

CHAPTER 4: CYCLOALKANES

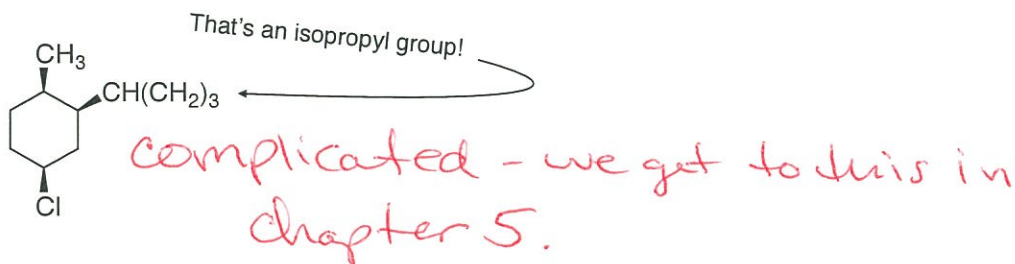
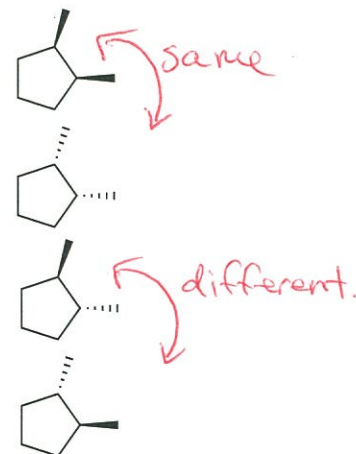
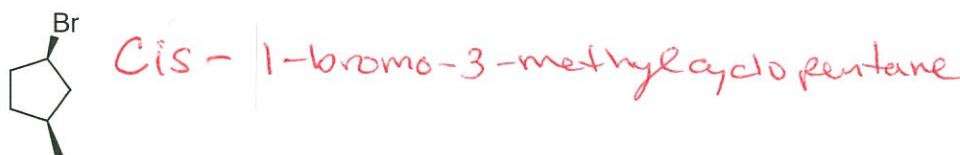
Naming. Write the complete IUPAC names for the following molecules

How many different molecules are drawn, below
(Hint: The answer is not 4)

3

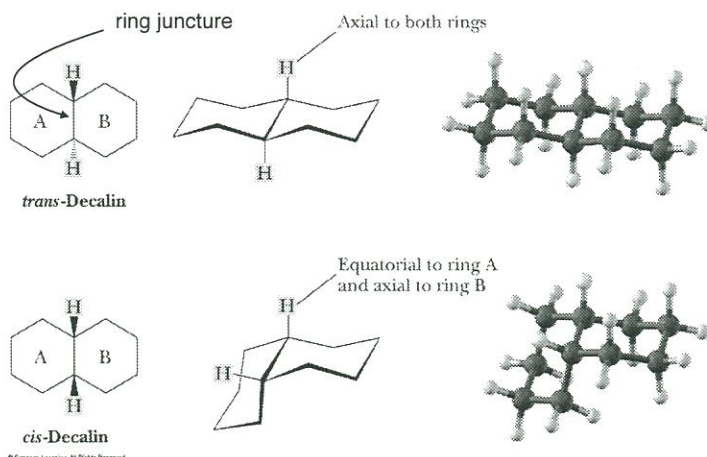


Don't forget to use cis and trans, when necessary

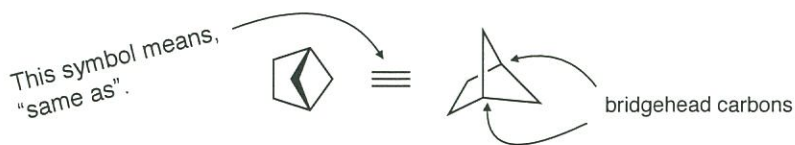


Bicyclic Nomenclature. Bicyclic ring systems can have a *trans*- or *cis*-ring juncture. Decalin (10 carbons) is the common name given to two fused six-membered rings.

The IUPAC names, however, are *trans*- and *cis*-bicyclo[4,4,0]decane, where the first two numbers represent the number of carbons on each side of the ring juncture, and the last number is the number of carbon atoms between the two carbons at the ring juncture (the number of atoms in the bridge=0).



Likewise, the following molecule is named bicyclo[2,1,1]hexane:



In this case, the first two numbers represent the number of carbon atoms on either side of the 'bridge' (numbers are always written in descending order) and last is the number of carbons *in* the bridge (or between the two bridgehead carbons).

