

(10) Today

Sections 5.1 – 5.5

Chirality and Determining the Configuration of Chiral Centers

Sections 5.6 – 5.12

Diastereomers, N,P, and S, and Prochirality

Next Class (11)

Sections 5.1 – 5.5

Chirality and Determining the Configuration of Chiral Centers

Sections 5.6 – 5.12

Diastereomers, N,P, and S, and Prochirality

(12) Second Class from Today

Section 5.11, 5.12

Chap 6

Third Class from Today (13)

Chap 6

Rework Test 1 by Monday June 9.

There are no classes on Thursday, June 19th.

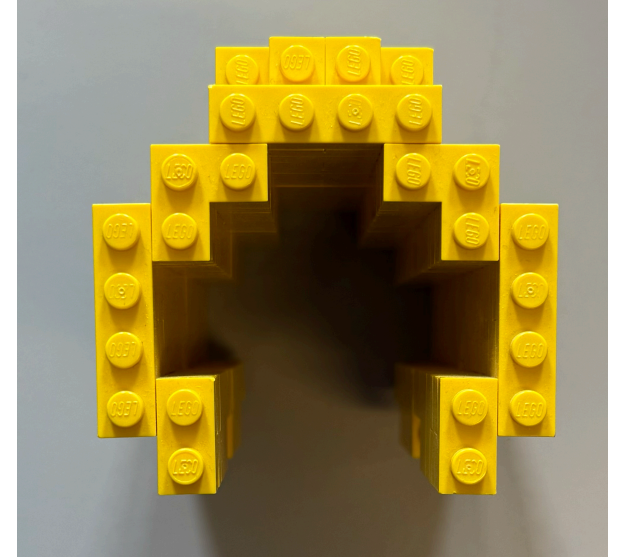
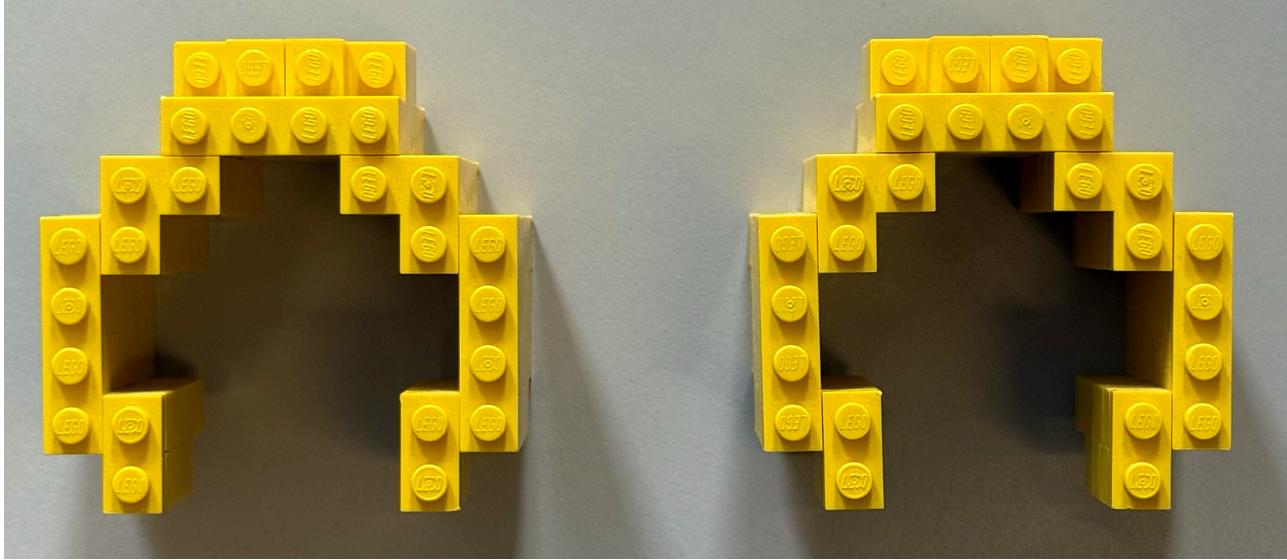
Handedness is a form of stereoisomerism: same connections different 3-D relationships.

Handedness: What makes your hands or your feet have handedness?



Does the large LEGO minifigure have a right hand?

Handedness: What makes your hands or your feet have handedness?



Does the large LEGO minifigure have a right hand?

