

Chapter 4: Organic Compounds

Part 2: Configurational Isomers and Cycloalkanes

Major Organic Chemistry Functional Groups



Alkane



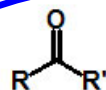
Alkene



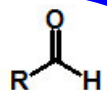
Conjugated
Alkene



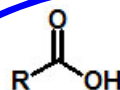
Alkyne



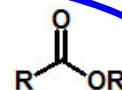
Ketone



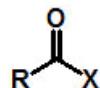
Aldehyde



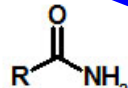
Carboxylic
Acid



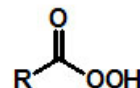
Ester



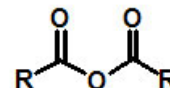
Acid Halide



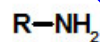
Amide



Peroxy Acid



Anhydride



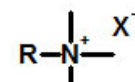
Primary
Amine



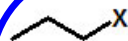
Secondary
Amine



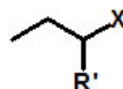
Tertiary
Amine



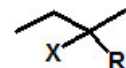
Quaternary
Ammonium Salt



Primary
Alkyl Halide



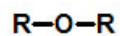
Secondary
Alkyl Halide



Tertiary
Alkyl Halide



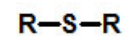
Alcohol



Ether



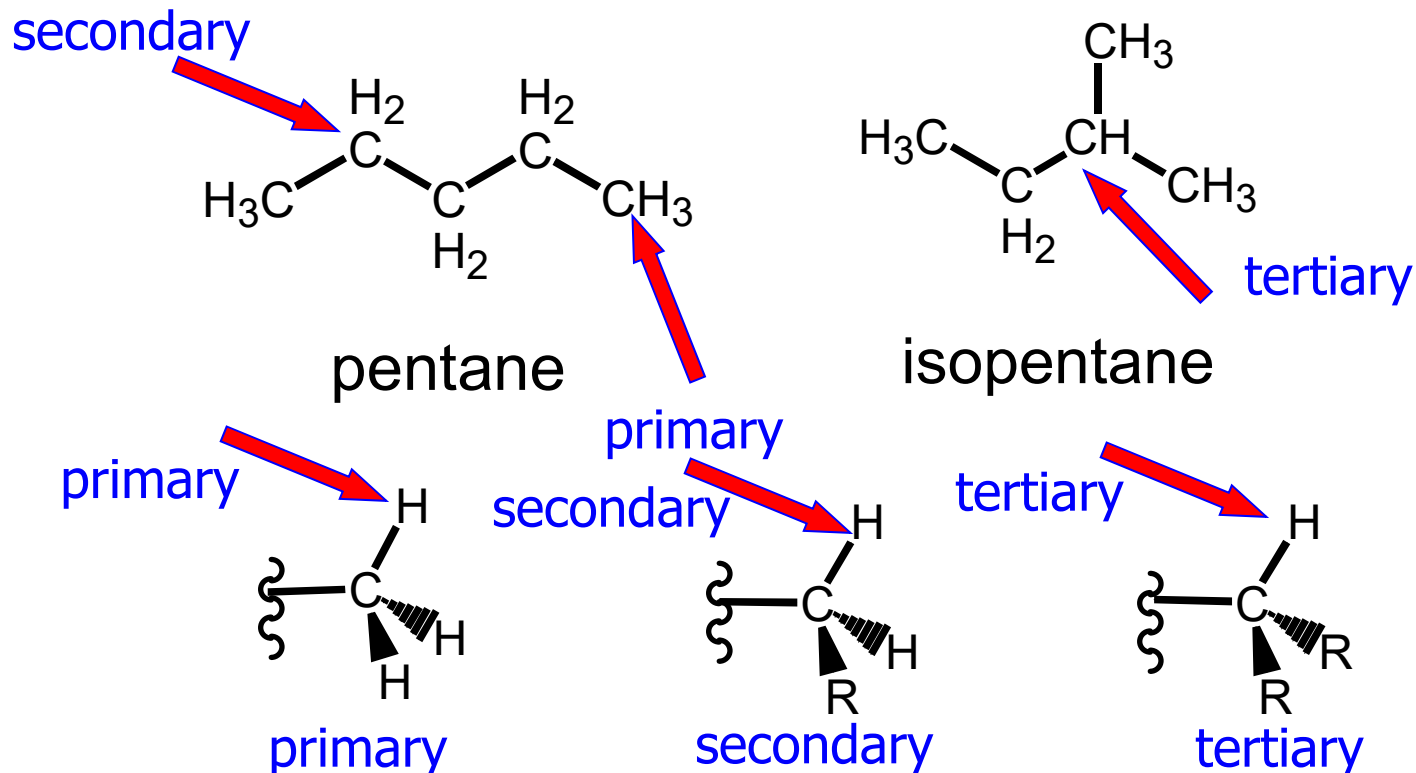
Thiol



Thioether

Naming Organic Compounds

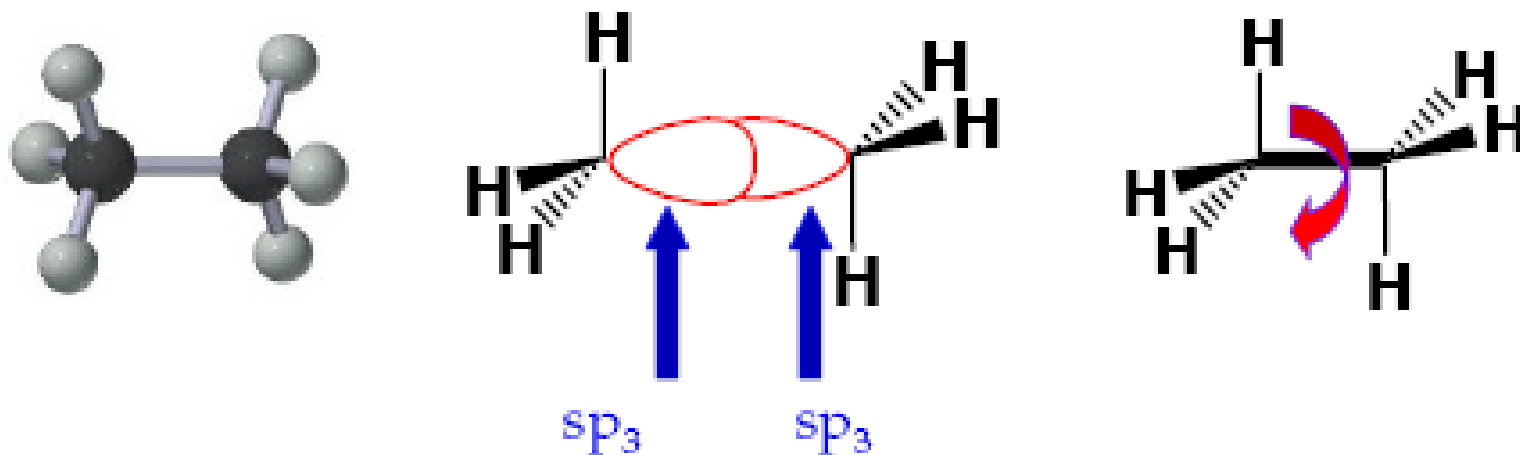
We need to make a distinction between different types of Carbons, Hydrogens, or Nitrogens



This naming scheme also applies for amines (nitrogen groups), alkyl halides, and alcohols

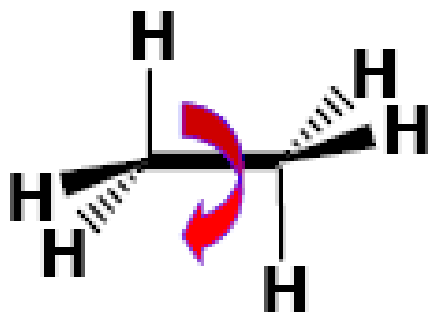
Conformations of Alkanes

Let's look again at ethane....

