Chapter 7
Stereochemistry
7.1
Molecular Chirality: Enantiomers
A molecule is **chiral** if its two mirror image forms **are not** superposable upon one another.

A molecule is **achiral** if its two mirror image forms **are** superposable.
Bromochlorofluoromethane is chiral.

It cannot be superposed point for point on its mirror image.
Bromochlorofluoromethane is chiral

To show nonsuperposability, rotate this model 180° around a vertical axis.
Bromochlorofluoromethane is chiral
Another look
are enantiomers with respect to each other are enantiomers with respect to each other

Enantiomers are enantiomers with respect to each other and nonsuperposable mirror images are called enantiomers.

Enantiomers are enantiomers with respect to each other and nonsuperposable mirror images are called enantiomers.
Isomers

- Constitutional isomers
- Stereoisomers
Isomers

- Constitutional isomers
- Stereoisomers
  - Enantiomers
  - Diastereomers
Chlorodifluoromethane is achiral
Chlorodifluoromethane is achiral

The two structures are mirror images, but are not enantiomers, because they can be superposed on each other.
7.2
The Stereogenic Center
The Stereogenic Center

a carbon atom with four different groups attached to it

also called:
- chiral center
- asymmetric center
- stereocenter
A molecule with a single stereogenic center is chiral.

Bromochlorofluoromethane is an example.
A molecule with a single stereogenic center is chiral.

2-Butanol is another example.
Examples of molecules with 1 stereogenic center

\[
\begin{align*}
\text{CH}_3 & \quad \text{CH}_3 \\
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 & \quad \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \\
\text{CH}_2\text{CH}_3 & \quad \text{CH}_2\text{CH}_3
\end{align*}
\]

a chiral alkane
Examples of molecules with 1 stereogenic center

Linalool, a naturally occurring chiral alcohol
Examples of molecules with 1 stereogenic center

1,2-Epoxypropane: a stereogenic center can be part of a ring attached to the stereogenic center are:

- H
- CH₃
- OCH₂
- CH₂O
Examples of molecules with 1 stereogenic center

Limonene: a stereogenic center can be part of a ring attached to the stereogenic center are:

- H
- CH₂CH₂
- CH₂CH=}
- C=
Examples of molecules with 1 stereogenic center

Chiral as a result of isotopic substitution

\[ \text{CH}_3 \text{D-C-} \]

H

T
A molecule with a single stereogenic center must be chiral.

But, a molecule with two or more stereogenic centers may be chiral or it may not (Sections 7.10-7.13).
7.3
Symmetry in Achiral Structures
Symmetry tests for achiral structures

Any molecule with a plane of symmetry or a center of symmetry must be achiral.
A plane of symmetry bisects a molecule into two mirror image halves. Chlorodifluoromethane has a plane of symmetry.
A plane of symmetry bisects a molecule into two mirror image halves. Chlorodifluoromethane has a plane of symmetry.
A plane of symmetry bisects a molecule into two mirror image halves. 1-Bromo-1-chloro-2-fluoroethene has a plane of symmetry.
A plane of symmetry bisects a molecule into two mirror image halves.  
1-Bromo-1-chloro-2-fluoroethene has a plane of symmetry.
A point in the center of the molecule is a center of symmetry if a line drawn from it to some element, when extended an equal distance in the opposite direction, encounters an identical element.
A point in the center of the molecule is a center of symmetry if a line drawn from it to any element, when extended an equal distance in the opposite direction, encounters an identical element.