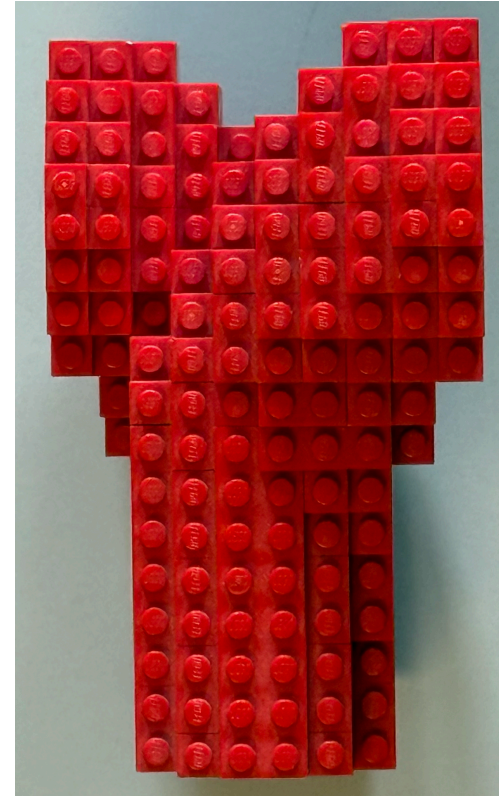
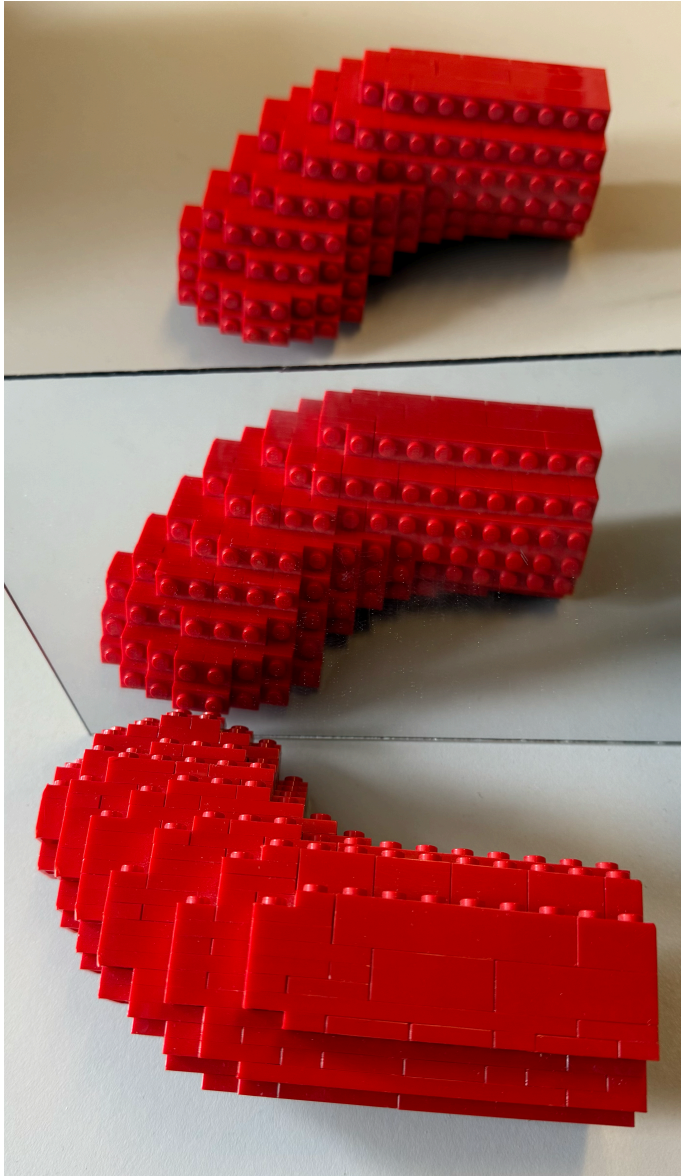
No, they're just hands... neither is a left or a right hand.
They just happen to be on the left and right sides of the minifigure.

Handedness: What makes your hands or your feet have handedness?



Try again... Does the large LEGO minifigure have a right arm?

Handedness: What makes your hands or your feet have handedness?



