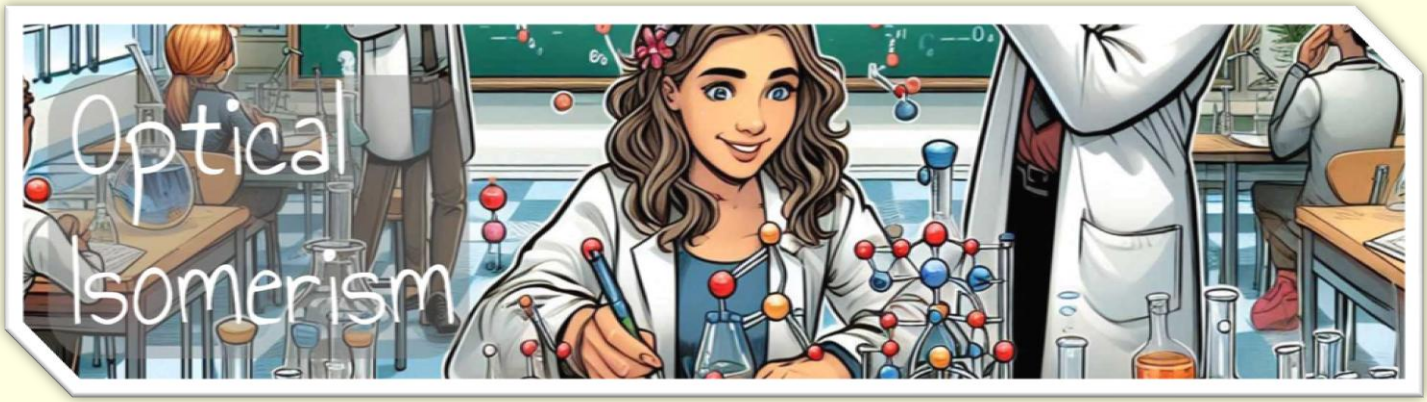


Answer all the questions below as fully as you can then check your answers

1. What is a stereoisomer?

a. Name the two types of stereoisomers.

b. What type of stereoisomerism is shown by unsaturated alkenes molecules?

c. What type of stereoisomerism is shown by carbon atoms attached to four different atoms or groups of atoms?

2. If a carbon atom is said to be asymmetrical or chiral what does this mean?

a. What is an enantiomer?

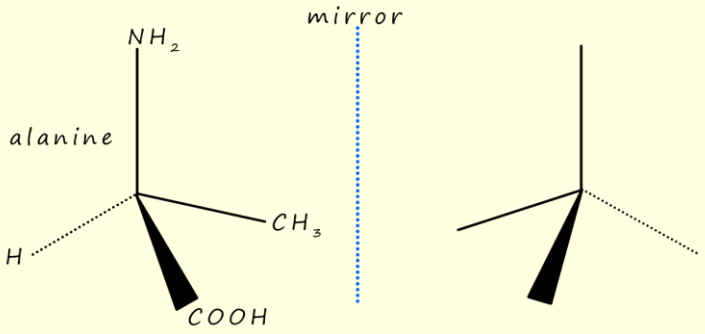
b. What is plane polarised light?

c. If a molecule is said to be optically active what does this mean?

3. The amino acid alanine (2-aminopropanoic acid) has a chiral carbon atom and can therefore exist as a pair of optically active enantiomers. One of the enantiomers is shown below.

a. Complete the diagram opposite to show the structure of the other enantiomer.

b. Mark the position of the chiral carbon atom in one of the alanine molecules above with an asterisk (*).



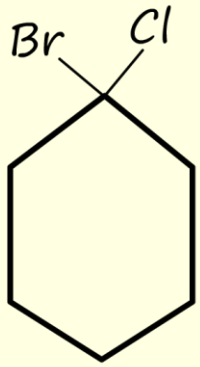
4. For the molecules a-d shown below draw out displayed formula for each molecule and mark any chiral carbon atoms with an asterisk (*).

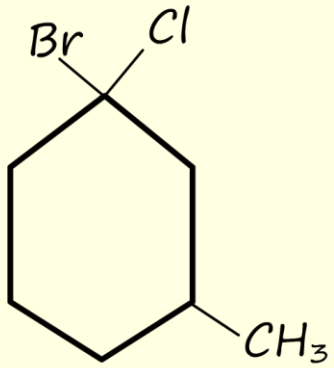
a. CH_2Cl_2 b. CH_2ClOH C. $CH_3CH(Br)CH_2CH_3$

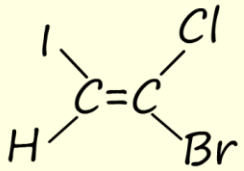
d. $CH_3CH(OH)Cl$

a. Draw out 3d representations similar to the one shown in question 3 for each of the optically active molecules above and then draw out diagrams to clearly show the structure of the two enantiomers for each of the optically active compounds.

5. Which of the molecules shown below are optically active? Identify at least one chiral carbon atom in each optically active molecule.







6. One of the isomers of the organic compound with the molecular formula $C_3H_6Cl_2$ is optically active. Draw out the displayed formula for 4 structural isomers of this compound and identify which one is optically active.

a. Once you have identified the optically active isomer draw out a 3d diagram to show the structure of each of the enantiomers for this optically active compound.

7. Explain briefly how optical activity in molecules is determined experimentally.

a. Explain the meaning of the words: dextrorotatory and laevorotatory.
b. Explain what a racemic mixture is and why it is optically inactive despite having optically active compounds present in the mixture.

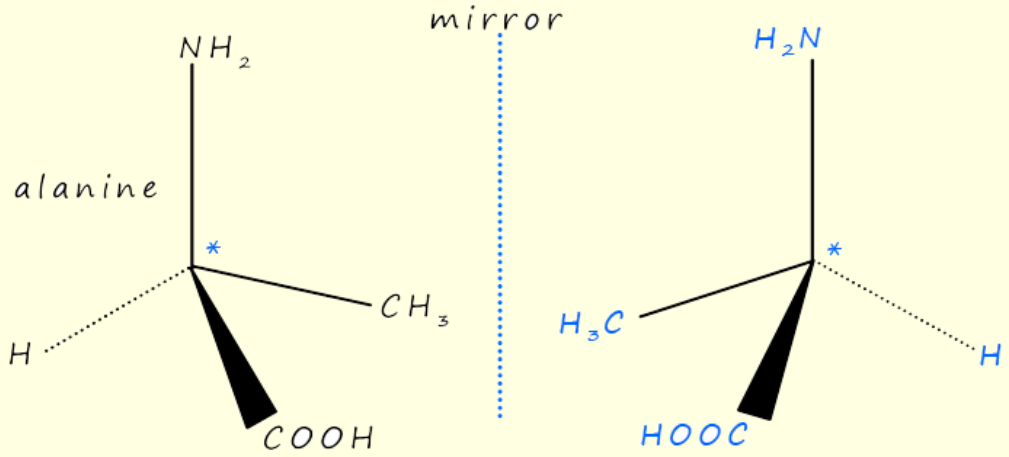
Answers

1. What is a stereoisomer?
   Stereoisomers have the same molecular formula and structural formula but the atoms are arranged differently is space
   a. Name the two types of stereoisomers.
   Geometrical and optical
   b. What type of stereoisomerism is shown by unsaturated alkenes molecules?
   Cis/trans or E/Z isomerism
   c. What type of stereoisomerism is shown by carbon atoms attached to four different atoms or groups of atoms?
   Optical isomerism

2. If a carbon atom is said to be asymmetrical or chiral what does this mean?
   Chiral carbon atoms have a tetrahedral arrangement with 4 different atoms or groups attached, asymmetrical implies that there are no planes of symmetry within the molecule.
   a. What is an enantiomer?
   Mirror image forms of a molecule which is non-super imposable on top of each other.
   b. What is plane polarised light?
   Light waves where all the planes vibrate in the same direction
   c. If a molecule is said to be optically active what does this mean?
   The molecule will rotate plane polarised light.

3. The amino acid alanine (2-aminopropanoic acid) has a chiral carbon atom and can therefore exist as a pair of optically active enantiomers. One of the enantiomers is shown below.

a. Draw the structure of the other enantiomer.

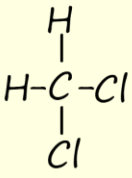


b. Mark the position of the chiral carbon atom in one of the alanine molecules above with an asterisk (*).

