Chapter 5:
Stereochemistry – Part 2 Diastereomers

Today –Chapter 5 (5.3, 5.5, 5.6, 5.8)

Diastereomers

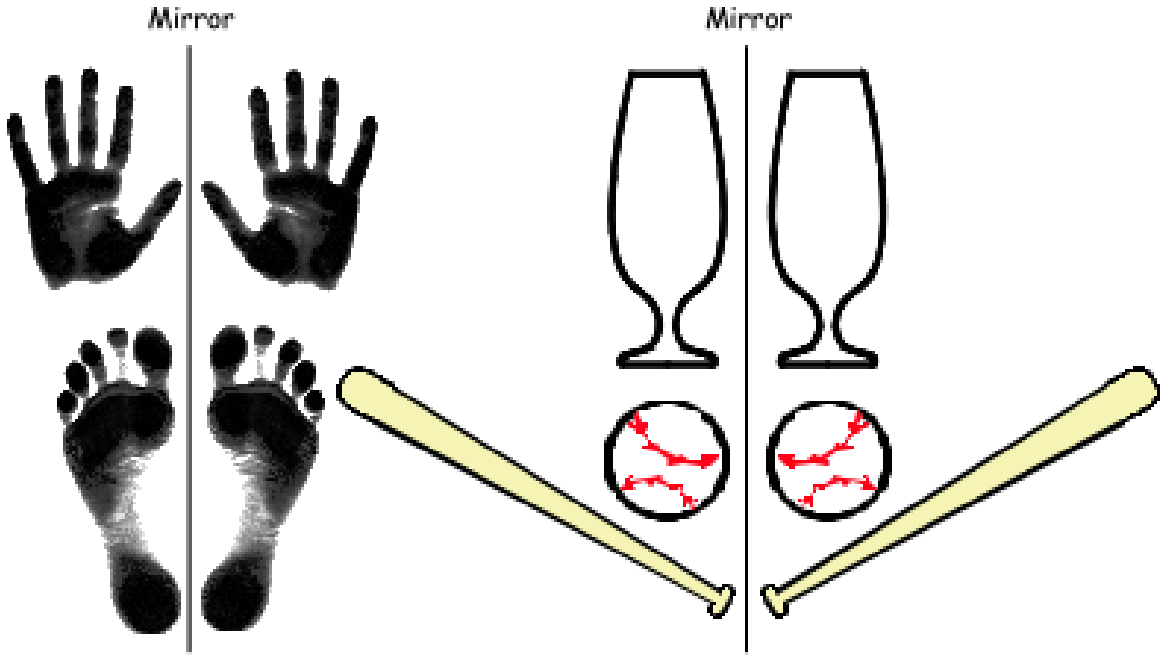
Monday Chapter 5 (5.4, 5.9-5.11)

Resolving Enantiomers

Wednesday Chapter 6

CHIRALITY

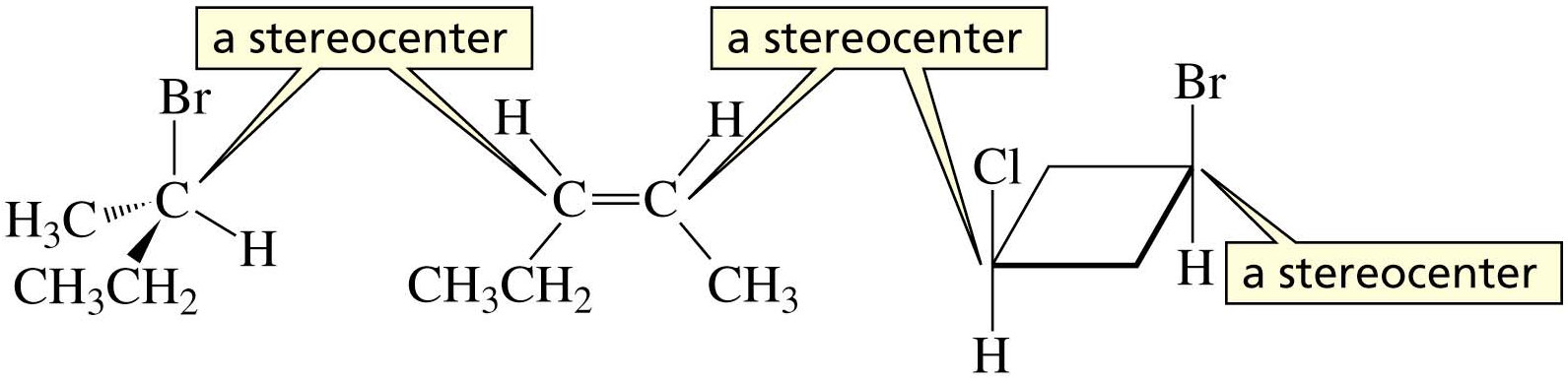
An object that cannot be superimposed on its mirror image is called chiral



