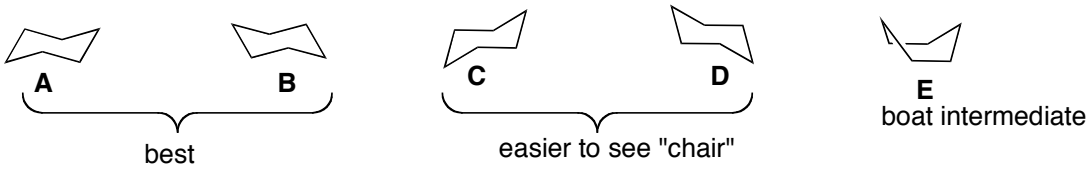
Ring Stability and Ring Strain (Section 3.12)

Ring Size	Total Ring Strain (kcal/mol)	Strain Per CH_2	Main Source Of Strain
3	28	9	Angle Strain
4	26	7	Angle Strain
5	7	1	Torsional Strain (eclipsing)
6	**0**	**0**	**-- STRAIN FREE**
7	6	1	Torsional Strain (eclipsing)
8	10	1	Torsional Strain (eclipsing)

Cyclohexane Chair Conformations (Section 3-13,14)

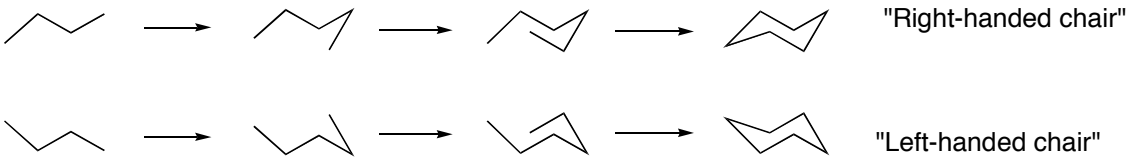
- Cyclohexane has no angle strain or torsional strain
- Cyclohexane has perfect 109º angles with staggered, non-eclipsed C-C bonds
- Obviously it is not flat (natural angle for a flat cyclohexane would be 120º)

Chair Conformations:



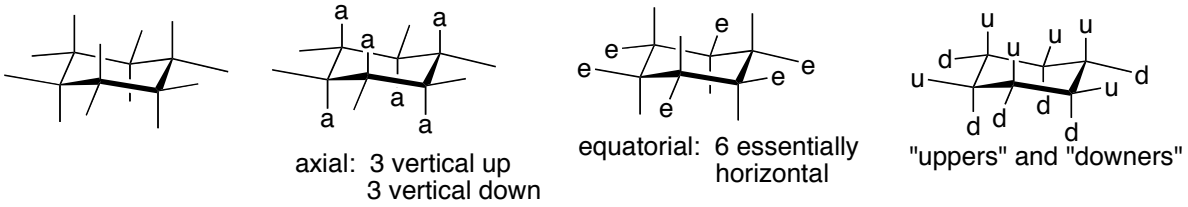
- Chairs **A** and **B** are constantly interconverting via "boat" **E**
- **A** and **B** are best to draw and work with.
- But **C**/**D** make it easier to visualize why it's called a "chair": 4 carbons make the seat of the chair, one makes backrest, one a footrest.

Process for Drawing Both Chairs:

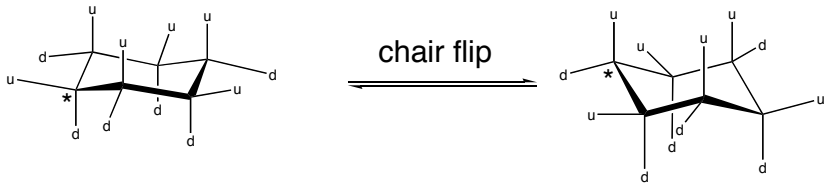


1. Draw a 4-carbon zig-zag. It helps if your left-most carbon is a little lower than your 3rd carbon
2. Add a 5th carbon and 6th carbon, but don't have them exactly underneath the 2nd and 3rd carbons.
3. Connect the 6th carbon to the orginal 1st carbon
   - For a "left-handed chair", start up and zig-zag down.