See diagram above

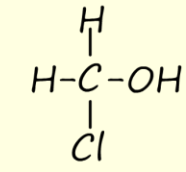
4. For the molecules a-d shown below draw out displayed formula for each molecule and mark any chiral carbon atoms with an asterisk (*).

CH_2Cl_2



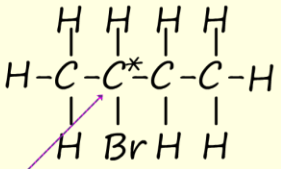
no chiral carbon atoms present

CH_2ClOH



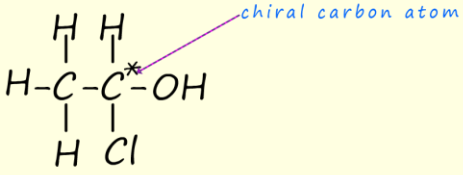
no chiral carbon atoms present

$CH_3CH(Br)CH_2CH_3$

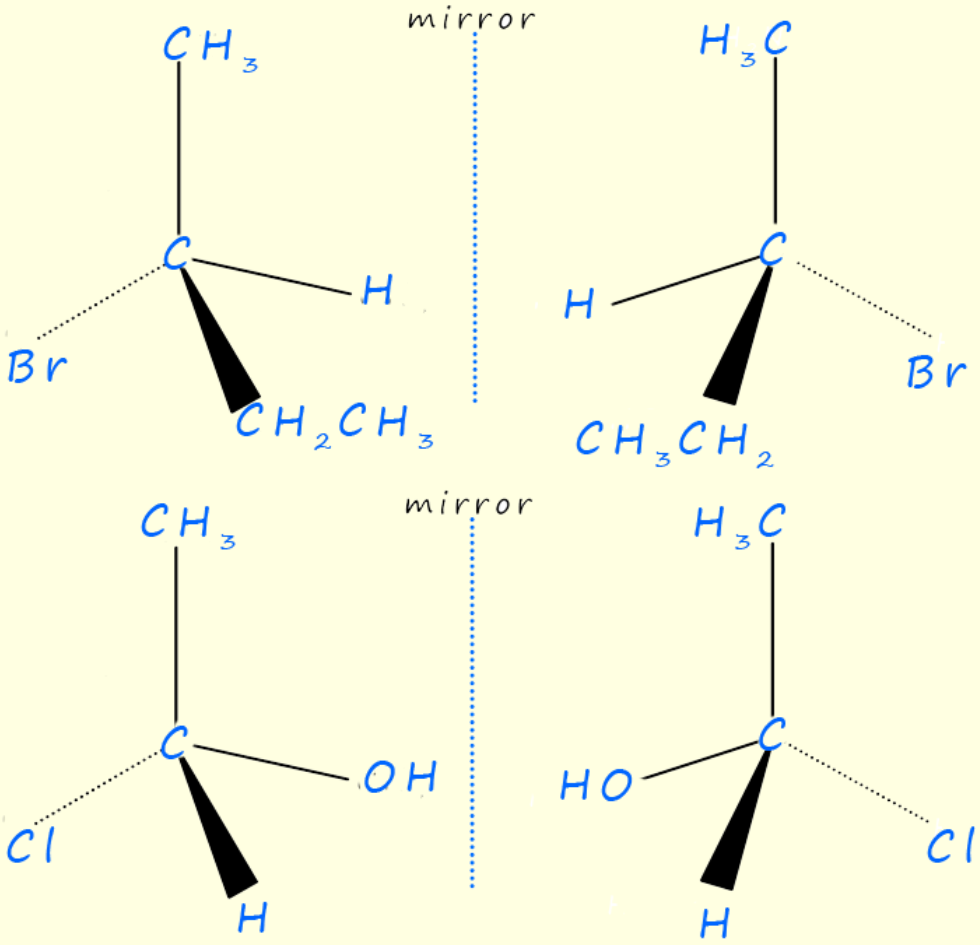


chiral carbon aton

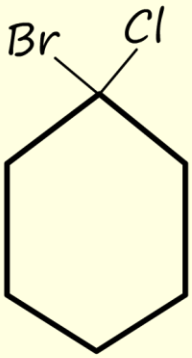
$CH_3CH(OH)Cl$



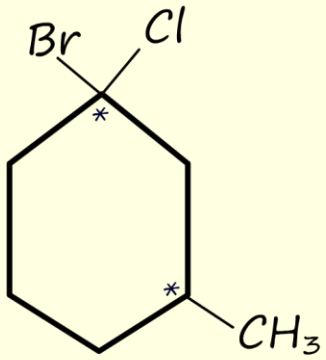
a. Draw out 3d representations similar to the one shown in question 3 for each of the optically active molecules above and then draw out diagrams to clearly show the structure of the two enantiomers for each of the optically active compounds.



