

**Problem Set 3**

1. Read Chapter 3 Sections 10 and 11. You should be familiar with the nomenclature for naming cycloalkanes and cis and trans geometric isomers (stereoisomers) of cycloalkanes.

Work the following problems found in Chapter 3 Sections 10 and 11 of the text: **Problems 15-18.**

2. Read Chapter 3 Section 12. You should be familiar with the structures of simple (unsubstituted) cycloalkanes containing 3-8 carbon atoms and why many cycloalkanes are higher in energy than the corresponding acyclic alkanes. What are angle strain, torsional strain and ring strain? How is ring strain measured? Which cycloalkanes have the most ring strain and why? Study Table 3-5. You should be familiar with the lowest energy conformations of cyclopropane, cyclobutane and cyclopentane and how to draw their structures using perspective drawings and Newman projections.

Work the following problems found in Chapter 3 Sections 12 of the text: **Problems 19 and 20.**

3. Read Chapter 3 Section 13. You should be familiar with the chair, boat and twist-boat conformations of cyclohexane. Which conformation is lowest in energy? Why? You are responsible for knowing that the chair conformation of cyclohexane rapidly undergoes ring-flip and that ring-flip causes the substituents at the equatorial and axial positions on the ring to switch. Be familiar with how to draw the chair conformations of cyclohexane using perspective drawings and Newman projections and how to distinguish equatorial hydrogen atoms from axial hydrogen atoms. Study the Problem-Solving Strategy for Drawing Chair Conformations on page 138.

Work the following problems found in Chapter 3 Sections 13 of the text: **Problems 21 and 22.**

4. Read Chapter 3 Section 14. You should be able to draw the ring-flip conformers of mono-substituted cyclohexanes using perspective drawings and Newman projections and recognize that the substituent will be in the equatorial position in one conformer and in the axial position in the other conformer. You should know that the conformer with a substituent in the axial position is higher in energy due to steric repulsion between the substituent and the two axial hydrogen atoms on the same side (face) of the ring—that is, because of 1,3-diaxial interactions. Why does the magnitude of the difference in energy between the equatorial and axial conformations of mono-substituted cyclohexanes increase as the size of substituents increases? Study Table 3-6. What effect does that have on the distribution of equatorial and axial conformers at equilibrium? Why does an equatorial *tert*-butyl group effectively lock the conformation and prevent ring-flip?

Work the following problems found in Chapter 3 Sections 14 of the text: **Problems 23-25.**

5. Read Chapter 3 Section 15. You should be familiar with how to draw the ring-flip conformations of cyclohexane containing more than one substituent. Know how to examine the 1-3-diaxial interactions in both conformers to determine which conformation is lowest in energy. It may help to draw the two conformers using Newman projections. Study the Problem-Solving Strategy for Recognizing Cis and Trans Isomers on page 143. Know that the magnitude of 1,3-diaxial interactions is greater for larger substituents compared to smaller substituents.

Work the following Problems found in Chapter 3 Section 15 of the text: **Solved problems 3 and 4.**

Work the following problems found in Chapter 3 Section 15 of the text: **Problems 26-30.**

6. Read Chapter 3 Section 16. You should be familiar with bicyclic alkanes and recognize that two different rings can be joined three different ways to form bicyclic alkanes—namely, fused ring, bridged ring and spirocyclic ring systems. What are bridgehead carbons? What is the IUPAC nomenclature for naming fused, bridged and spirocyclic ring systems? You are responsible for knowing that fusing and bridging two rings introduces energetic and steric constraints that limits the conformational flexibility of individual rings. In systems that contain a cyclohexane ring, fusing and bridging can completely inhibit ring-flip (e.g., *trans*-decalin), or hold cyclohexane in higher-energy boat conformations (e.g., norbornane). Why is *cis*-decalin conformationally flexible such that it can undergo ring-flip? It helps to build molecular models and examine the conformational flexibility.

Work the following problems found in Chapter 3 Section 16 of the text: **Problems 31 and 32.**

Work the following problems found at the back of Chapter 3 to test your knowledge of material in sections 10-16: **Problems 34c,e,g, 35, 36f,g,h,i,j,k,l, 37c,d,e,f, 39d,e,f,g,h, 41f, 45-47, 51, and 52.**