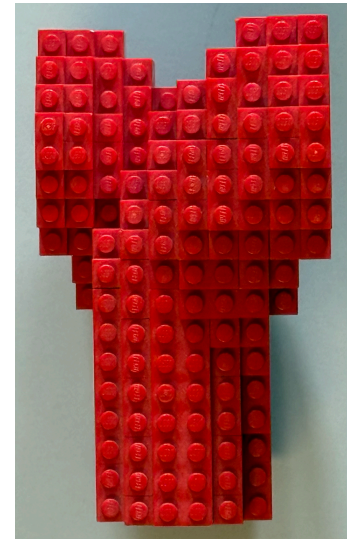
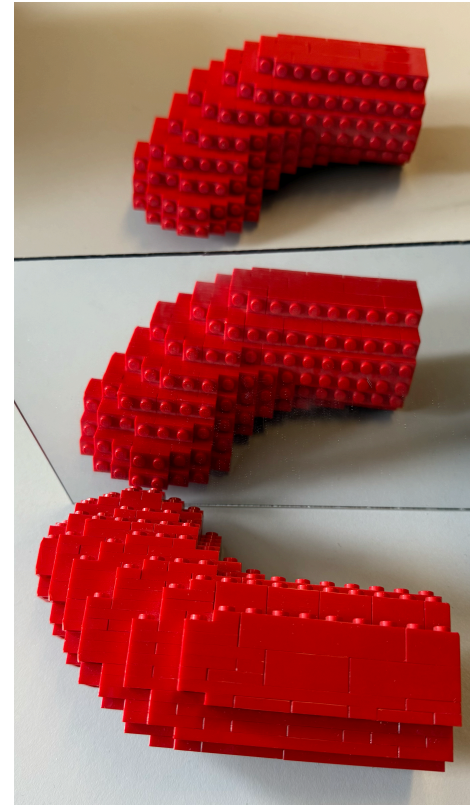
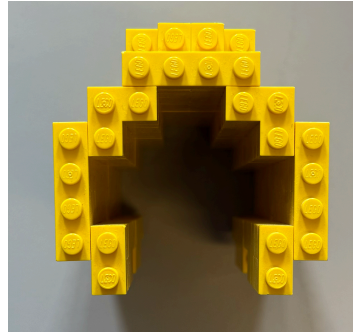
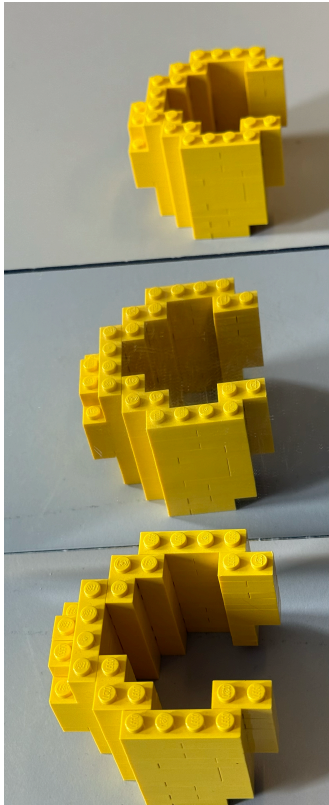
Try again... Does the large LEGO minifigure have a right arm?

YES, the minifigure's arms have handedness.

Handedness: What makes **your** hands or feet have handedness?

Section 5.1 – 5.5

The mirror image of your left hand is not superposable onto your left hand.



Superposable means that when you superimpose the two objects everything lines up.

The mirror image of a chiral object is not superposable on the original object

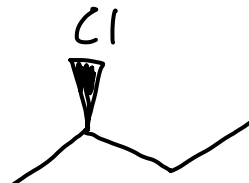
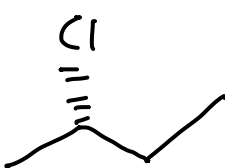
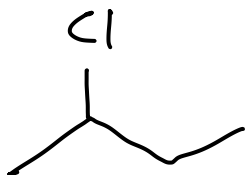
Which of the following are chiral?