Chiral objects
Nonsuperimposable
mirror images

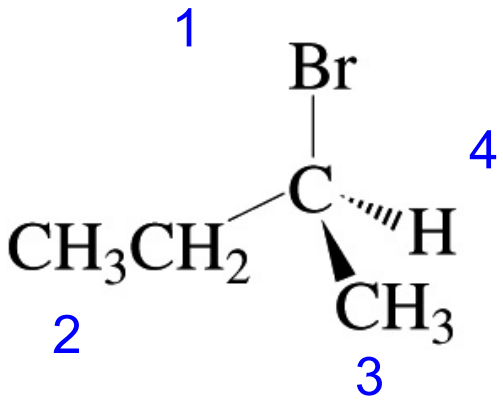
Nonchiral objects
Superimposable
mirror images

A stereocenter (stereogenic center) is an atom at which the interchange of two groups produces a stereoisomer

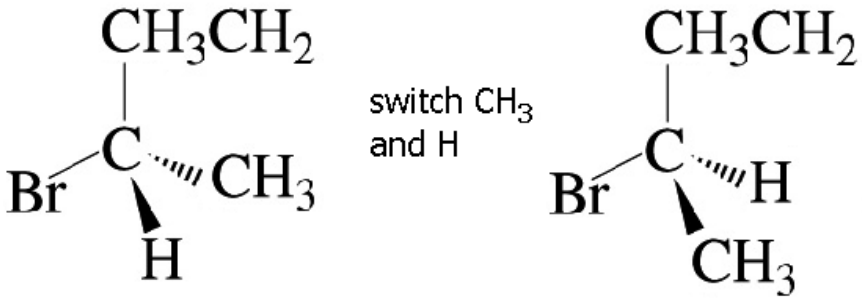


Naming Enantiomers ~ *R* and *S*

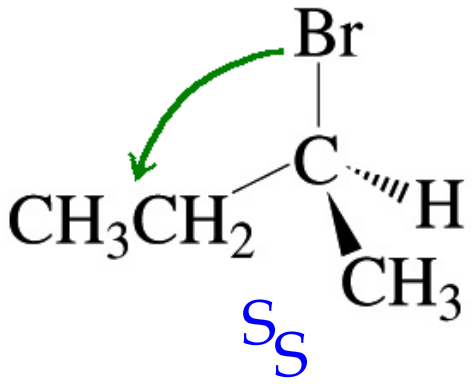
1. Rank the groups bonded to the asymmetric carbon or chirality center



2. Orient the lowest priority (4) away from you.
If necessary, rotate the molecule so that the lowest priority group is bonded by a hatched wedge



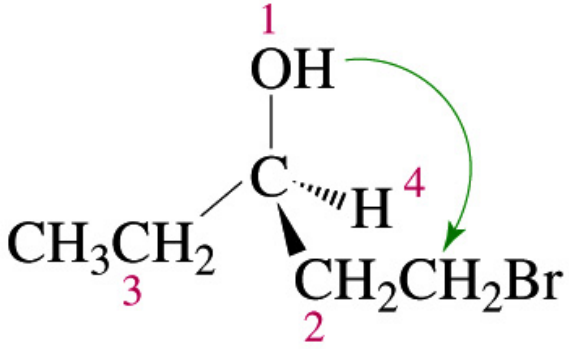
3. Once the group (or atom) with the lowest priority is bonded by hatched wedge,



