A-LEVEL CHEMISTRY • EXERCISE SHEET

29.4 Optical isomerism

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

Objective

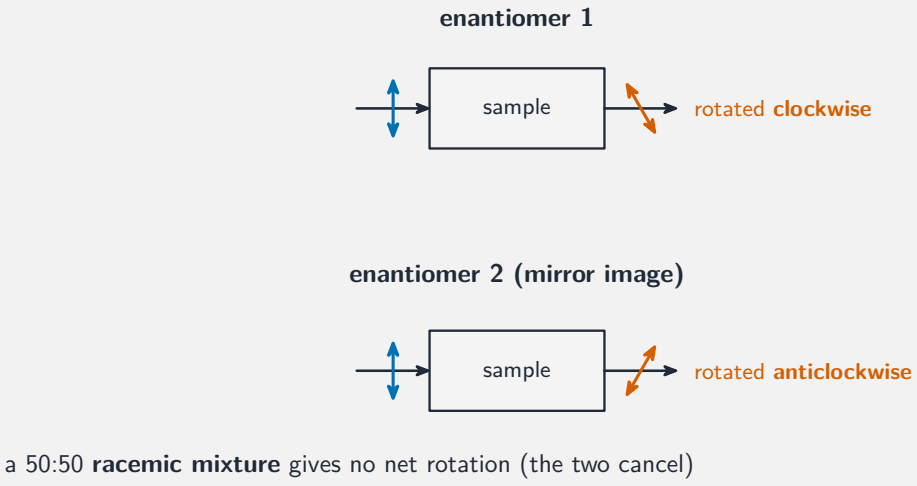
Build the skills to answer exam questions on **optical isomerism** 旋光异构—**chiral centres** 手性中心, **enantiomers** 对映体, **plane-polarised light** 平面偏振光 and **racemic mixtures** 外消旋混合物.

You must be able to:

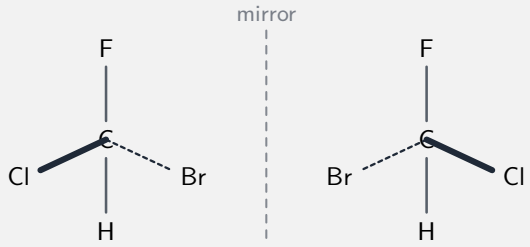
- identify a chiral centre (4 different groups on one carbon)
- describe how enantiomers differ (rotation of plane-polarised light; biological activity)
- explain why a racemic mixture is optically inactive

1 Worked examples

Chirality and optical activity



The two enantiomers rotate plane-polarised light in opposite directions; a 50:50 racemic mixture gives no net rotation



enantiomers: mirror images that cannot be superimposed
(the central carbon has 4 different groups)

Optical isomers are non-superimposable mirror images

- a **chiral centre** is a carbon with **four different** groups → two non-superimposable mirror images (enantiomers).
- enantiomers are identical in all properties **except**: they rotate plane-polarised light in **opposite** directions, and may have different biological effects.
- a **racemic mixture** (50:50) shows **no** net rotation —the two opposite rotations cancel.

Drugs: one enantiomer may cure while the other harms —so makers use a chiral catalyst or separate the enantiomers.

2 Practice

2.1 State what feature a molecule must have to show optical isomerism. [1]

2.2 State why a racemic mixture does not rotate plane-polarised light. [1]

3 Exam-style questions

3.1 A chiral carbon atom is bonded to: [1]

- **A** four identical groups
- **B** two identical and two different groups
- **C** four different groups
- **D** three different groups and one H, with a double bond

3.2 Two enantiomers of a molecule always have the **same**: [1]

- **A** rotation of plane-polarised light

- **B** boiling point
- **C** effect in the body
- **D** direction of optical rotation

3.3 The molecule $CH_3CH(OH)COOH$ (lactic acid) is optically active.

(a) Mark the chiral centre and state how many enantiomers it has. [2]

(b) State the two ways in which the enantiomers differ. [2]

3.4 Explain why drug manufacturers often want a single enantiomer rather than a racemic mixture. [2]

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4 Go further

You are now ready for the real exam questions on this subtopic. Open the **29.4 Optical isomerism** past-paper sheet in the Library, or try these in **Practice mode**:

- 9701/42 N25 —Q8 (optical isomerism)
- 9701/44 N25 —Q8 (optical isomerism)

Solutions

2.1 a chiral centre —a carbon atom bonded to four different groups.

2.2 the two enantiomers are present in equal amounts, so their equal and opposite rotations cancel.

3.1 C. A chiral carbon has four different groups attached.

3.2 B. Enantiomers share all physical properties such as boiling point; only the direction of optical rotation and biological activity differ.

3.3 (a) the central carbon (bonded to –OH, –COOH, $–CH_3$ and –H) is the chiral centre; it has 2 enantiomers.
(b) they rotate plane-polarised light in opposite directions; they may have different biological effects.

3.4 the two enantiomers can behave very differently in the body —one may be effective or safe while the other is inactive or harmful; so the maker wants only the beneficial single enantiomer.