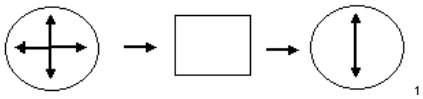
Stereochemistry: The Basics of Solving Problems

Important Terms:

1. *Optically Active* – optically active compounds rotate plane polarized light (*Figure 1.1*)



[1]

Figure 1.1: Non-polarized light hitting a crystal (which is optically active) and becoming polarized light (lying in the same plane)

2. *Dextrorotatory* – compound that rotates plane polarized light clockwise (*Figure 1.2*)

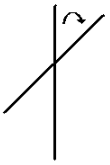


Figure 1.2: a dextrorotatory compound being rotated clockwise

3. *Levorotatory* – compound that rotates plane polarized light counterclockwise (*Figure 1.3*)

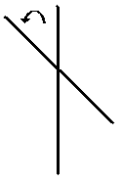


Figure 1.3: A levorotatory compound being rotated counterclockwise

4. *Stereocenter* – generally a Carbon with four different attachments (Figure 1.4)

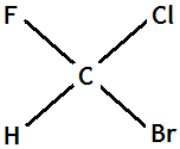
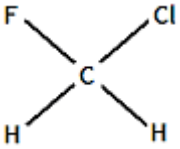


Figure 1.4: The molecule on the left is a stereocenter since it has FOUR different attachments while the one on the right has only THREE different attachments

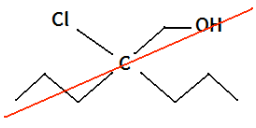


5. *Stereoisomer* – isomers that differ only in the position of atoms in space and cannot be interconverted by rotation around a sigma bond
6. *Enantiomer* – a pair of molecules that are non super imposable mirror images
7. *Diastereomer* – any two molecules that are not enantiomers
8. *Chiral* – an optically active molecule that is not super imposable with its mirror image (chiral + chiral = enantiomer)
9. *Racemic Mixture* – an equimolar mixture of enantiomers

**Note*! Do not use the two terms *configuration* and *confirmation* interchangeably, there is a difference! Configurations take into consideration of whether the attachments in a molecule are going clockwise or counterclockwise (R or S) while a conformation "are the different positions that a molecule can twist into"[2]

How to find a stereocenter: It's pretty simple to locate a stereocenter. Only one rule should be kept in mind and that is that the Carbon atom has to have FOUR DISTINCT ATTACHMENTS. As long as you keep that in mind, you should be fine, now here are a few examples to go through:

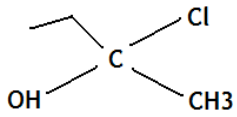
a.



This Carbon is not a stereocenter because it has two propyl attachments which violates the rule of having four different attachments

[1] Diagram taken from *Chemistry 14C Thinkbook*, Steven Hardinger, page 32
[2] *Organic Chemistry as a Second Language*, David R. Klein, page 134

b.



This Carbon is a stereocenter since it has four distinct attachments.

How to determine configuration of a stereocenter:

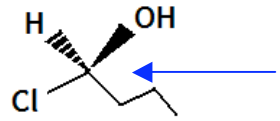
Cahn-Ingold-Prelog Priority Rules – Rules that assign priority to atoms or groups for various purposes such as labeling the absolute configuration of a stereocenter. Lowest priority is assigned to the atom or group wit the lowest atomic number.[3]

The three basic rules of finding a configuration!:

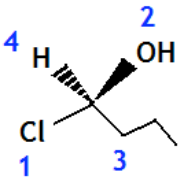
1. Find stereocenter
2. Assign priorities through highest atomic numbers (Cahn-Ingold-Prelog Priority Rule)
3. Put number four to the back

**Note, it is especially helpful to use a model kit when determining stereocenters and finding configurations.*

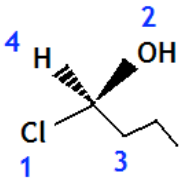
a.