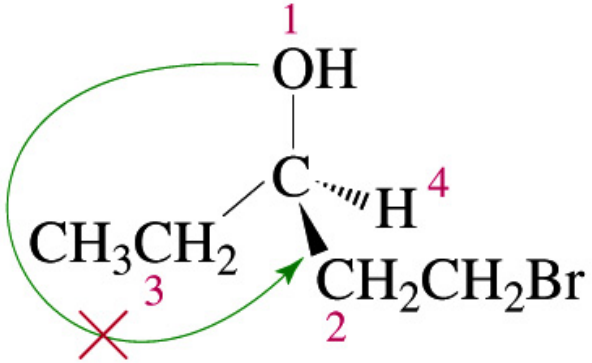
S

S

4.



(*R*)-1-bromo-3-pentanol



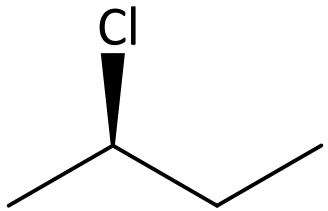
The *R,S* system of nomenclature

Clockwise = *R* configuration

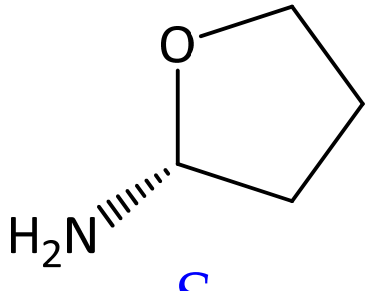
Counterclockwise = *S* configuration

Designating Configurations

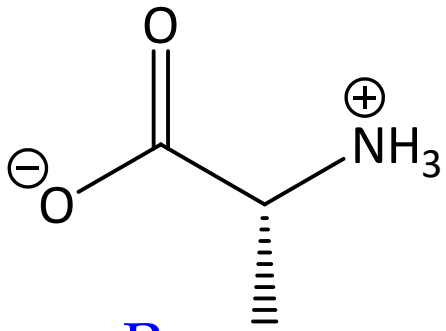
Designate each chiral center below as either *R* or *S*.



R



S



R

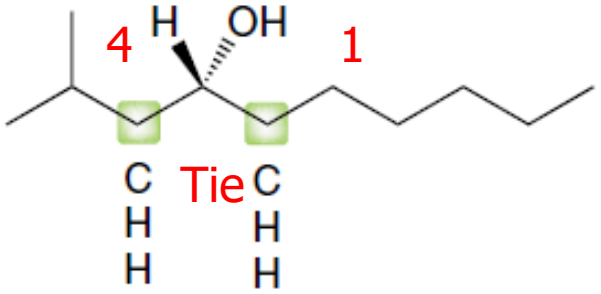
Designating Configurations

- Cahn-Ingold-Prelog rules:
  1. Using atomic numbers, prioritize the four groups attached to the chiral center
  2. Arrange the molecule in space so the lowest priority group faces away from you
  3. Count the group priorities 1...2...3 to determine whether the order progresses in a clockwise or counterclockwise direction
  4. Clockwise = *R*
     Counterclockwise = *S*

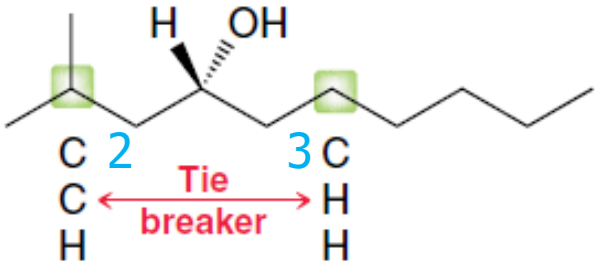
Designating Configurations

- When the groups attached to a chiral center are similar, it can be tricky to prioritize them.
- Analyze the atomic numbers one layer of atoms at a time.
  - Is this molecule *R* or *S*?