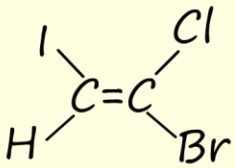
5. Which of the molecules shown below are optically active? Identify at least one chiral carbon atom in each optically active molecule.



no chiral centres, molecule is achiral

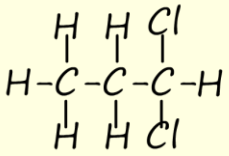


molecule has 2 chiral carbon atoms, indicated with an asterisk (*)

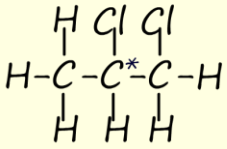


C=C bonds are planar (flat), chiral carbon atoms are tetrahedral. So this molecule is achiral.

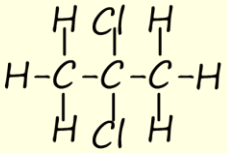
6. One of the isomers of the organic compound with the molecular formula $C_3H_6Cl_2$ is optically active. Draw out the displayed formula for 4 structural isomers of this compound and identify which one is optically active.



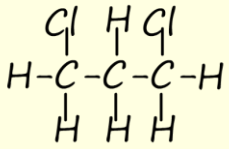
1,1-dichloropropane achiral molecule



1,2-dichloropropane chiral molecule

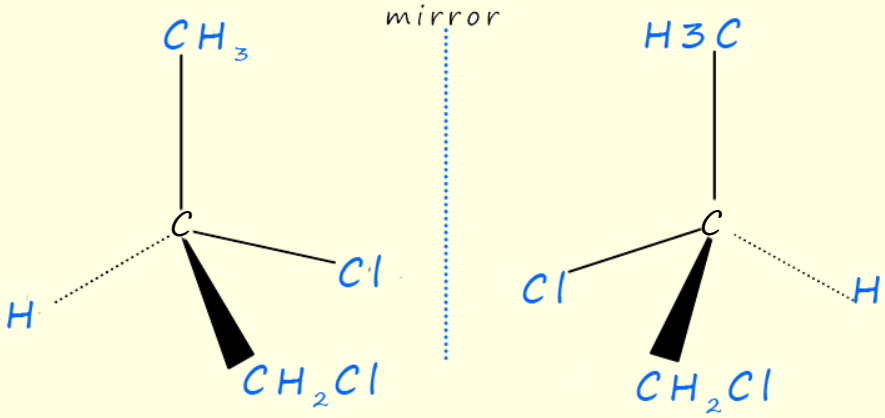


2,2-dichloropropane achiral molecule



1,3-dichloropropane achiral molecule

a. Once you have identified the optically active isomer draw out a 3d diagram to show the structure of each of the enantiomers for this optically active compound.



7. Explain briefly how optical activity in molecules is determined experimentally.
The sample to be tested in dissolved in a suitable solvent and plane polarised light is passed through the sample, the plane polarised will be rotated, normally by a few degrees by the optically active molecules. The amount of rotation is measured and recorded.

a. Explain the meaning of the words: dextrorotatory and laevorotatory.
Optically active molecules will either rotate plane polarised light clockwise or anticlockwise. If the plane polarised light is rotated clockwise this isomer is termed dextrorotatory. The mirror image isomer or enantiomer will rotate plane polarised light anti-clockwise, this isomer is isomer is termed laevorotatory.

b. Explain what a racemic mixture is and why it is optically inactive despite having optically active compounds present in the mixture.
A racemic mixture is a 50:50 mixture of each optically active enantiomer. It is optically inactive since each enantiomer in the mixture will rotate plane polarised light in equal but opposite directions.