uc3m | Universidad Carlos III de Madrid

OpenCourseWare (2023)

CHEMISTRY II

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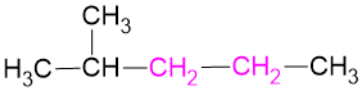
SOLUTIONS OF STEREOCHEMISTRY EXERCISES

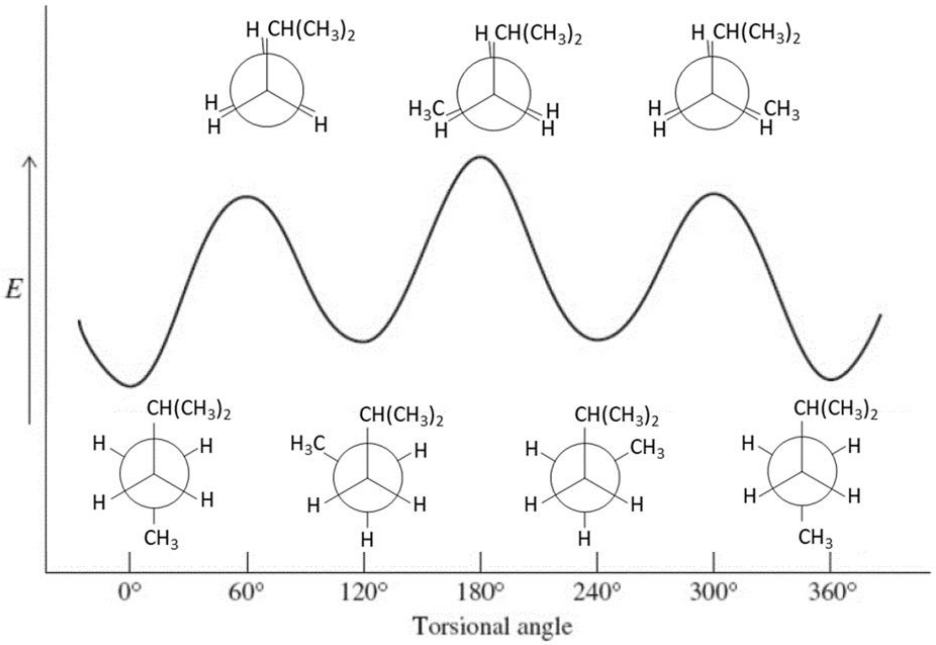
Exercise 1. Draw a qualitative potential-energy diagram for rotation about the C3-C4 bond in 2-methylpentane. Show Newman projections for all conformations located at the maximum and minimum points on your graph**.**

SOLUTION

C3 contains two hydrogens and a 1-methylethyl group, while C4 contains two hydrogens and a methyl group:



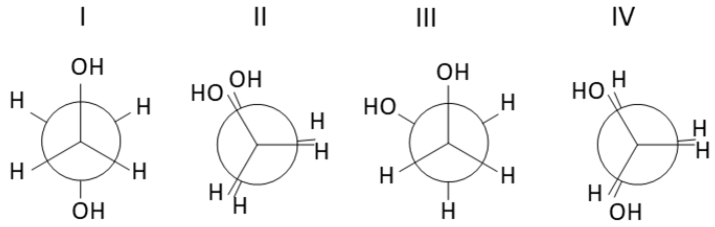
C3 – C4 bond



The single difference is that one of the alkyl groups is a 1-methylethyl substituent instead of methyl. Because of its greater size, the energies of all its steric interactions will be larger, especially in conformations that bring the two alkyl groups close together (*gauche*). Therefore, the energy differences between the *anti* and all other conformations will increase, with the greatest increase at 180° (*eclipsed* conformation).

Exercise 2. Arrange the following conformations of 1,2-ethanediol in order of stability. Name the conformations using the prefixes *anti*, *syn*, and the suffixes *periplanar* and *clinal*.

SOLUTION



The relative stabilities are determined by the steric (strain) interactions present in each conformer, which depend on the relative positions of the substituents: I > III > IV > II

I: Alternately *antiperiplanar*

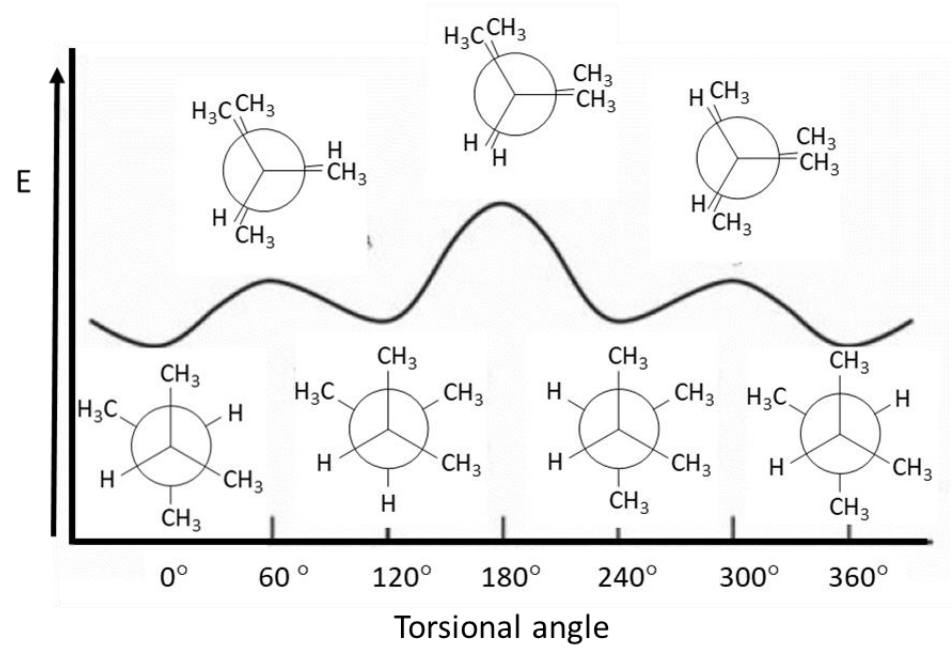
II: Eclipsed *sinperiplanar*

III: Gauche *sinclinal*

IV: Eclipsed *anticlinal*

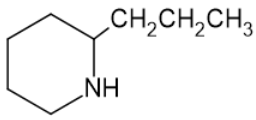
Exercise 3. Draw the expected potential-energy diagram for the rotation about the C2-C3 bond in 2,3-dimethylbutane. Include the Newman projections of each staggered and eclipsed conformation.

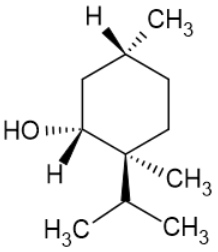
SOLUTION

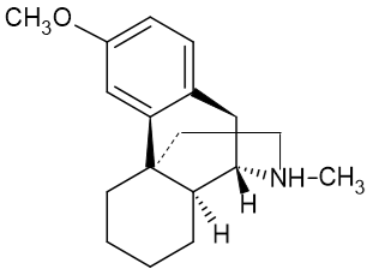


Exercise 4. Which of the following molecules are chiral? Identify the chirality center(s) in each.

(a) (b) (c)





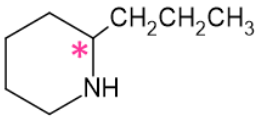


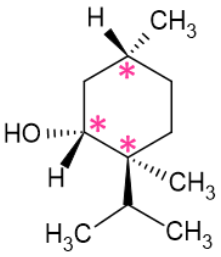
Coniine Menthol Dextromethorphan

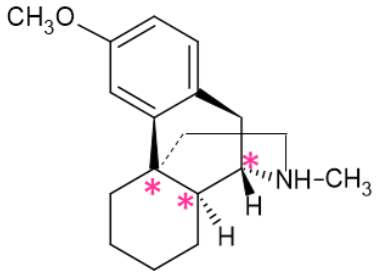
(poison hemlock) (flavoring agent) (cough suppressant)

SOLUTION

(a) (b) (c)





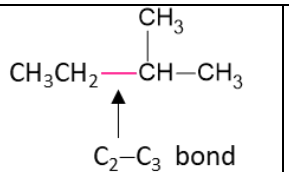


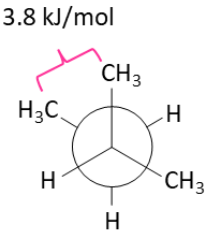
Exercise 5. Consider 2-methylbutane (isopentane). Sighting along the C2-C3 bond:

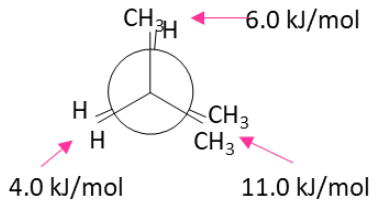
(a) Draw a Newman projection of the most stable conformation.
(b) Draw a Newman projection of the least stable conformation.
(c) If a $CH_3 \leftrightarrow CH_3$ eclipsing interaction costs 11 kJ/mol, a $H \leftrightarrow H$ eclipsing interaction costs 4.0 kJ/mol, a $CH_3 \leftrightarrow H$ eclipsing interaction costs 6.0 kJ/mol, and a $CH_3 \leftrightarrow CH_3$ gauche interaction costs 3.8 kJ/mol, make a quantitative plot of energy versus rotation about the C2-C3 bond.

SOLUTION

a) y b)

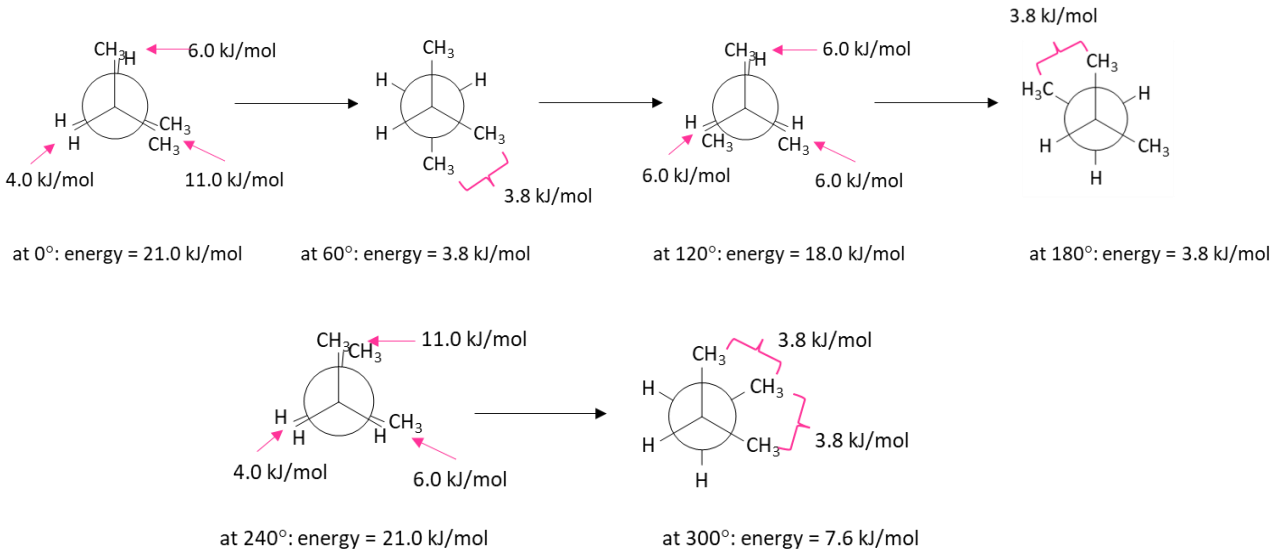


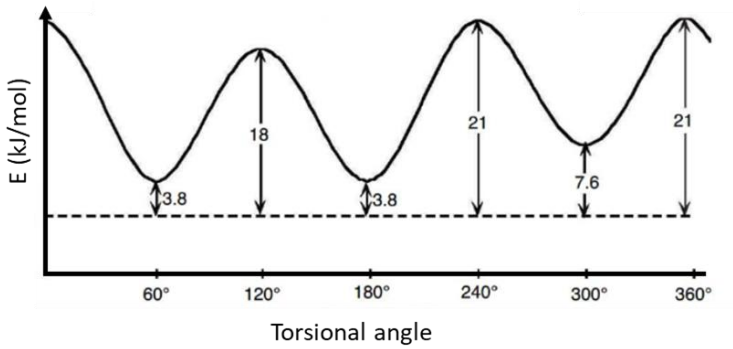




2-Methylbutane	Most stable conformation	Least stable conformation

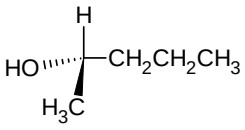
(c) Consider the least stable conformation to be at zero degrees. Keeping the front of the projection unchanged, rotate the back by 60° to obtain each conformation.





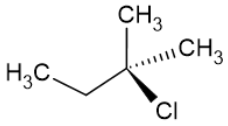
Exercise 6. Draw a tetrahedral representation of (*S*)-2-pentanol-(2-hydroxypentane).

SOLUTION

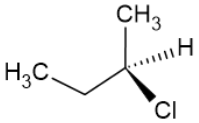


Exercise 7. Below are four compounds. Which two compounds are enantiomers of each other?

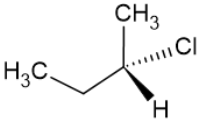
1)



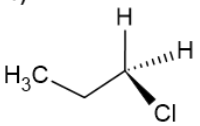
2)



3)



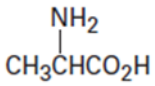
4)



SOLUTION

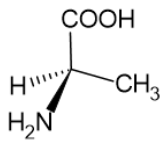
1 and 2; b) 2 and 3; c) 3 and 4; d) 2 and 4.

Exercise 8. Alanine, an amino acid present in proteins, is chiral; draw the two enantiomers of alanine using the standard convention of solid, wedge, and dashed lines, and identify the R and S enantiomer.

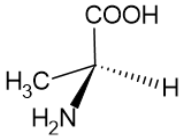


Alanina

SOLUTION

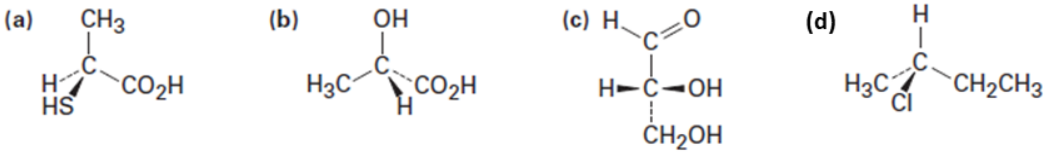


(2*R*)-2-aminopropanoic acid



(2*S*)-2-aminopropanoic acid

Exercise 9. Assign R or S configuration to the chiral center in each of the following molecules. Name them according to the IUPAC nomenclature.



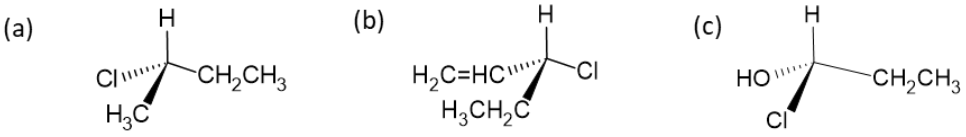
SOLUTION

(a) (2S)-2-sulfanylpropanoic acid; (b) (2S)-2-hydroxypropanoic acid; (c) (2R)-2,3-dihydroxypropanal; (d) (2R)-2-chlorobutane.

Exercise 10. Draw tetrahedral representations of the following molecules:

(a) (2*S*)-2-chlorobutane
(b) (3*R*)-3-chloropent-1-ene
(c) (1S)-1-chloropropan-1-ol

SOLUTION



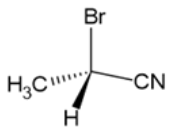
(2*S*)-2-chlorobutane

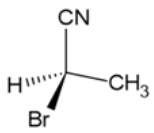
(3R)-3-chloropent-1-ene

(1S)-1-chloropropan-1-ol

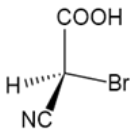
Exercise 11. Which of the following pairs of structures represent the same enantiomer and which represent different enantiomers? Name them according to the IUPAC nomenclature.

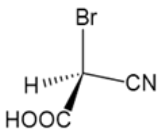
(a)



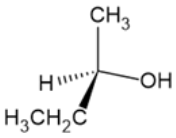


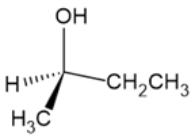
(b)



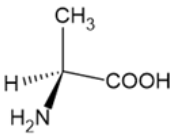


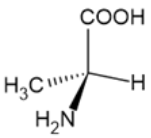
c)





(d)

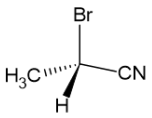




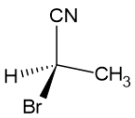
SOLUTION

(b), (c) y (d)

(a)

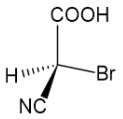


(2*S*)-2-bromopropanenitrile

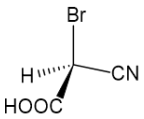


(2*R*)-2-bromopropanenitrile

(b)

