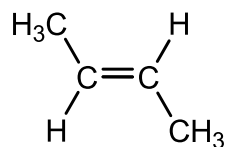
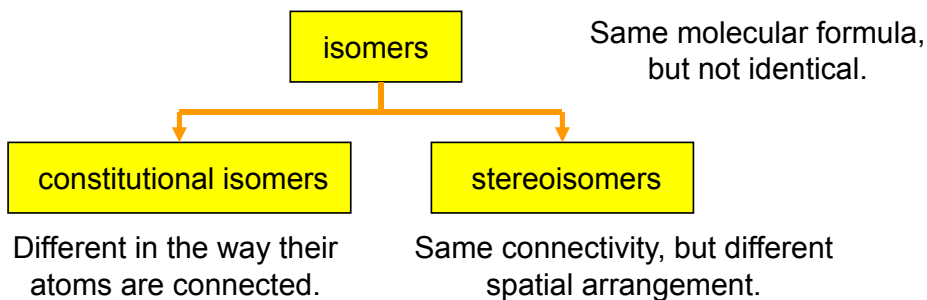
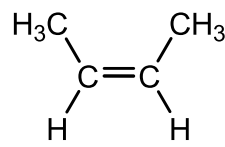


A Reminder...



trans-2-butene

and



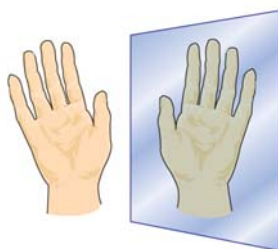
cis-2-butene

are *stereoisomers*.

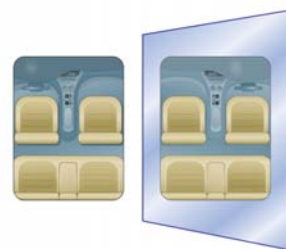
Chirality: A Type of Stereoisomerism

Any object that *cannot* be superimposed on its mirror image is **chiral**.

chiral objects

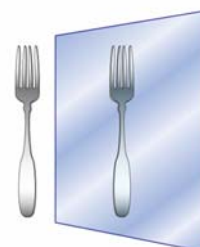
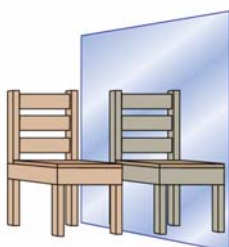


right hand left hand



Any object that *can* be superimposed on its mirror image is **achiral**.

achiral objects



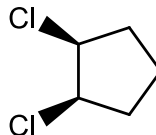
Chirality: A Type of Stereoisomerism

Molecules can also be **chiral** or **achiral**.

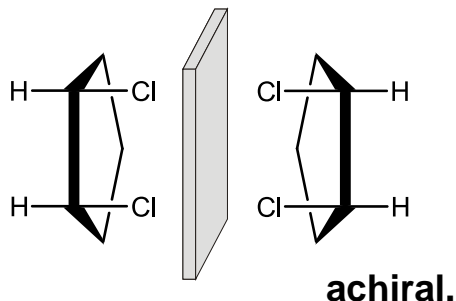
How do we know which?

Example #1:

Is this molecule chiral?



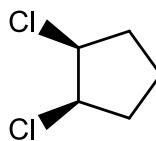
1. If a molecule can be superimposed on its mirror image, it is **achiral**.



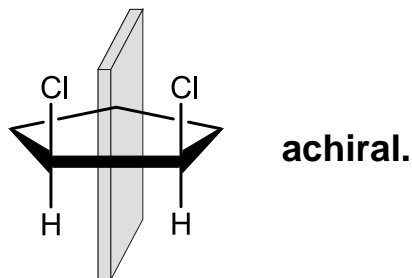
Mirror Plane of Symmetry = Achiral

Example #1:

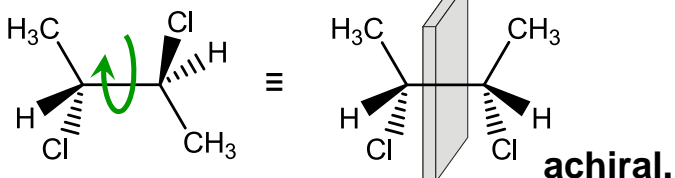
Is this molecule chiral?