Think about the object, not the drawing

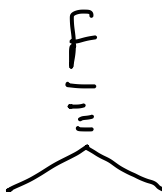


these two can be split in half
and the missing half can be
regenerated using a mirror

Build

2-chlorobutane

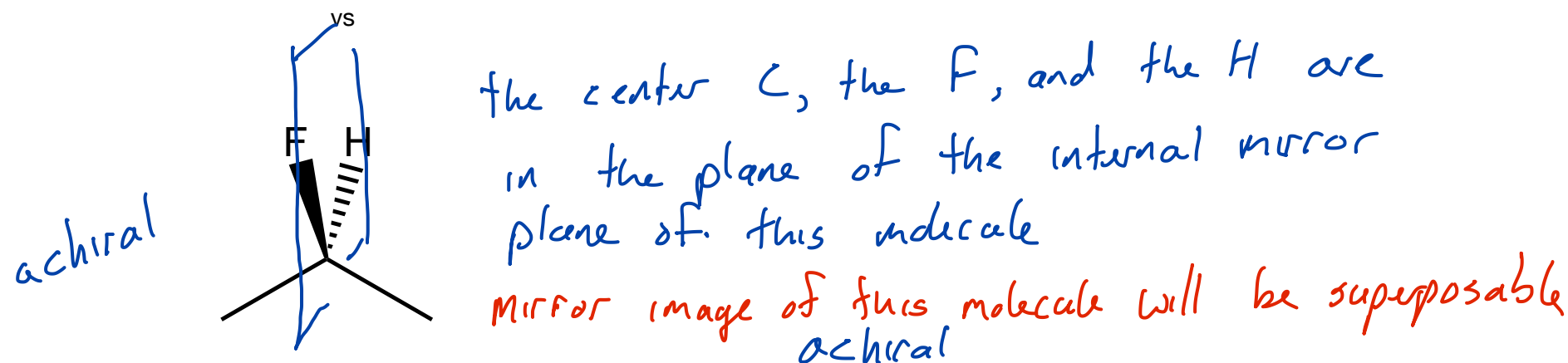
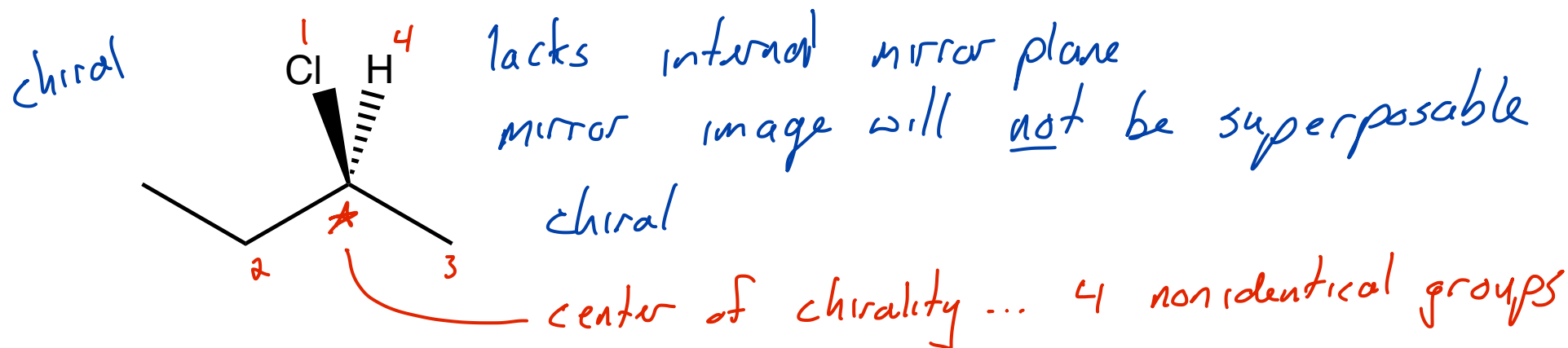
not superposable ... chiral

2-fluoropropane

superposable ... different views
of the same molecule

The mirror image of a Chiral Object is not superposable on the original object

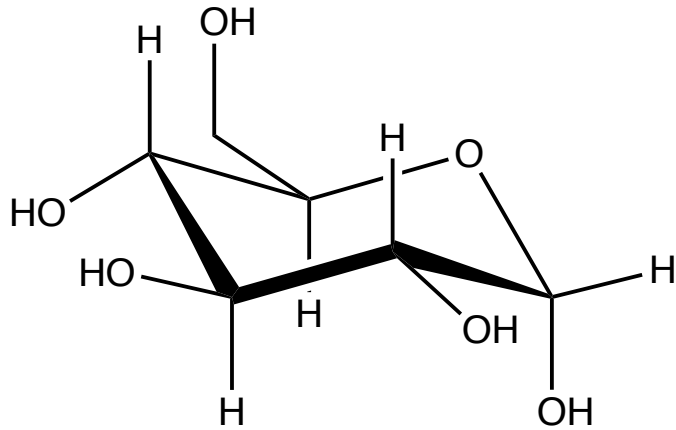
A chiral object cannot have an internal mirror plane (a.k.a. plane of symmetry)*



