4.5.1 Chirality, optical evidence and substitution

Name: _____ Class: _____ Date: _____ **Total: 16 marks**

KEY WORDS chiral centre

Objective

Identify four different groups and interpret optical data without overclaiming. Questions and marking guidance are original.

1 Key knowledge and worked examples

A tetrahedral carbon with four different attached groups is a chiral centre in these examples. Enantiomers are non-superimposable mirror images. A pure enantiomer rotates plane-polarised monochromatic light; its partner rotates equally oppositely under identical conditions. A racemate contains equal amounts, cancelling rotation.

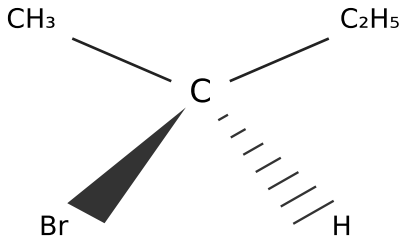
Worked explanation

Butan-2-ol has H, OH, CH_3 and CH_2CH_3 attached at carbon 2, so it is chiral. Propan-2-ol has two identical methyl groups and is achiral. Zero rotation can mean an achiral substance or an equal enantiomer mixture; it cannot alone distinguish them.

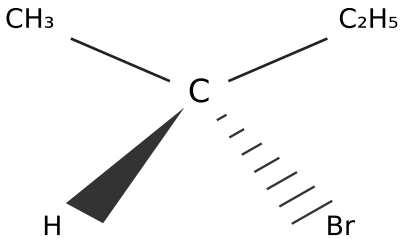
S_N2 at a chiral centre gives inversion. An ideal S_N1 planar carbocation can be attacked from both faces, producing a racemate under achiral conditions. Actual optical observations help test the simple model; a flat formula cannot determine the sign of rotation.

Swap two groups to obtain the other enantiomer

One enantiomer of 2-bromobutane



Opposite configuration



2 Practice

2.1 Name the four groups at the chiral centre of 2-bromobutane. [2]

2.2 Explain why propan-2-ol is achiral and butan-2-ol is chiral. [2]

2.3 One pure enantiomer gives +12° under specified conditions. State the rotation of its pure partner and an equal mixture under identical conditions. [2]

3 Exam-style questions

3.1 An optically active secondary halogenoalkane undergoes substitution. Product is optically active with inversion. Explain which simple mechanism this supports, and why the sign of rotation alone is not a structural proof. [3]

3.2 A product solution has zero optical rotation. Give two different molecular explanations and an additional observation that would help distinguish them. [3]

3.3 Draw two opposite configurations of 2-bromobutane with wedge/dash bonds and label the four groups. [4]