You try naming these:

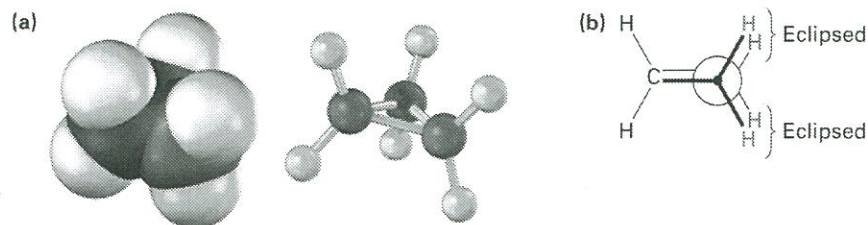


Bicyclo[3,2,1]octane



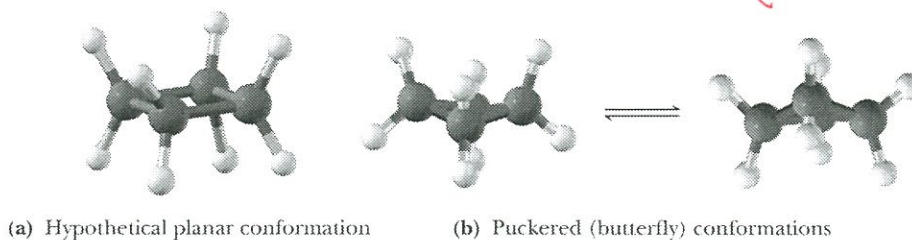
Bicyclo[4,2,2]decane

Cyclopropane. Despite the fact that the carbons in cyclopropane are all SP³ hybridized and the standard C-C-C angles for this hybridization is 109.5 degrees, the angles are actually about 60°. This deviation from tetrahedral creates A LOT of Angle strain. Since cyclopropane is mostly planar, there are also six fully eclipsed C-H sigma bonds, this adds torsional strain. All together, propane has 115 kJ/mol of strain energy - wow!

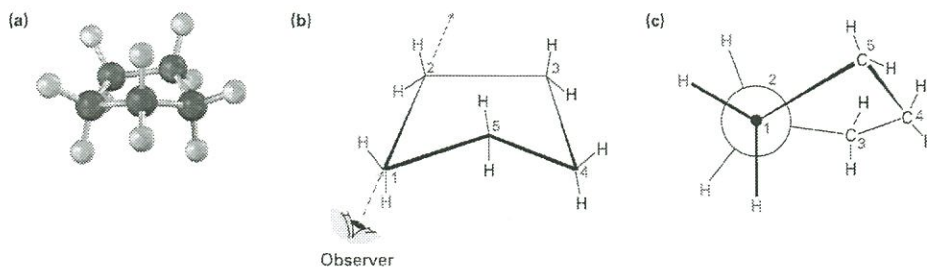


Cyclobutane. One might consider the C-C-C angles in cyclobutane to be 90°, however the molecule can alleviate some of its torsional strain by “puckering”, resulting in interior angles that are actually MORE strained (88°). Despite the *increase* in angle strain from the hypothetical planar conformation (90° angles), the total ring strain in cyclobutane is reduced to 110 kJ/mol. If *increasing* angle strain results in *lowering* the total strain, this must mean the resulting reduction in torsional strain is significant! In fact, there are 8 eclipsing C-H interactions in cyclobutane.

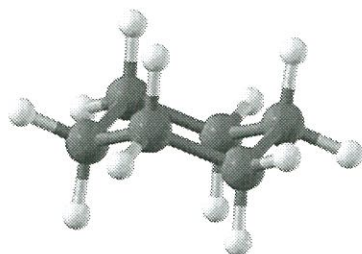
(4 on top, 4 on bottom)



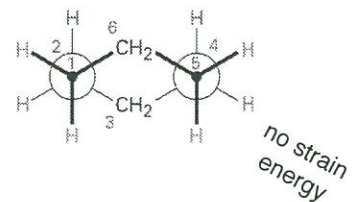
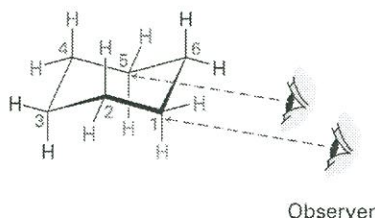
Cyclopentane. Cyclopentane also “puckers” since there are 10 eclipsing C-H interactions. Like cyclobutane, the relatively small increase in angle strain results in *lowering* the overall total ring strain to only 26 kJ/mol. Notice, in figure (c), the C-H bonds are not completely eclipsed!



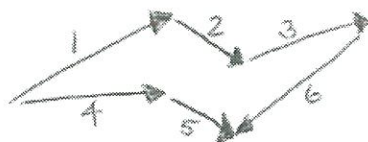
Cyclohexane. The lowest energy conformation for a six membered ring is called a chair conformation, and despite there being 12 C-H bonds, there is NO torsional strain (check out the Newman projection on the right). If that wasn't enough of a good thing, the bond angles in a chair mimic a nearly perfect tetrahedron. Relative to the three-, four- and five-membered rings, cyclohexane has ZERO total ring strain!



View from the side



Here's a tip on how to draw a chair - the numbers represent my pen/pencil strokes from 1 through 6. Notice 1 and 6, 2 and 5, and 3 and 4, are parallel to each other.



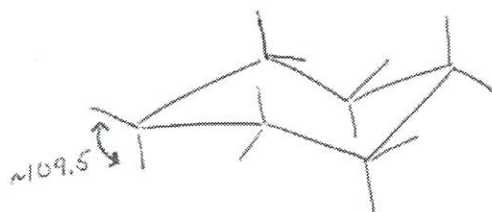
Now you practice (leave out the numbers and arrows):



First, try tracing these chairs first, then draw your own

This time, draw a cyclohexane chair showing all axial and equatorial positions. Make sure your H-C-H angles are NOT 90°. Tip: Draw the six axial (three up, three down) positions first, then the equatorial ones (three up, three down - angles are near 109.5°).

Me:



You:

