Optical isomerism

AQA 7405 · A level

Answer on your own paper. Show your working where needed.

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.

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 optical rotation

At the same concentration and path length, one enantiomer rotates plane-polarised light by +12°. Predict the rotation for the other enantiomer and for an equal-mole mixture of the two.

6. Two products from one carbonyl compound

Ethanal reacts with cyanide ions in an achiral environment to form a hydroxynitrile. Identify any new chiral atom and its groups. Explain whether the product is a single enantiomer or a mixture.

7. Check the whole groups

A student says $CH_3CH(Br)CH(CH_3)_2$ cannot be chiral because three groups on the Br-bearing carbon contain carbon. Assess the claim and name the four groups on that carbon.

8. What does zero rotation tell you?

A liquid shows no overall optical rotation. A student concludes that its molecules have no chiral centres. Give a different composition consistent with the observation and explain why it works.

9. Extra challenge · Use optical rotation and mechanism evidence

The pure enantiomers of a hydroxynitrile give readings of +20° and −20° at the same total concentration and path length. A mixture gives +8° under those conditions. Assume the rotations add in proportion to the mole fractions. Calculate the composition.

Explain, using carbonyl geometry, what reading to expect if the same compound was formed from an achiral aldehyde with cyanide in an achiral environment.

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