"Axial" and "Equatorial" Positions for Substituents



1. Each carbon has one axial and one equatorial H's
2. Always have six axial attachments
3. 3 axials up (on alternating carbons)
4. 3 axials down (on alternating carbons)
5. Always have six equatorial attachments
6. For processing cis/trans problems, it's helpful to recognize "upper" from "downer" positions
7. When a chair flips, what was equatorial becomes axial, and what was axial becomes equatorial

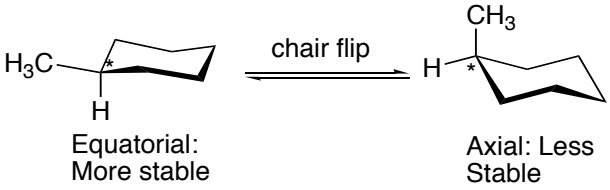


Drawing equatorial and axial bonds:

- Make axial straight up or straight down (3 each)
- Make equatorial bond lines almost exactly horizontal
- Equatorials are easiest to draw on left and right-most carbons

Drawing Mono- and DiSubstituted Cyclohexanes (Sections 3-14,15)

- Always attach the first substituent onto the leftmost carbon (easiest to draw)



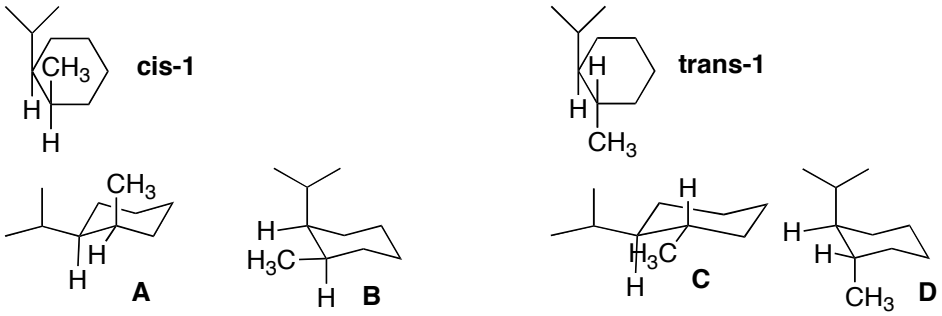
- Draw in the H on any substituted carbon, but skip on H-only carbons
- **Equatorial is better than axial for steric reasons**. In the axial configuration, the substituent has destabilizing steric interactions
  - 2 extra gauche interactions, and 1,3-diaxial interactions
- For disubstituted chairs, let the cis/trans relationship guide whether the second substituent should be in an "upper" or "lower" position relative to the original substituent.
- If one substituent is bigger than the other, the most stable chair will always have the larger substituent equatorial

Cis and Trans Disubstituted Cyclohexanes

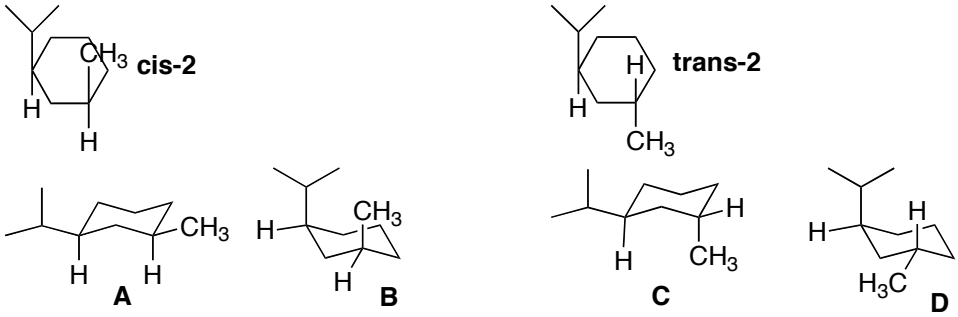
Questions:

1. Draw both chair forms for cis-2-methyl-1-isopropylcyclohexane.
2. Which is the best chair for cis-2-methyl-1-isopropylcyclohexane?
3. Draw both chair forms and identify the best chair for trans-2-methyl-1-isopropylcyclohexane.
4. Which is more stable, cis- or trans-2-methyl-1-isopropylcyclohexane?
5. Then answer the same questions for the 1,3- and 1,4- isomers.

1,2-DiSubbed



1,3-DiSubbed



1,4-DiSubbed