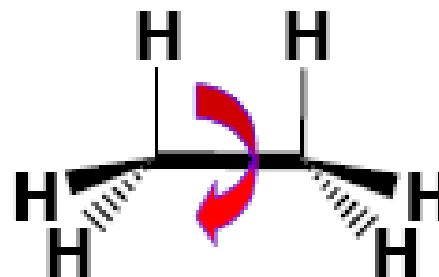


Rotation about a σ bond

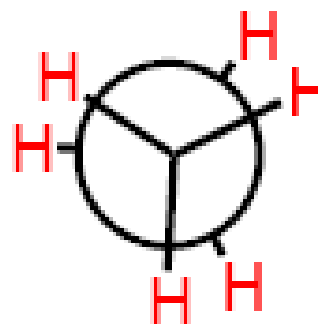
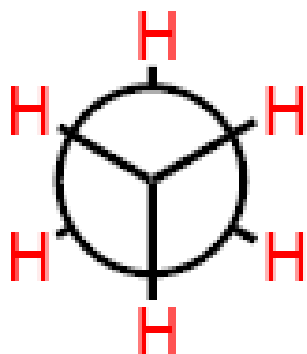
Conformational Isomers



staggered conformer



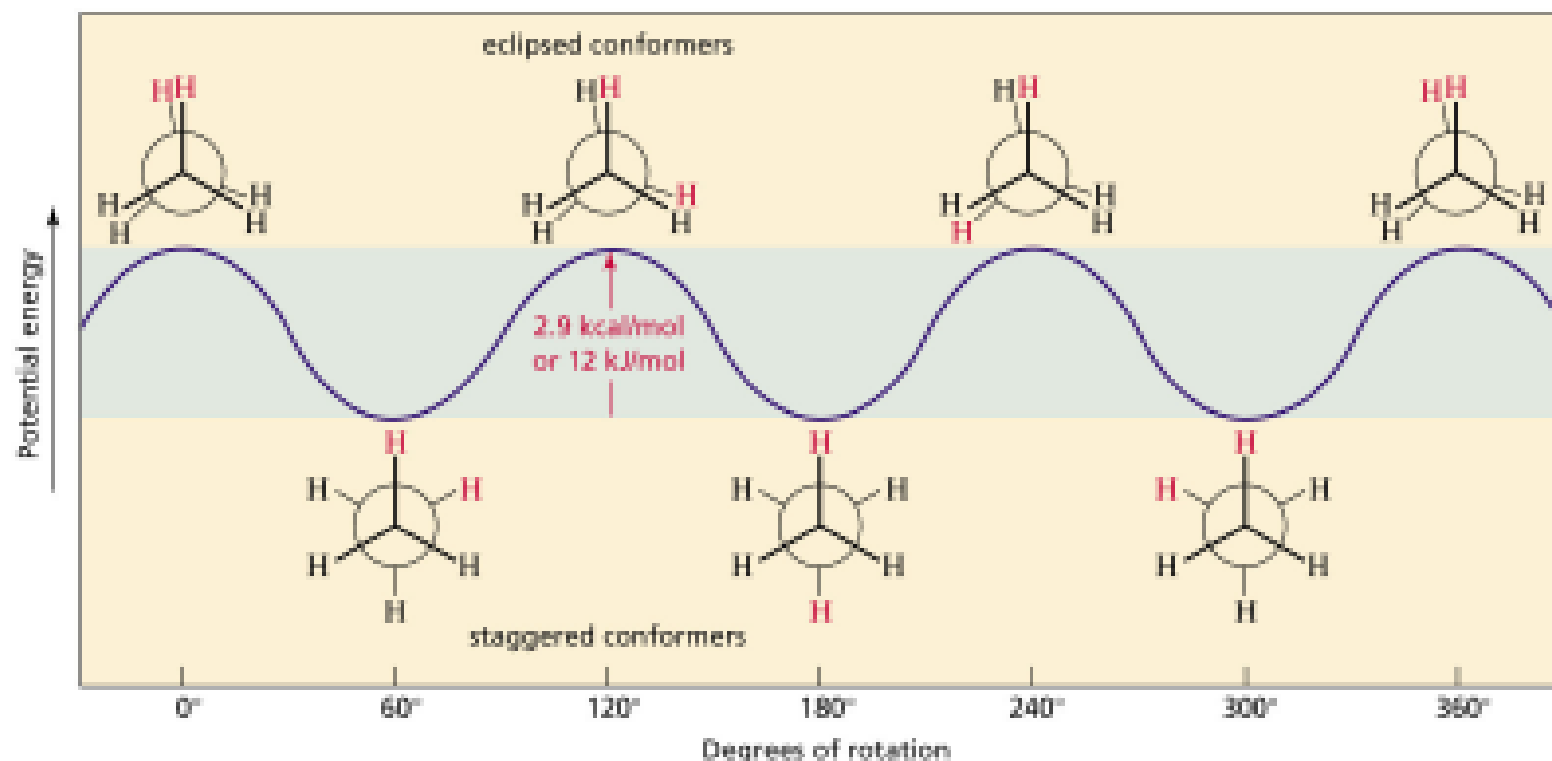
eclipsed conformer



←Newman
projections

- ▶ Conformational isomer: isomer created by a rotation about a (single) bond