*Technically, it's an improper axis of rotation, but a mirror plane is an S_1 and a center of inversion is an S_0 , and almost every point group that contains an S_n axis also contains a mirror plane of some sort. The S_4 point group is only point group that has an improper axis of rotation and doesn't also have a plane of symmetry. The C_i point group is the only point group that has a center of inversion and doesn't also have a plane of symmetry.

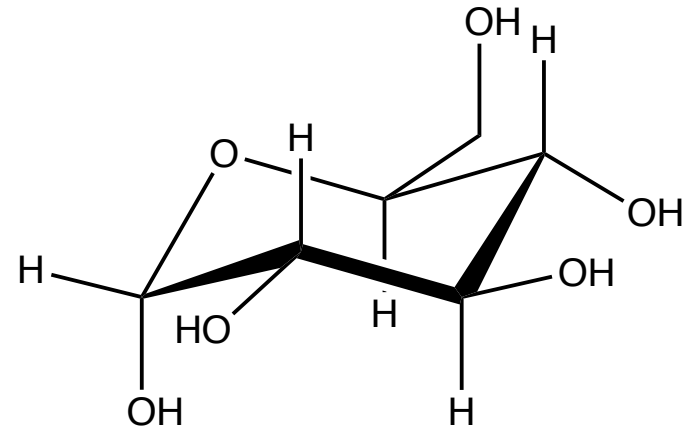
Why Do I care?

Section 5.1 – 5.5



D-glucose
11¢ per gram

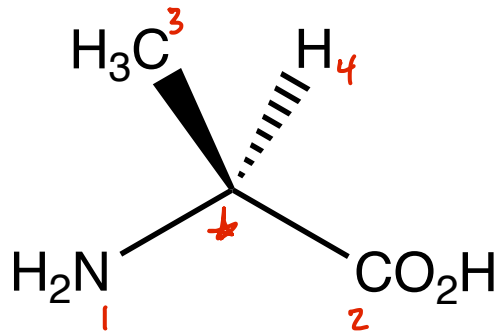
*naturally occurring
sugar*



L-glucose
\$130 per gram

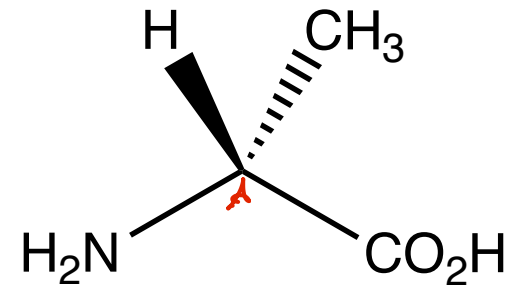
Why Do I care?

Section 5.1 – 5.5



L-alanine

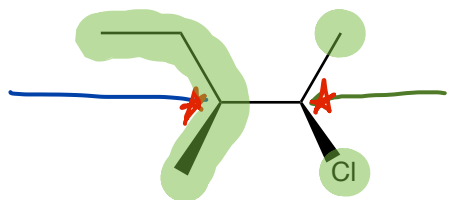
*used to make
proteins*



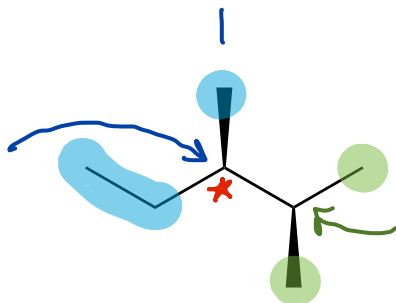
D-alanine

*uncommon
found in bacterial
cell walls*

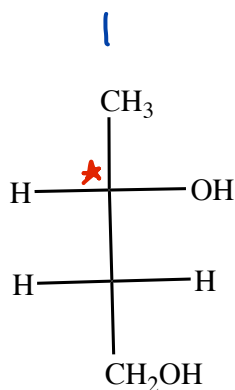
Section 5.1 – 5.5

$$\begin{array}{c} \text{Et} \\ | \\ \text{Me} \\ | \\ \text{H} \\ | \\ \text{CHClCH}_3 \end{array}$$

$$\begin{array}{c} \text{Me} \\ | \\ \text{C} \\ | \\ \text{sec-butyl} \\ | \\ \text{H} \end{array}$$