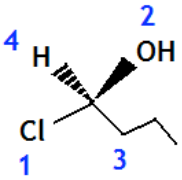
First, locate the stereocenter



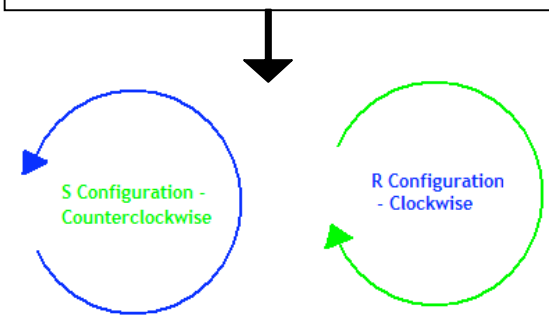
Now assign priorities to the different attachments. Chlorine would be number one since it has the atomic number, then Oxygen with 2 and so on.



Once the priorities are assigned, make sure the lowest one (4) is sent to the back. (The hydrogen which has the number 4 priority is already in the back with the dashed wedge).



Once priorities have been determined, follow these rules to determine if it is in the S or R configuration. Since this molecule is going clockwise (in a 1-2-3 pattern), it is in the R configuration.

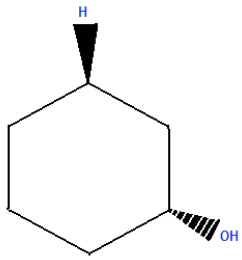


[3] *Chemistry 14C Thinkbook*, Steven Hardinger, page 194

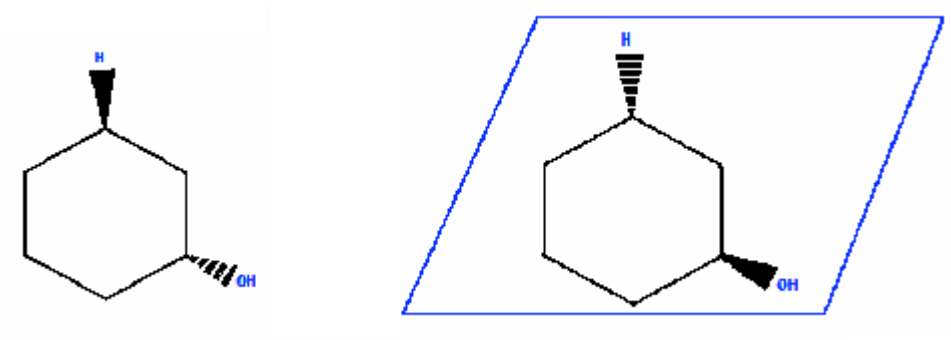
Drawing Enantiomers and Diastereomers:

Enantiomers- these are basically two compounds that are non-super imposable mirror images. It means no matter how you place them, they will never be imposed on top of each other. Just think of it as your hands, they are mirror images of each other. But when you try to stack one hand on top of another, it doesn't fit. That's the gist of it.

*Note: When drawing an enantiomer of a molecule with wedges, the solid wedges become dashed wedges and vice versa



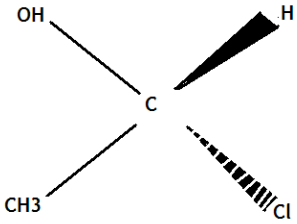
a. Draw the entantiomer of



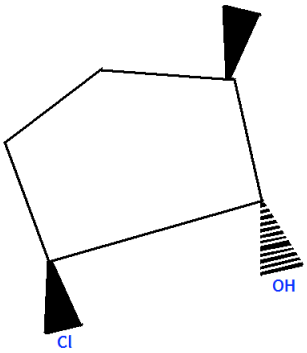
Remember that when drawing an enantiomer, the wedges turn into dashes and dashes turn into wedges. So the H which was originally wedges turns into a dash and the OH which was originally dashed turns into a wedge. (Think of the blue box as the mirror itself)

Diastereomers – Diastereomers are different form enantiomers because enantiomers only come in twos while a whole group ca be considered diastereomers. A molecule has to have more than one stereocenter to have diastereomers. Only one stereocenter in a molecule is limited to only an enantiomer.

a. Draw a diastereomer of



Remember the "one stereocenter" rule. This molecule has only one stereocenter and therefore can only have an enantiomer which means no diastereomers.



b. Draw a diastereomer of:

There are a few possibilities of diastereomers, as long as its not a mirror image of the original molecule, everything should be fine. The molecule on the right is an example of one possible diastereomer.