First layer:



Second layer:

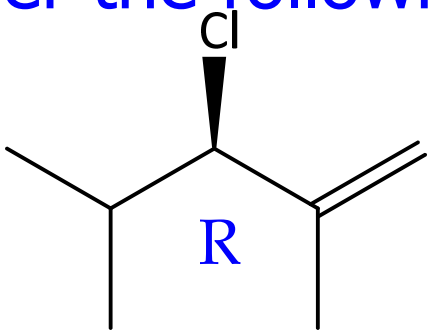


R

Designating Configurations

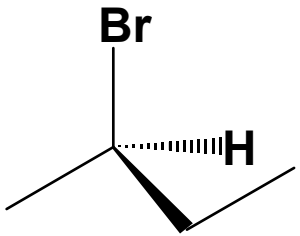
- When prioritizing for the Cahn-Ingold-Prelog rules, double bonds count as two single bonds.

- Determine whether the following molecule is *R* or *S*.

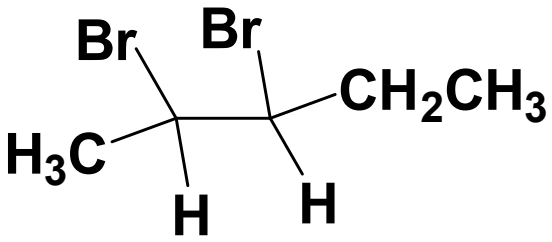


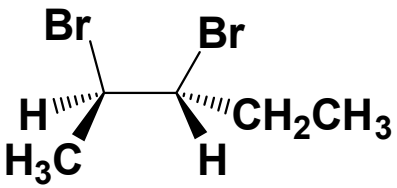
Stereoisomeric Relationships

Draw (R) – 2- bromo – butane

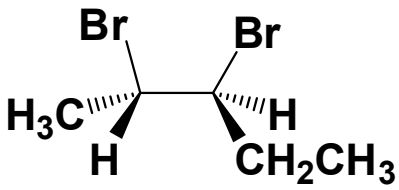


Let's look at 2,3 – dibromopentane

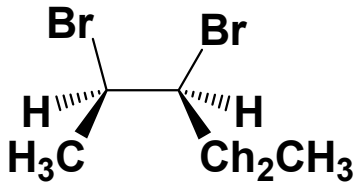




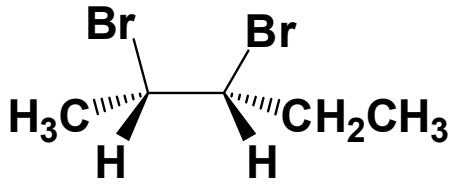
R R



S S



R S

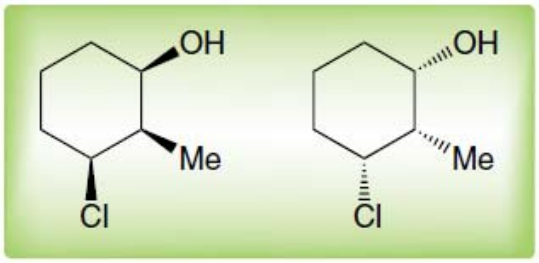


S R

Diastereomers are stereoisomers that are not enantiomers

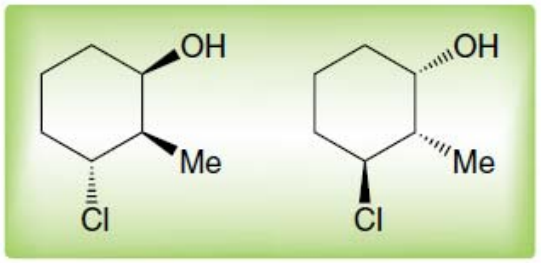
Stereoisomeric Relationships

- Consider a cyclohexane with three substituents:



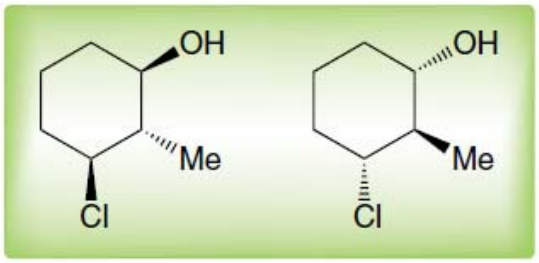
1*R*, 2*R*, 3*S*

1*S*, 2*S*, 3*R*



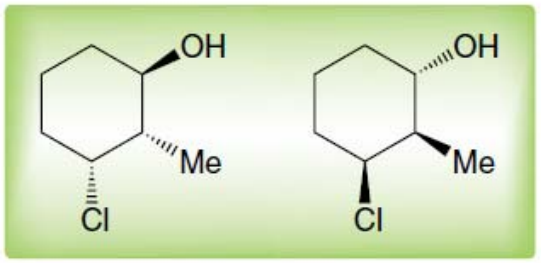
1*R*, 2*R*, 3*R* 1*S*, 2*S*, 3*S*

- What patterns do you notice?



