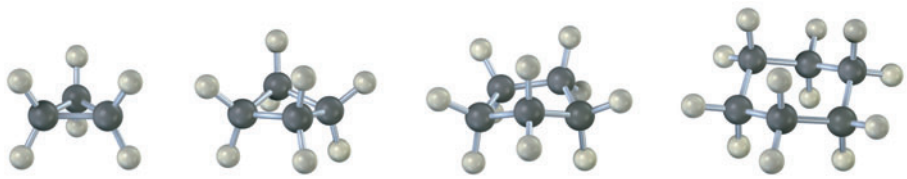
WHY THIS CHAPTER?

We'll see numerous instances in future chapters where the chemistry of a given functional group is strongly affected by being in a ring rather than an open chain. Because cyclic molecules are so commonly encountered in all classes of biomolecules, including proteins, lipids, carbohydrates, and nucleic acids, it's important that the effects of their cyclic structures be understood.

4.1 Naming Cycloalkanes

Saturated cyclic hydrocarbons are called **cycloalkanes**, or **alicyclic** compounds (**ali**phatic **cyclic**). Because cycloalkanes consist of rings of $-CH_2-$ units, they have the general formula $(CH_2)_n$, or C_nH_{2n}, and can be represented by polygons in skeletal drawings.



Cyclopropane **Cyclobutane** **Cyclopentane** **Cyclohexane**

Substituted cycloalkanes are named by rules similar to those we saw in the previous chapter for open-chain alkanes (Section 3.4). For most compounds, there are only two steps.

Rule 1 **Find the parent.**

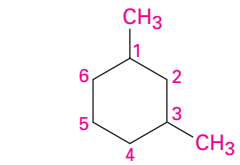
Count the number of carbon atoms in the ring and the number in the largest substituent chain. If the number of carbon atoms in the ring is equal to or greater than the number in the substituent, the compound is named as an alkyl-substituted cycloalkane. If the number of carbon atoms in the largest substituent is greater than the number in the ring, the compound is named as a cycloalkyl-substituted alkane. For example:

Methylcyclopentane **1-Cyclopropylbutane**

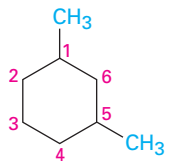
Rule 2 **Number the substituents, and write the name.**

For an alkyl- or halo-substituted cycloalkane, choose a point of attachment as carbon 1 and number the substituents on the ring so that the *second* substituent

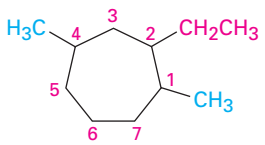
has as low a number as possible. If ambiguity still exists, number so that the third or fourth substituent has as low a number as possible, until a point of difference is found.



NOT

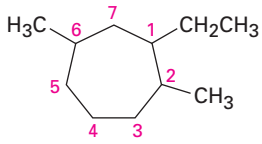


1,3-Dimethylcyclohexane (Lower) NOT **1,5-Dimethylcyclohexane** (Higher)

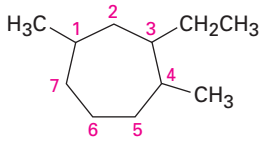


2-Ethyl-1,4-dimethylcycloheptane (Lower, Lower)

NOT

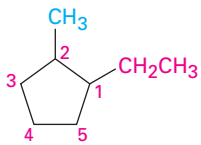


1-Ethyl-2,6-dimethylcycloheptane (Higher)

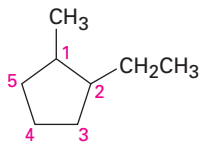


3-Ethyl-1,4-dimethylcycloheptane (Higher)

(a) When two or more different alkyl groups that could potentially receive the same numbers are present, number them by alphabetical priority.

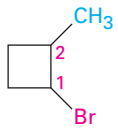


NOT

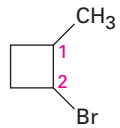


1-Ethyl-2-methylcyclopentane NOT **2-Ethyl-1-methylcyclopentane**

(b) If halogens are present, treat them just like alkyl groups.

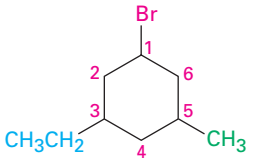


NOT

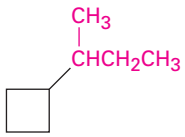


1-Bromo-2-methylcyclobutane NOT **2-Bromo-1-methylcyclobutane**

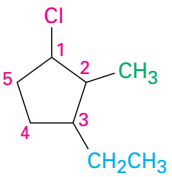
Some additional examples follow:



1-Bromo-3-ethyl-5-methylcyclohexane

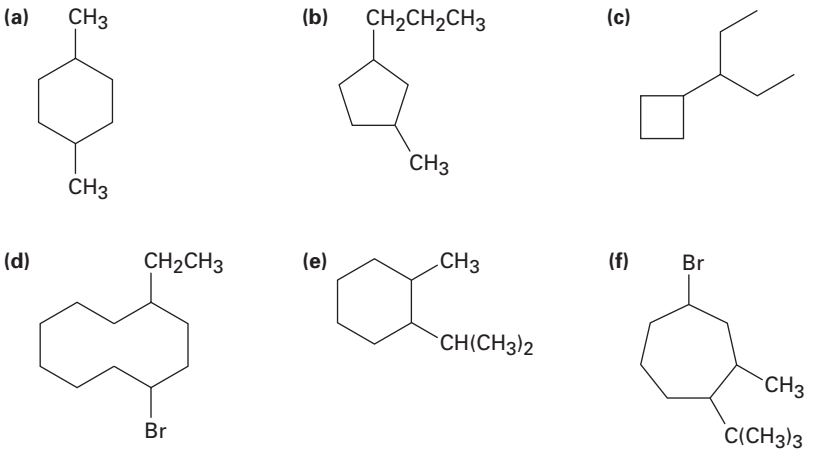


(1-Methylpropyl)cyclobutane or *sec*-butylcyclobutane



1-Chloro-3-ethyl-2-methylcyclopentane

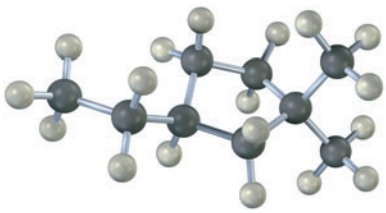
Problem 4.1 Give IUPAC names for the following cycloalkanes:



Problem 4.2 Draw structures corresponding to the following IUPAC names:

(a) 1,1-Dimethylcyclooctane **(b)** 3-Cyclobutylhexane
(c) 1,2-Dichlorocyclopentane **(d)** 1,3-Dibromo-5-methylcyclohexane

Problem 4.3 Name the following cycloalkane:



4.2 Cis–Trans Isomerism in Cycloalkanes

In many respects, the chemistry of cycloalkanes is like that of open-chain alkanes: both are nonpolar and fairly inert. There are, however, some important differences. One difference is that cycloalkanes are less flexible than open-chain alkanes. In contrast with the relatively free rotation around single bonds in open-chain alkanes (Sections 3.6 and 3.7), there is much less freedom in cycloalkanes.