- ▶ Staggered- most stable: all 6 C-H bonds are as far away as possible
- ▶ Eclipsed- least stable: all 6 C-H bonds are as close as possible to each other

Conformations of Ethane

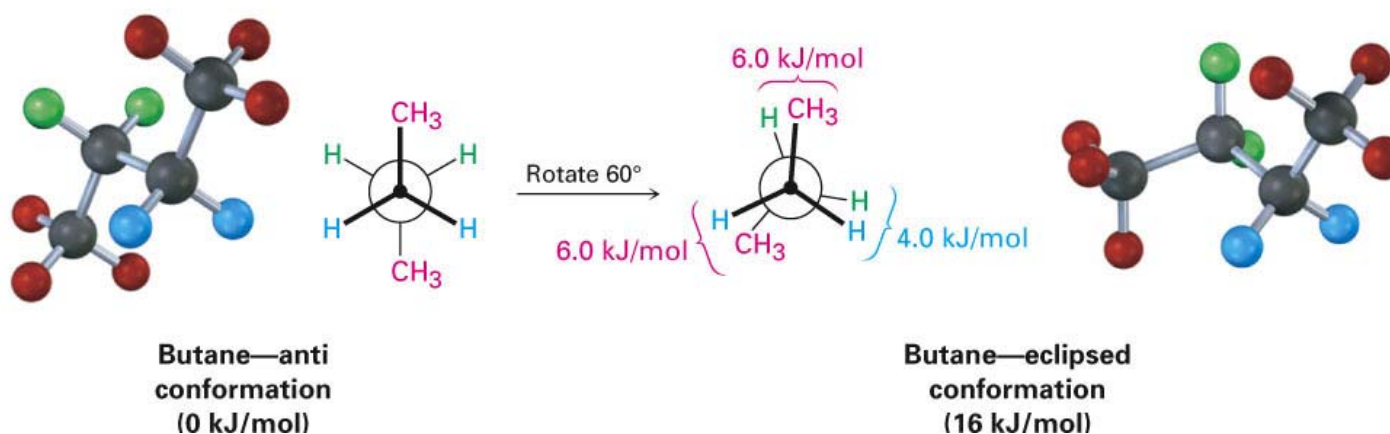


- ▶ A staggered conformer is more stable than an eclipsed conformer.
- ▶ Torsional strain: repulsion between pairs of bonding electrons