2. If you can find a mirror plane of symmetry in the molecule, in any conformation, it is **achiral**.

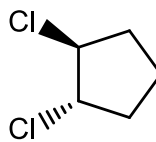


Can subject unstable conformations to this test.

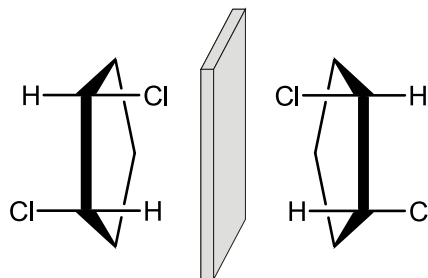


Finding Chirality in Molecules

Example #2:
Is this molecule chiral?



1. If a molecule *cannot* be superimposed on its mirror image, it is **chiral**.

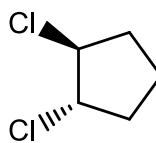


chiral.

The mirror image of a chiral molecule is called its **enantiomer**.

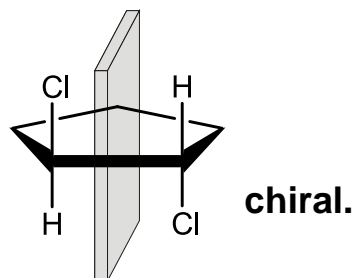
Finding Chirality in Molecules

Example #2:
Is this molecule chiral?



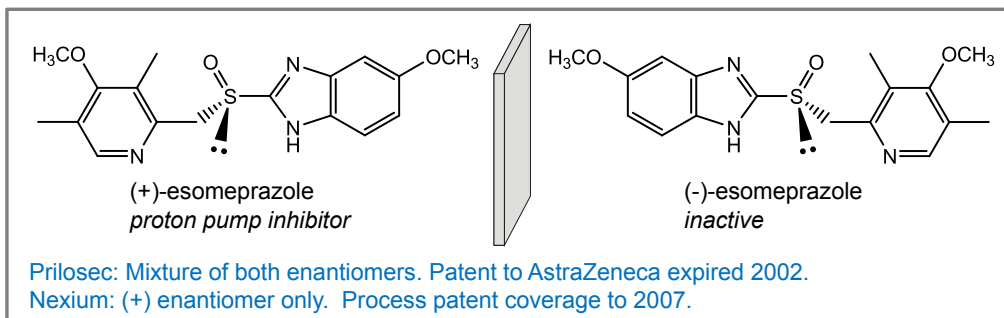
2. If you *cannot* find a mirror plane of symmetry in the molecule, in any conformation, it is **chiral**.

(Or maybe you haven't looked hard enough.)

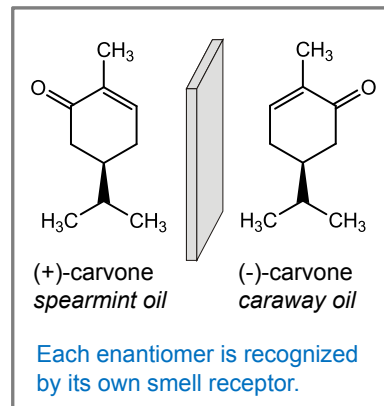
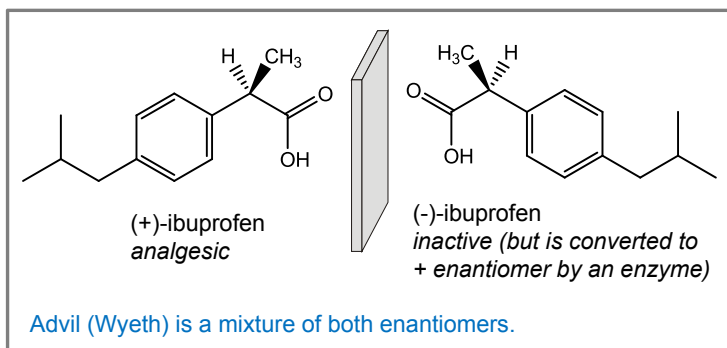


chiral.