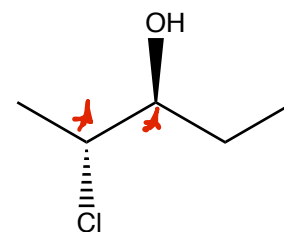
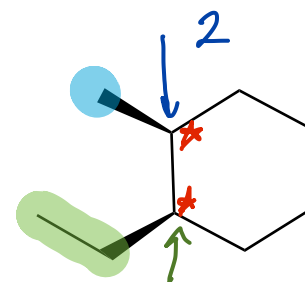
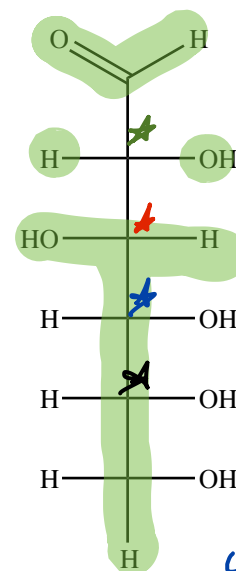
Et
Me
H
iso-propyl



CH_3
 CH_3
 H
 other

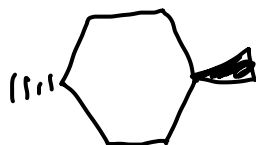


Cl
CH₃
H
other


$$\begin{array}{l} \Delta H \\ H \\ CH_2CH_3 \\ \text{others} \end{array}$$

$$\begin{array}{c} M_c \\ H \\ \underline{CH}_2 \cdots \\ \underline{CH} CH_2 CH_3 \end{array}$$
$$\begin{array}{c} \text{Et} \\ | \\ \text{H} \\ | \\ \text{CH}_2 \\ | \\ \text{CH} \end{array}$$


4

Definitions



stereoisomers
not enantiomers

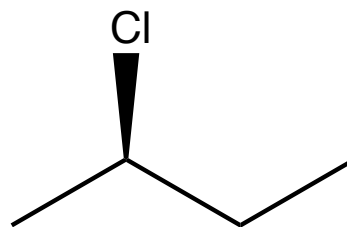
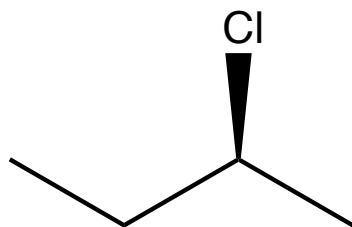
stereoisomers are molecules that have the same connectivity but different 3-D relationships between parts of the molecules

e.g. (*R*)-2-chlorobutane vs (*S*)-2-chlorobutane

The word **enantiomer** describes the relationship between two stereoisomers.

enantiomers are stereoisomers that are nonsuperposable mirror images of each other and an object must be **chiral** to have an enantiomer

e.g. (*S*)-2-chlorobutane vs (*R*)-2-chlorobutane



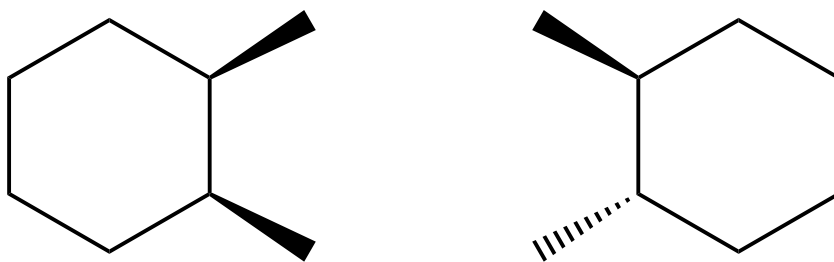
Definitions

stereoisomers are molecules that have the same connectivity but different 3-D relationships between parts of the molecules

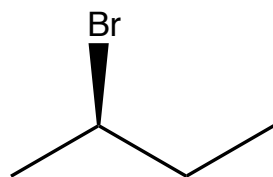
e.g. (*cis*)-1,2-dimethylcyclohexane vs (*trans*)-1,2-dimethylcyclohexane

The word **diastereomer** describes the relationship between two stereoisomers.