Conformations of Other Alkanes

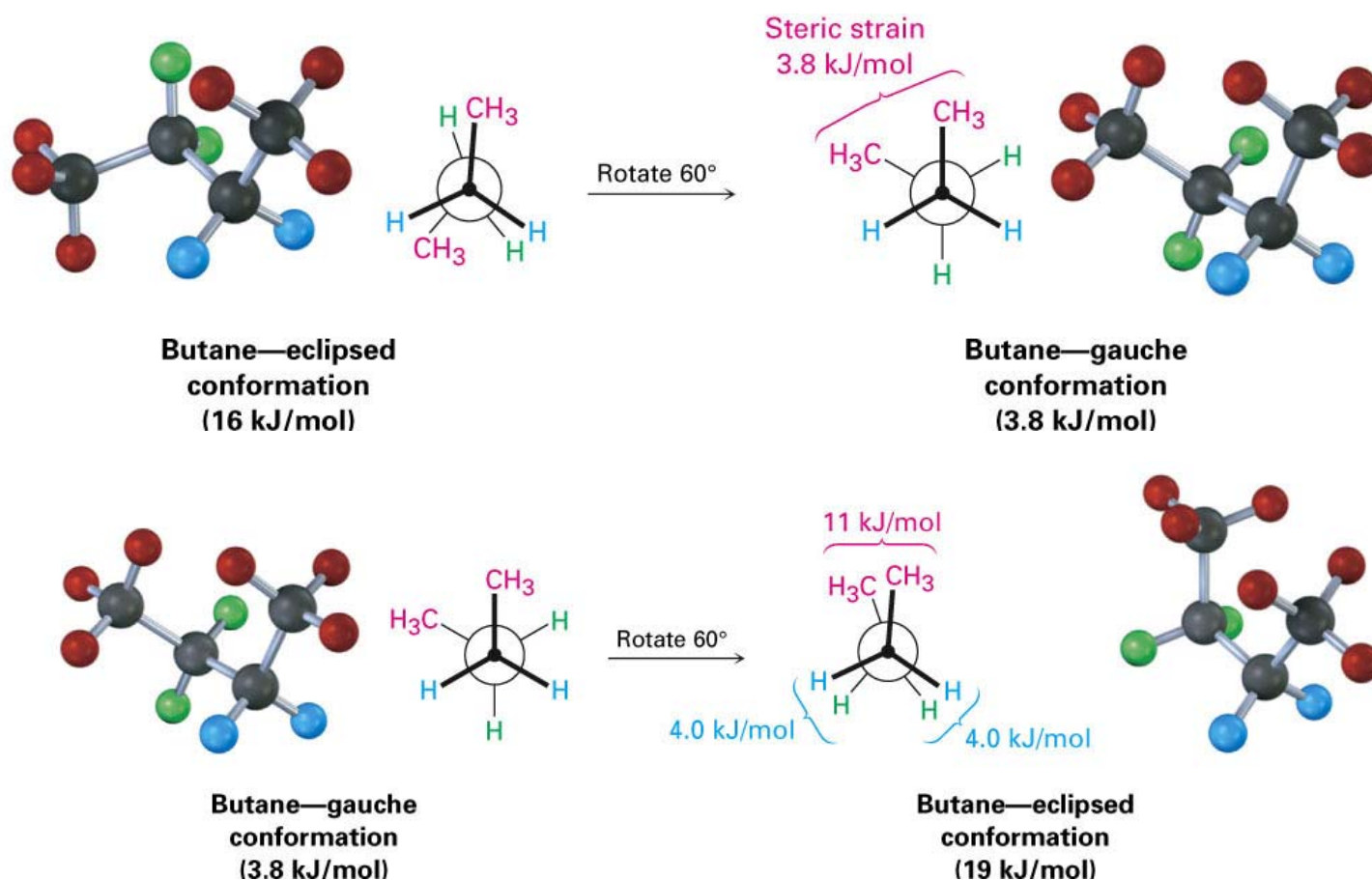
- Conformational situation is more complex for larger alkanes
- Not all staggered conformations have the same energy, and not all eclipsed conformations have the same energy