Pharmacology of Enantiomers

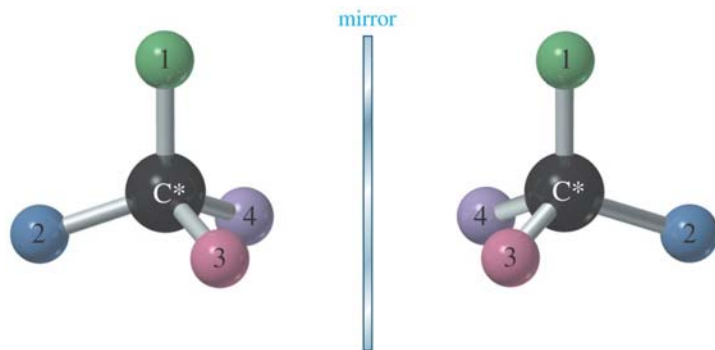


More examples at <http://z.umn.edu/2301drugs>.



Chirality Is Often Due to Chiral Centers

Chiral center: A tetrahedral atom with four different groups attached.

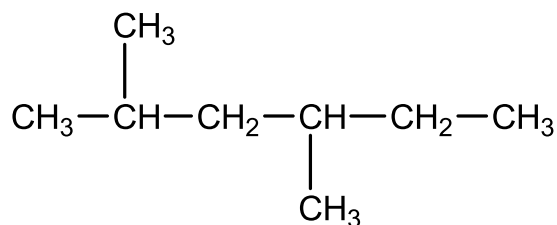
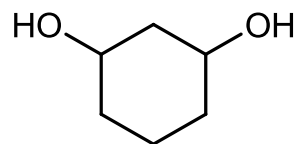
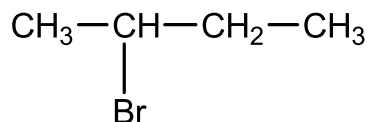


Cannot be superimposed on their mirror images. **Chiral.**

Stereocenter: Atom for which exchange of two groups leads to a stereoisomer. Includes alkene carbons.

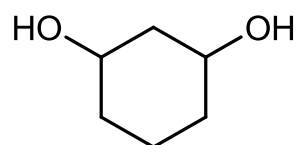
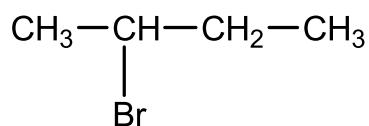
Identifying Chiral Centers

Where are the chiral centers in the following molecules?



Chirality Is Often Due to Chiral Centers

- If a molecule contains **no** chiral centers, it is almost always *achiral* (with very few exceptions).
- If a molecule has **one** chiral center, or an **odd number** of chiral centers, it is *always chiral*.
- If a molecule has **two** chiral centers, or an **even number** of chiral centers, it may or may not be chiral.



Chiral or achiral?

If chiral, what do enantiomers look like?

Cahn-Ingold-Prelog Notation: (*R*) vs. (*S*) Configuration of Chiral Centers

1. Assign priority numbers (1 through 4) to each group attached to the chiral center, based on atomic number.

In case of a tie, look at next atoms along the chain.

- If one has a higher atomic number than others, it gets priority.
- Then, if one has more copies of an atom, it gets priority.
Multiple bonds count as multiple copies of the same atom.

2. Rotate the molecule so that the lowest-priority (#4) group is pointed to the back.
3. If groups 1 \rightarrow 2 \rightarrow 3 are organized clockwise, then configuration is (*R*); if groups 1 \rightarrow 2 \rightarrow 3 are organized counterclockwise, then configuration is (*S*).