

29.4 Optical isomerism

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS optically active 旋光活性 • enantiomers 对映体 • plane-polarised light 平面偏振光 • racemic mixture 外消旋混合物
• chirality 手性

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

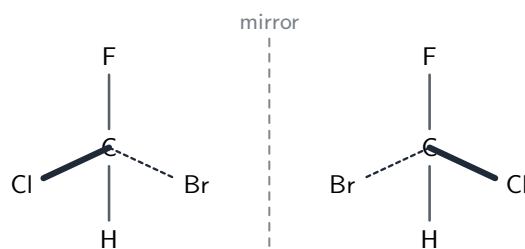


enantiomer 2 (mirror image)



a 50:50 **racemic mixture** gives no net rotation (the two cancel)

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
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3.3 The molecule $\text{CH}_3\text{CH}(\text{OH})\text{COOH}$ (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]

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.