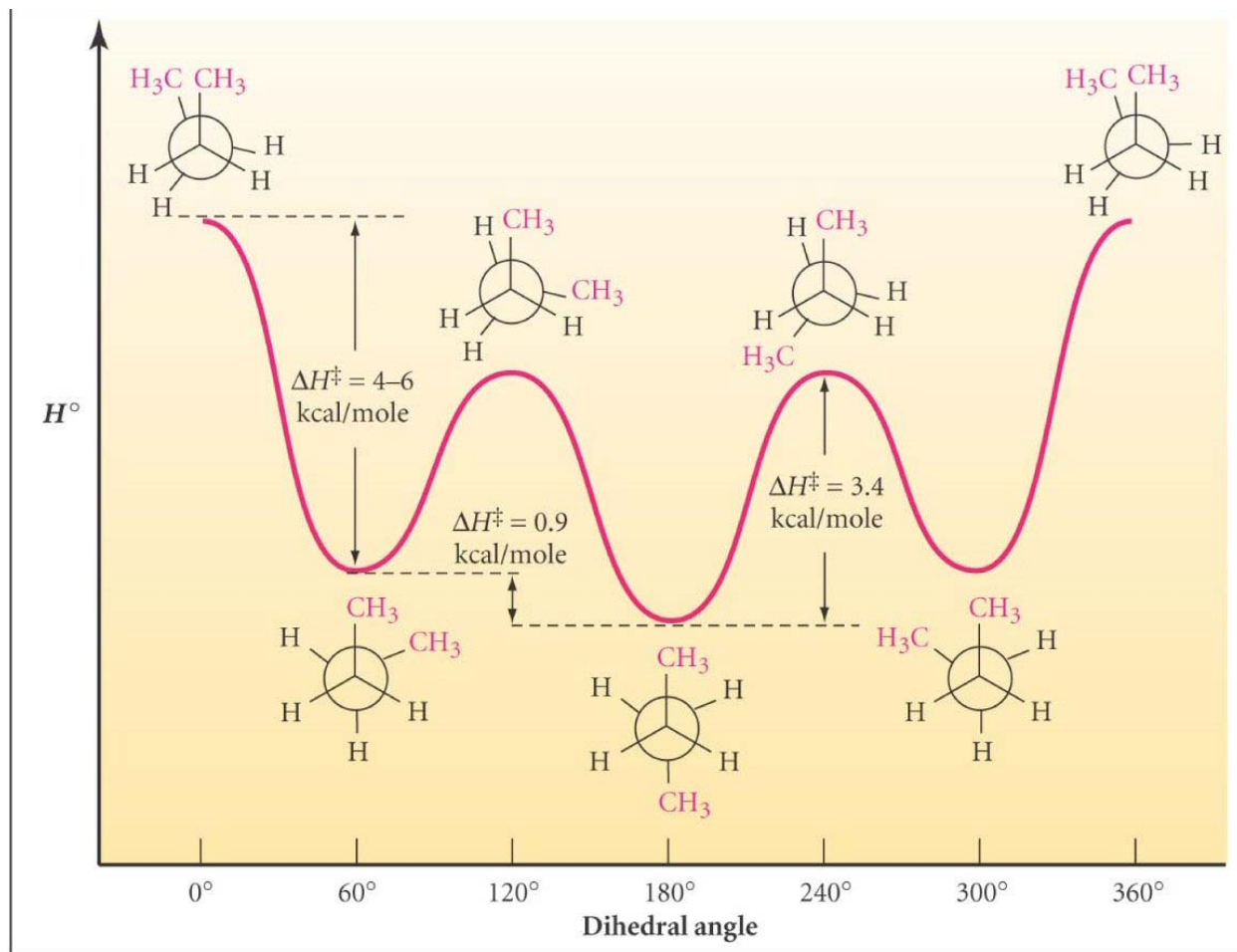
Let's look at Butane



Conformations of Butane

- ▶ **Anti** conformation- methyl groups are 180° apart
 - ▶ **Gauche** conformation- methyl groups are 60° apart
- Which is the most energetically stable?





We are rotating about the C2-C3 bond.

Each figure is a 60 degree turn.

Note: The BACK carbon (#4) is the one moving in this example.

You can see an explanation and animation by Dr. Davis here:

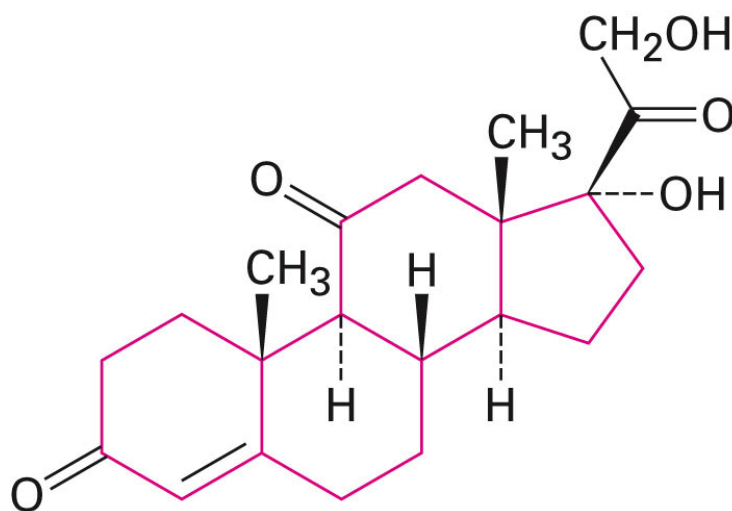
<https://www.youtube.com/watch?v=xXci5VGousQ>

Think: What costs more energy? Cl and CH_3 eclipsing or $\text{CH}_3\text{-CH}_3$ eclipsing

Chapter 4 Part 2: Cycloalkanes

We've discussed open-chained compounds up to this point

Many organic compounds contain rings of carbon atoms

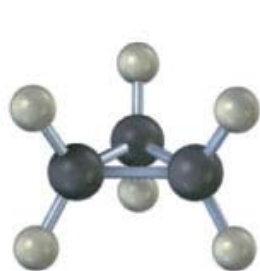


Cortisone

Naming Cycloalkanes

Cycloalkanes are saturated cyclic hydrocarbons

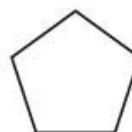
-- They have the general formula (C_nH_{2n})



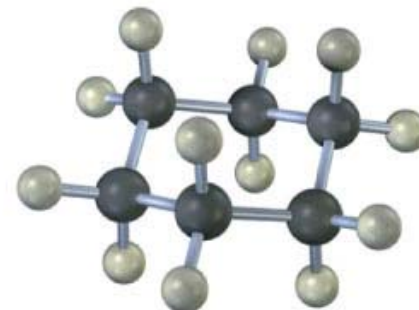
Cyclopropane



Cyclobutane



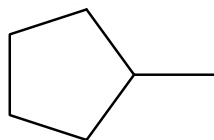
Cyclopentane



Cyclohexane

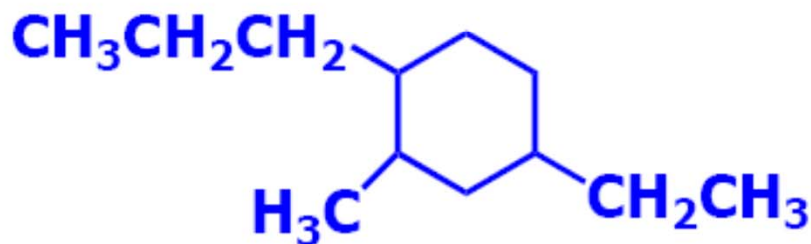
Naming Cycloalkanes

1. No number is needed for a single substituent on a cycloalkane.



methylcyclopentane

2. Name substituents in alphabetical order.
3. If there are more than two substituents, number the ring such that the prefixes get the lowest possible number.



4-ethyl-2-methyl-1-propylcyclohexane

Cycloalkanes: Ring Strain

Angle strain results when carbon bond angles deviate from the ideal 109.5° bond angle