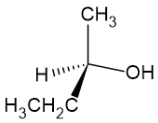


(2*S*)-bromo(cyano)acetic acid

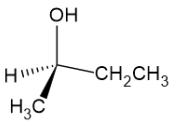


(2*S*)-bromo(cyano)acetic acid

c)

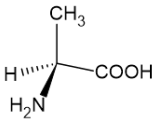


(2*R*)-butan-2-ol

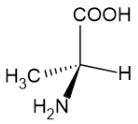


(2*R*)-butan-2-ol

(d)



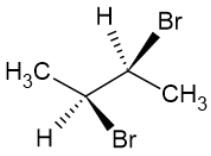
(2*S*)-2-aminopropanoic acid



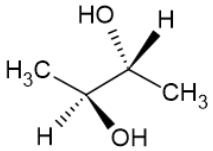
(2*S*)-2-aminopropanoic acid

Exercise 12. Assign *R* or *S* configuration to each chirality center and give IUPAC name in the following molecules:

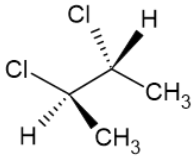
(a)



(b)

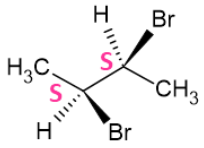


c)



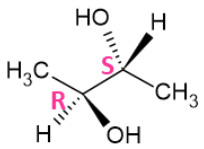
SOLUTION

(a)



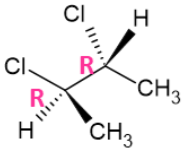
(2*S*,3*S*)-2,3-dibromobutane

(b)



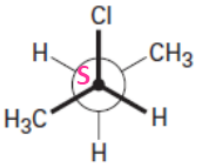
(2*R*,3*S*)-butane-2,3-diol

c)



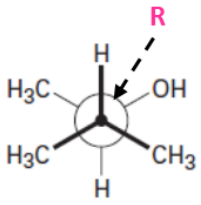
(2*R*,3*R*)-2,3-dichlorobutane

(d)



(2S)-2-chlorobutane

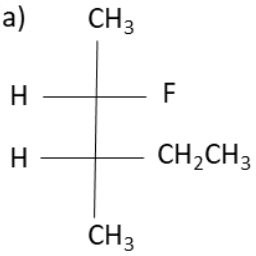
(e)



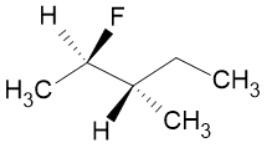
(2*R*)-3-methylbutan-2-ol

Exercise 13. What are the stereochemical relations (identical, enantiomers, diastereomers) of the following four molecules? Assign absolute configurations at each stereocenter.

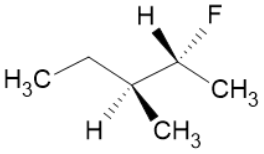
(a)



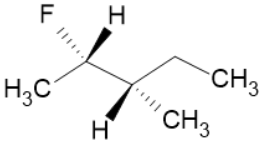
(b)



(c)



(d)

