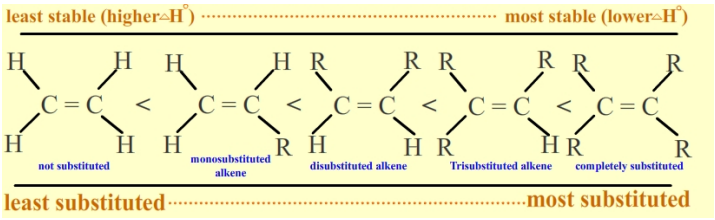
8.6: STABILITY OF ALKENES

Learning Objective

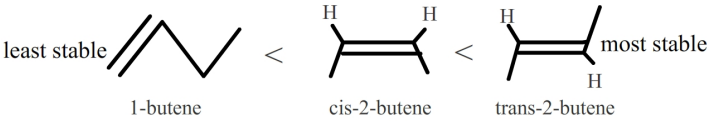
- use heats of hydrogenation to compare the stabilities of alkenes

HEATS OF HYDROGENATION

The stability of an alkene can be determined by measuring the amount of energy associated with the hydrogenation of the molecule. Since the double bond is breaking in this reaction, the energy released in hydrogenation is proportional to the energy in the double bond of the molecule. This is a useful tool because heats of hydrogenation can be measured very accurately. The ΔH^o is usually around -30 kcal/mol for alkenes. Stability is simply a measure of energy. Lower energy molecules are more stable than higher energy molecules. More substituted alkenes are more stable than less substituted ones due to hyperconjugation. They have a lower heat of hydrogenation. The following illustrates stability of alkenes with various substituents:



In disubstituted alkenes, trans isomers are more stable than cis isomers due to steric hindrance. Also, internal alkenes are more stable than terminal ones. See the following isomers of butene:



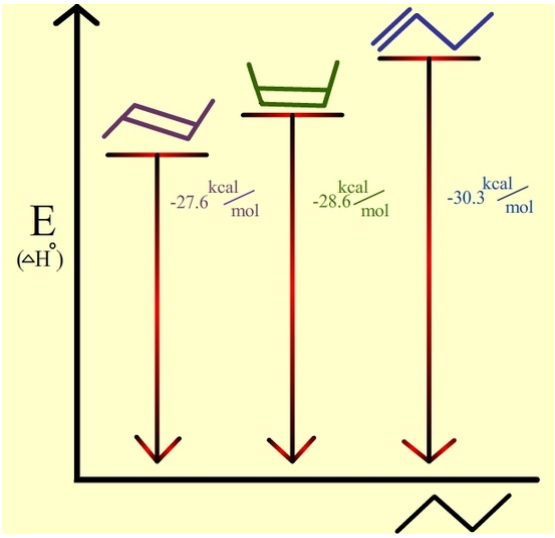


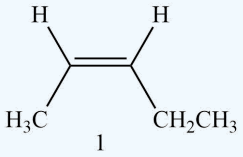
Figure ***7.6.3***: *Trans-2-butene is the most stable because it has the lowest heat of hydrogenation.*

In cycloalkenes smaller than cyclooctene, the cis isomers are more stable than the trans as a result of ring strain.

Exercises

1. When looking at their heats of hydrogenation, is the cis or the trans isomer generally more stable?
2. Arrange the following alkenes in order of increasing stability: 2,3-dimethyl-2-butene; trans-2-hexene; 2-methyl-2-pentene; cis-2-hexene
3. Which is the more stable alkene in each pair?

A)



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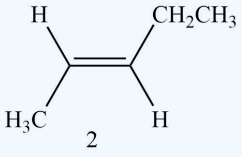

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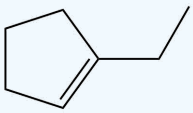
B)



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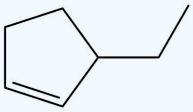

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Answer

1. Trans alkenes are more stable as demonstrated by the lower heats of hydrogenation when compared to their cis-isomers.
2. (least substituted and cis) cis-2-hexene < trans-2-hexene < 2-methyl-2-pentene < 2,3-dimethyl-2-butene (most substituted)
3. A) 2 b/c trans with same substitution at C=C B) 1 b/c the C=C is more substituted

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