Optical isomerism

OCR A H432 · A level

Show your working where needed. Check the worked answers when you finish.

Name _____ Date _____

1. Spot a chiral carbon

In each alcohol, examine the carbon bonded to OH. Decide whether it is chiral. A is $CH_3CH(OH)CH_3$. B is $CH_3CH(OH)CH_2CH_3$. Give the groups that make the distinction.

2. Connectivity and arrangement

A student calls two non-superimposable mirror images structural isomers because their diagrams look different. Correct the student by comparing the connectivity and three-dimensional arrangements.

3. Draw both mirror images

Draw the two enantiomers of butan-2-ol, $CH_3CH(OH)CH_2CH_3$, using a solid wedge and a dashed wedge in each diagram. Show the four groups bonded to the chiral carbon.

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4. Change the branching

Compare optical isomerism in 2-methylbutane, $CH_3CH(CH_3)CH_2CH_3$, and 3-methylhexane, $CH_3CH_2CH(CH_3)CH_2CH_2CH_3$. Focus on the carbon at the branch point.

5. Compare two wedge drawings

At a chiral carbon, a student swaps the positions of H and OH. They also swap the other two groups, methyl and ethyl. Do the two drawings show different enantiomers? Explain.

6. Compare two reduction products

Reduction changes each C=O into CH(OH). Compare the products from $CH_3COCH_2CH_2CH_3$ and $CH_3CH_2COCH_2CH_3$. Which product has a chiral centre? Justify both decisions.

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7. Inspect each carbon

Number the chain of $HOOCCH(OH)CH(OH)CH_3$ starting at COOH as carbon 1. Identify all its chiral carbons and justify the choice.

8. Find the change that removes chirality

The OH-bearing carbon in $CH_3CH(OH)CH_2CH_2Br$ is chiral. What happens to that centre when the alcohol group is oxidised with acidified dichromate? Explain in terms of the organic structure.

9. Extra challenge · Track chiral centres through a reaction

Number $HOCH_2CH(Br)CH(CH_3)CH(OH)CH_3$ from the CH_2OH end. Identify every chiral carbon and give the four groups at C3.

In a proposed reaction, only the secondary alcohol is oxidised to a ketone. Write the product structure and identify every chiral carbon that remains.

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Worked answers

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1. Spot a chiral carbon

A has two CH_3 groups at that carbon. B has four different groups, H, OH, CH_3 and CH_2CH_3, so its OH-bearing carbon is chiral.

2. Connectivity and arrangement

The molecules are enantiomers, a pair of stereoisomers. The atoms are bonded in the same order, with different arrangements in space.

3. Draw both mirror images

In one diagram, put ordinary bonds to CH_3 above left and CH_2CH_3 above right. Below the centre, put OH on a solid wedge and H on a dashed wedge.

Keep the ordinary bonds in place for the second diagram. Swap OH and H between the wedges to reverse the three-dimensional arrangement.

4. Change the branching

The branch carbon in 2-methylbutane has two methyl groups. In 3-methylhexane the branch carbon has H, methyl, ethyl and propyl groups, so it is chiral.

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Worked answers

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5. Compare two wedge drawings

No. One pair swap reverses the arrangement, but two swaps restore the original handedness. The two drawings can be superimposed by rotating the molecule.

6. Compare two reduction products

The first gives pentan-2-ol with methyl, propyl, H and OH around C2. The second gives pentan-3-ol with two ethyl groups around C3, so that centre is not chiral.

7. Inspect each carbon

Carbons 2 and 3 are chiral. Each carries H, OH and two different groups containing carbon. Carbon 1 has a planar carbonyl arrangement and carbon 4 has three identical H atoms.

8. Find the change that removes chirality

The product is $CH_3C(=O)CH_2CH_2Br$. That carbon is now the planar carbonyl carbon and has no four different groups arranged tetrahedrally. The product contains no chiral centre.

9. Extra challenge · Track chiral centres through a reaction

C2, C3 and C4 are chiral. The groups at C3 are H, CH_3, $CH(Br)CH_2OH$ and $CH(OH)CH_3$. The two longer groups are different when followed away from the centre.

The product is $HOCH_2CH(Br)CH(CH_3)C(=O)CH_3$. C4 is now planar. C2 and C3 each retain four different groups and are still chiral.

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