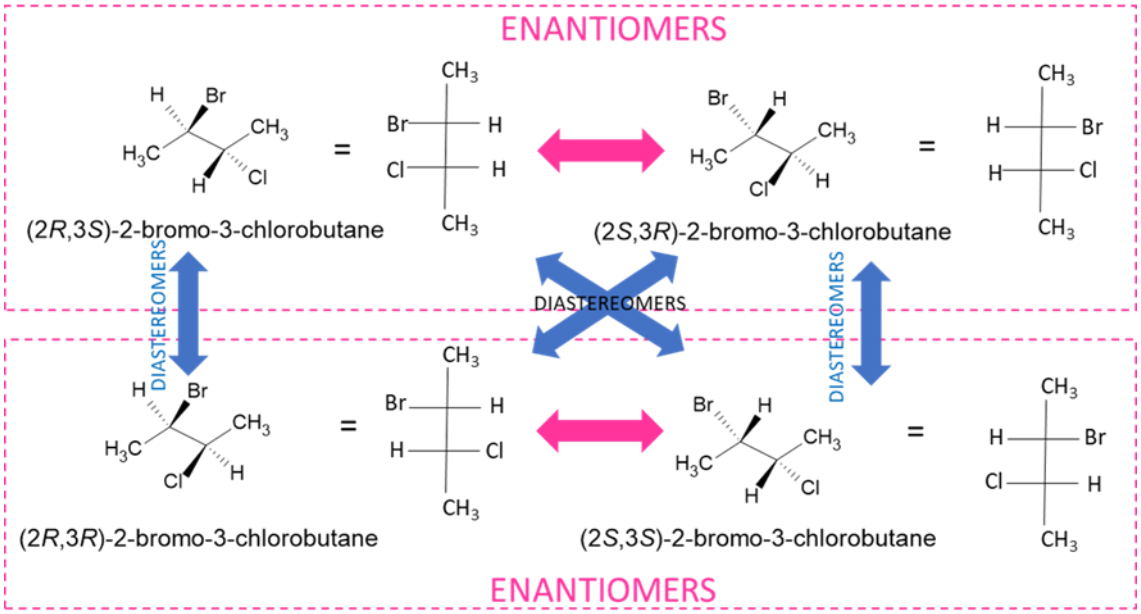


SOLUTION

(a) (2*S*, 3*S*)-2-Fluoro-3-methylpentane; (b) (2*R*, 3*S*)-2-Fluoro-3-methylpentane; (c) (2R, 3R)-2-Fluoro-3-methylpentane. (a) and (c) are enantiomers; (a) and (d) are identical; (a) and (b), (b) and (c), (b) and (d) are diastereomers; (c) and (d) are enantiomers. With the inclusion of the mirror image of 2, there are four stereoisomers.

Exercise 14. Draw the possible stereoisomers of 2-bromo-3-chlorobutane and establish the relationship between them. Use line-bond (Hashed-wedged line) and Fisher representations.

SOLUTION



Exercise 15. Draw the possible stereoisomers of 2,3 dibromobutane and establish the relationship between them. Use line-bond (Hashed-wedged line) and Fisher representations.

SOLUTION

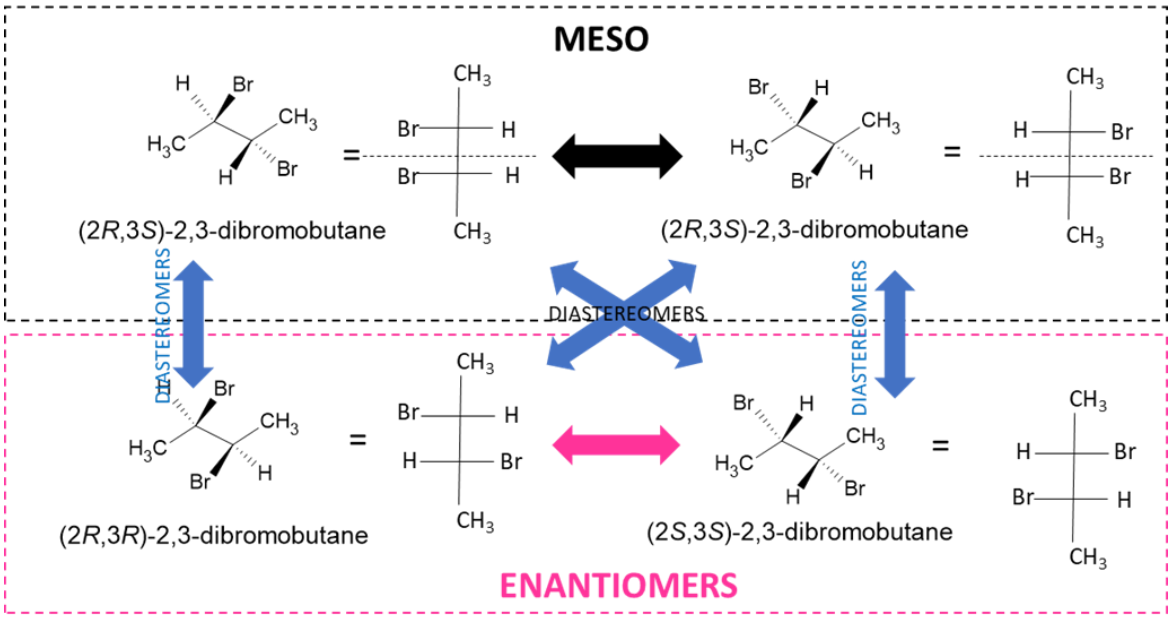


IMAGE CREDITS

- Images of all exercises were made by authors.