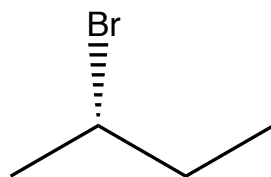
Diastereomers are stereoisomers that are nonsuperposable but are **NOT** mirror images of each other



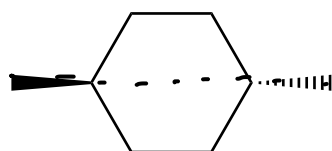
Recognizing Enantiomers and Diastereomers: Why is it important?



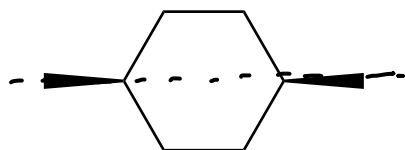
BP = 91 °C



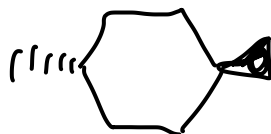
BP = 91 °C*



BP = 119 °C†



BP = 125 °C††



non-superposable mirror images
enantiomers have the same
physical properties ...
only difference is how they
interact with other chiral objects
& polarized light

diastereomers have different
physical properties so they
are easier to separate &
they react differently

not superposable but also not
mirror images of each other

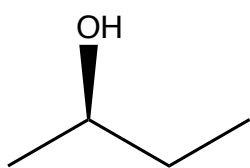
*<https://en.wikipedia.org/wiki/2-Bromobutane>

†<https://us.vwr.com/store/product/16811100/trans-1-4-dimethylcyclohexane-95-0-by-gc>

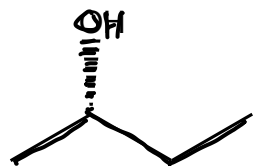
††<https://us.vwr.com/store/product/9559540/cis-1-4-dimethylcyclohexane-98-0>

What's the Relationship?

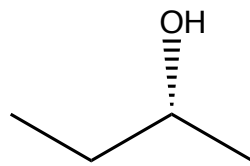
Section 5.1 – 5.5



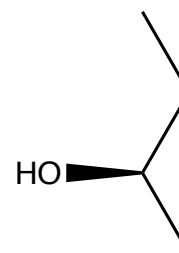
A



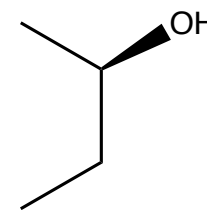
B



C



D



E

different view of the same molecule/rotamer or enantiomer or diastereomer

AB enantiomers

AC dif views

AD dif views

AE dif view/rotamer

Assign Priorities

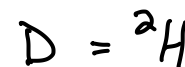
highest priority is given to the group with the highest atomic number for the atom directly bonded to the chirality

1 bond further away from the chirality

in a tie, consider the atomic numbers of the atoms attached to the atom that is bonded to the *center* chirality center

if the atom that is attached to the chirality center has a doubly bonded or triply bonded atom attached to it the atom is treated like there are two or three atoms

for isotopes, the mass number is used (D vs H, ~~^{12}C vs ^{13}C~~)

