CHE 102 – Spring 2005 – Study Guide Ch. 26 and 27

Chapter 26: Stereoisomerism

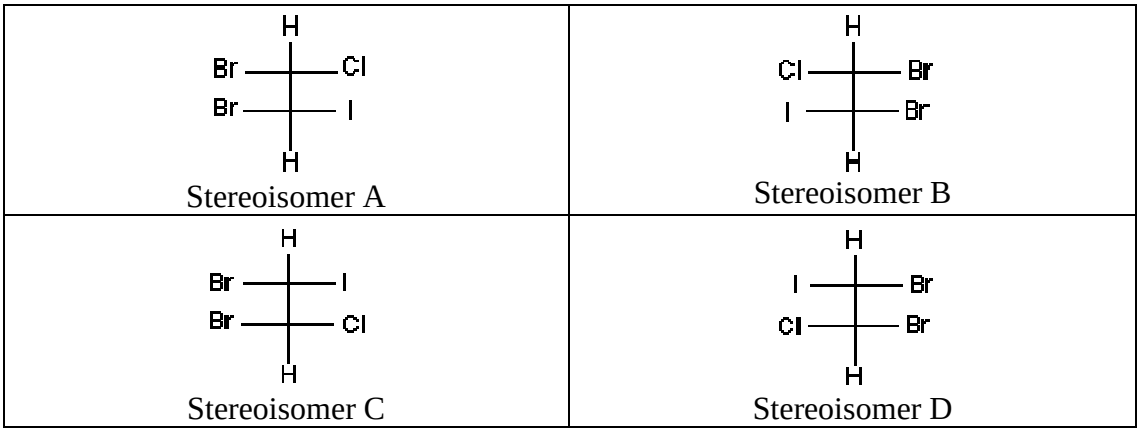
1. Definitions
    a. Isomer: Same formula, different structure
    b. Stereoisomer: same formula, same structure, different spatial arrangement
        i. Rotate the plane of polarized light (α = specific rotation = amount that light is rotated)
        ii. Dextrorotatory (+): clockwise rotation of light
        iii. Levorotatory (-): counterclockwise rotation of light
    c. Chiral Carbon: An asymmetric carbon resulting in a molecule with a non-superimposable mirror image which can rotate light. In order to be chiral a carbon must be:
        i. Bonded to four different groups
        ii. Have a tetrahedral arrangement or bond angles
        iii. Contain no additional planes of symmetry.
        iv. Ex. Hands, feet
    d. Achiral: Molecules or objects that can be superimposed on each other. Ex. pencil, cube

2. Projection Formulas: method for drawing 3D molecules in a 2D form. The dark triangle indicate bonds coming out of the paper (C and D) and the dashed triangles indicate bonds going into the paper (A and B)

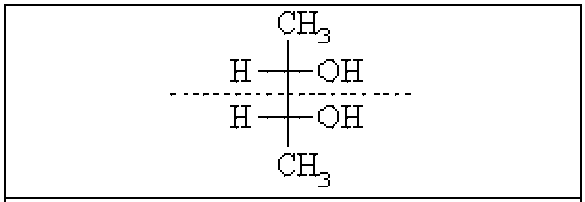
3. Stereoisomers: Molecules with the same formula, same structure, but different geometry.
    a. The maximum number of stereoisomers is given by 2^N where N = number of chiral carbons on the molecule. A molecule may contain less then the maximum number of stereoisomers if the molecule has a meso structure.
    b. Stereoisomers are related to each other in three ways, they can be Enantiomers or Diasteromers or Meso compounds.

4. Enantiomers:
    a. Chiral molecules that are mirror images of each other.
    b. Not all chiral molecules posses an enantiomer, in order to determine if a molecule is an enantiomer or just the same molecule drawn in a different manner use the following rules:
        i. Make exchanges between pairs of atoms with the end goal of turning one molecule into the other.
        ii. An even number of exchanges = same molecule
        iii. An odd number of exchanges = different molecule = enantiomer
    c. The easiest way to draw the enantiomer of a molecule is to simply draw its mirror image.

5. Diastereomers:
    a. Stereoisomers that are not enantiomers
    b. Example: A molecule with 2 chiral carbons will have a maximum of $2^2 = 4$ stereoisomers.
        i. Enantiomers: A/B and C/D
        ii. Stereoisomers: A/C, A/D, B/C, and B/D



6. Meso compounds: contain a chiral carbon but are not chiral molecules because they contain an additional plane of symmetry such that the chiral carbons on each side of the plane are mirror images. Thus, meso compounds do not have enantiomers, but they can have diastereomers.
    a. Look for molecules which have the same groups around both chiral carbons
    b. Look for molecules that have an additional plane of symmetry
    c. Meso compounds decrease the maximum number of stereoisomers a molecule has. For example a molecule with $2^2 = 4$ stereoisomers will only have a total of 3 if one of them is a meso compound.



Example of a Meso Compound

7. Properties of Stereoisomers
    a. Generally have identical chemical properties except for α.
    b. They quite often have different biological activity.
    c. Meso compounds generally have different properties then either the (+) or (–) enantiomers
    d. Racemic mixture: contains equal amounts of a pair of enantiomers. Shows no optical rotation (because the enantiomers cancel each other). Generally indicated by a (+/-) symbol. Formed in laboratory synthesis. Biological synthesis generally makes either the (+) or (-) enantiomer exclusively.

8. Importantance of Stereochemistry – examples p. 742
    a. Asparagine
    b. Limonene
    c. Thalidomide
    d. Lactic Acid
    e. Many drugs (Asprin, Lopressor, Sudafed, L-Dopa, Ritalin)
    f. Glucose