1*R*, 2*S*, 3*S*

1*S*, 2*R*, 3*R*



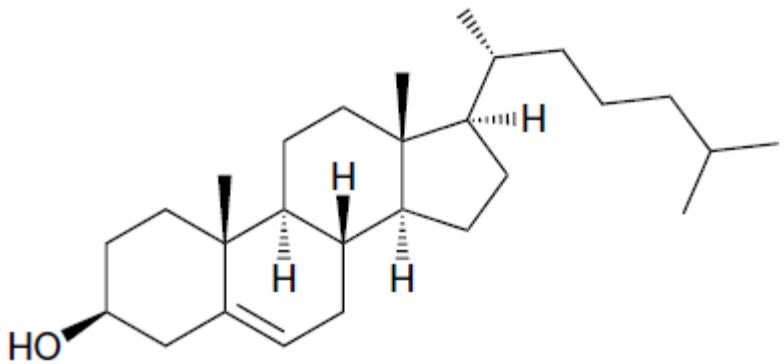
1*R*, 2*S*, 3*R* 1*S*, 2*R*, 3*S*

Stereoisomeric Relationships

- The number of possible stereoisomers for a compound depends on the number of chiral centers (n) in the compound.

$$\text{Maximum number of stereoisomers} = 2^n$$

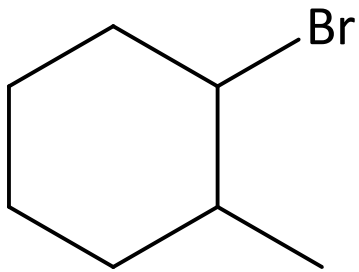
- What is the maximum number of possible cholesterol isomers? 2^8!!



Cholesterol

Stereoisomeric Relationships

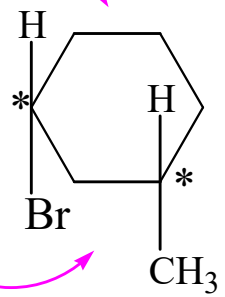
- Draw each of the four possible stereoisomers for the following compound. It might be helpful to also make a handheld model for each isomer.

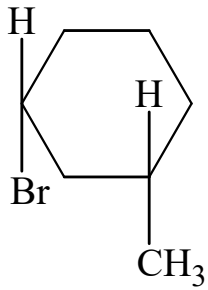


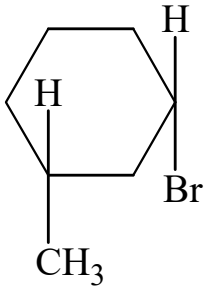
- Pair up the isomers in every possible combination and label the pairs as either enantiomers or diastereomers.

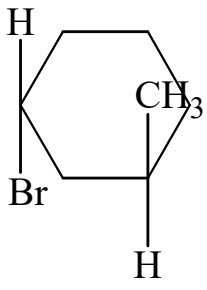
Identification of Asymmetric Carbons in Cyclic Compounds

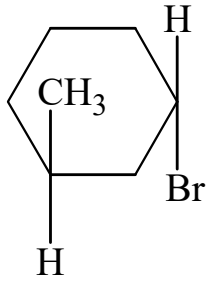
these two groups are different











cis-1-bromo-3-methylcyclohexane

trans-1-bromo-3-methylcyclohexane

Label these R and S!

For Next Time….

Monday Chapter 5 (5.4, 5.9 – 5.11)

Resolving Enantiomers

Suggested Homework Problems Chapter 5

#4, 9, 19,23,31, 36,38 (a-c), 39 (a-e),45, 55