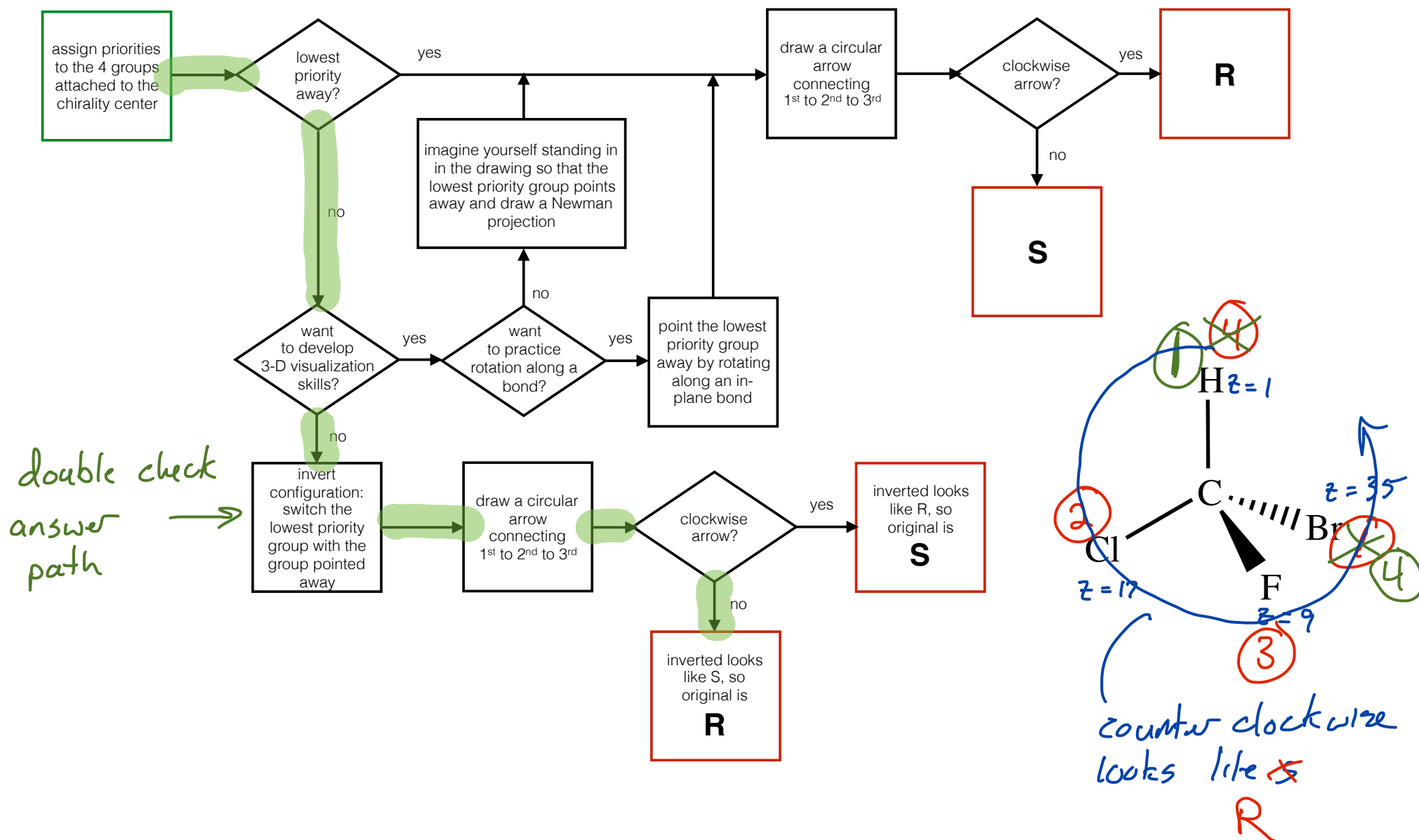


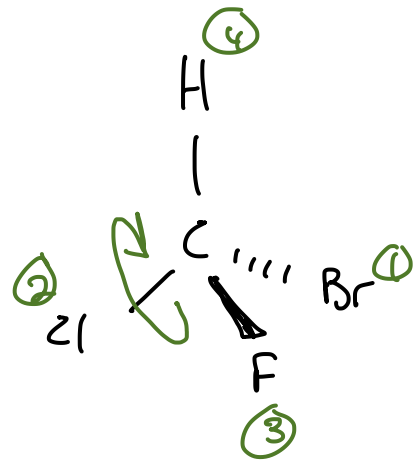
Point lowest priority group away

Draw a circle from 1st to 2nd to 3rd priority groups

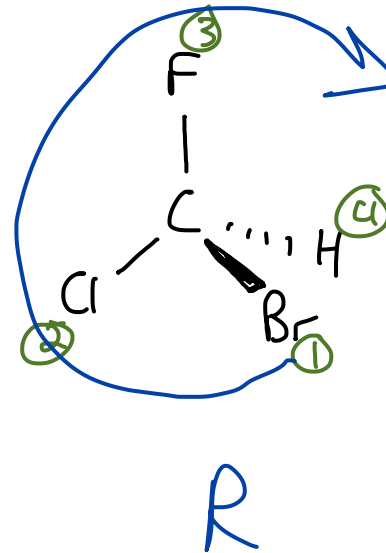
Clockwise circle is **R** configuration

Counter Clockwise circle is **S** configuration

Determining Configuration (*R* vs *S*)



rotate or
 \Rightarrow
 in-plane
 bond
 to put
 4 in
 back
 120



Practice determining the configuration of centers of chirality

Section 5.1 – 5.5

Priorities are based on the atomic number of the atoms bonded to the chiral center.

Highest atomic number is 1st place to lowest atomic number in 4th place

In a tie, go one bond further out.