good overlap



poor overlap



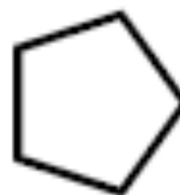
Cyclopropane

60



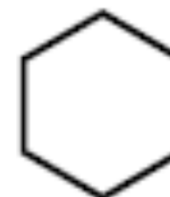
Cyclobutane

90



Cyclopentane

108

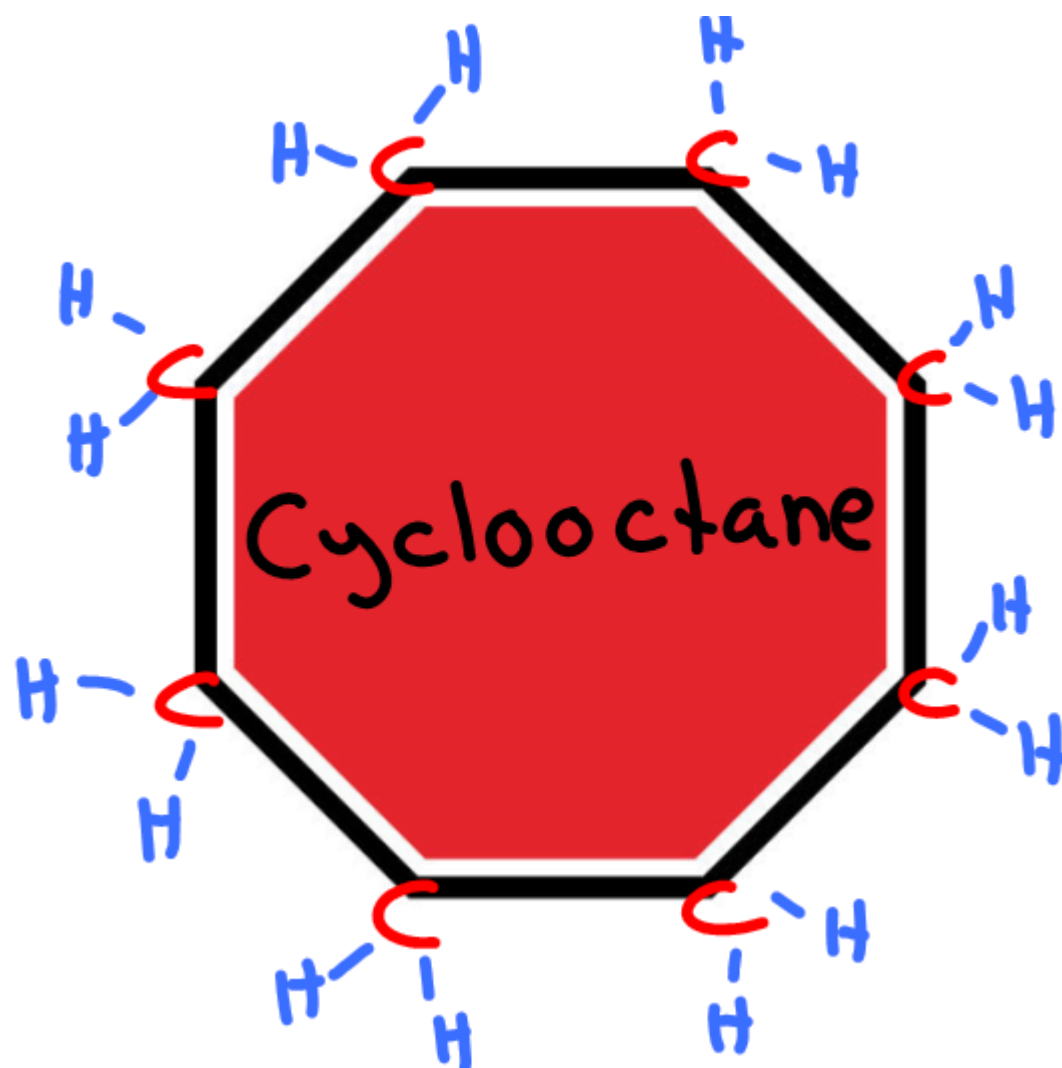


Cyclohexane

120

Types of Strain

- ▶ **Torsional strain** - eclipsing of bonds on neighboring atoms
- ▶ **Steric strain** - repulsive interactions between nonbonded atoms in close proximity
- ▶ **Angle or RING strain** - expansion or compression of bond angles away from most stable



For Next Time....

- ▶ Friday More Chapter 4 (4.5-4.9)
 - ▶ BRING YOUR MODEL SET!

- ▶ Monday Finish Chapter 4 (if we haven't)
 - ▶ Chapter 5 (5.1-5.4)
 - ▶ BRING YOUR MODEL SET!

- ▶ Wednesday Exam #1 (Chapters 1-4)

- ▶ Homework Problems Chapter 4
- ▶ #1, 6, 10, 19, 25, 28, 36, 43, 48, 51, 52, 63