Solutions

Each answer shows the steps, then the **result**.

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

2.3

- A carbon atom with four different groups attached; the molecule is not superimposable on its mirror image

2.4

- It contains equal amounts of the two enantiomers, which rotate the plane of polarised light by equal amounts in opposite directions, so the rotations cancel

2.5

- They differ in the direction in which they rotate plane-polarised light; they are identical in all ordinary physical properties such as boiling point, and in reactions with non-chiral reagents

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

3.5

(a)

- Carbon 2; it carries $-H$, $-Br$, $-CH_3$ and $-CH_2CH_3$, which are four different groups

(b)

- Two tetrahedral structures drawn as mirror images, using wedges and dashes, which cannot be superimposed on each other

(c)

- The product is optically active; in S_N2 the hydroxide attacks from the side opposite the bromine, so the configuration is inverted and a single enantiomer of the alcohol is formed rather than a mixture

(d)

- The mechanism goes through a carbocation intermediate which is planar, with the positive carbon having three groups in a plane; the nucleophile attacks either face with equal probability, giving equal amounts of the two enantiomers, so the product is racemic and optically inactive

(e)

- The carbonyl carbon in butanone is planar; the cyanide ion attacks from either face with equal probability, giving equal amounts of the two enantiomers of the hydroxynitrile, whose rotations cancel