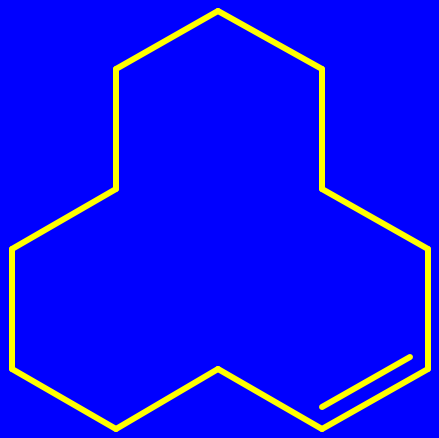
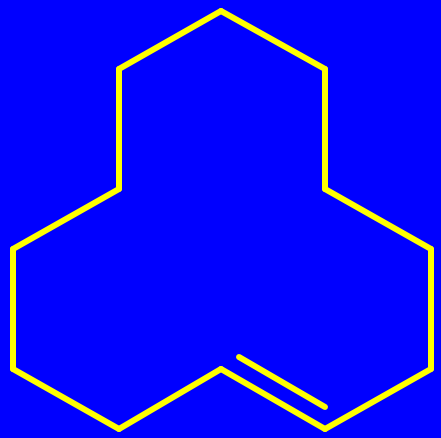


cis-Cyclododecene



trans-Cyclododecene

Stereoisomeric cycloalkenes

trans-cyclooctene is smallest *trans*-cycloalkene that is stable at room temperature

cis stereoisomer is more stable than *trans* through C_{11} cycloalkenes

cis and *trans*-cyclododecene are approximately equal in stability

When there are more than 12 carbons in the ring, *trans*-cycloalkenes are more stable than *cis*. The ring is large enough so the cycloalkene behaves much like a noncyclic one.