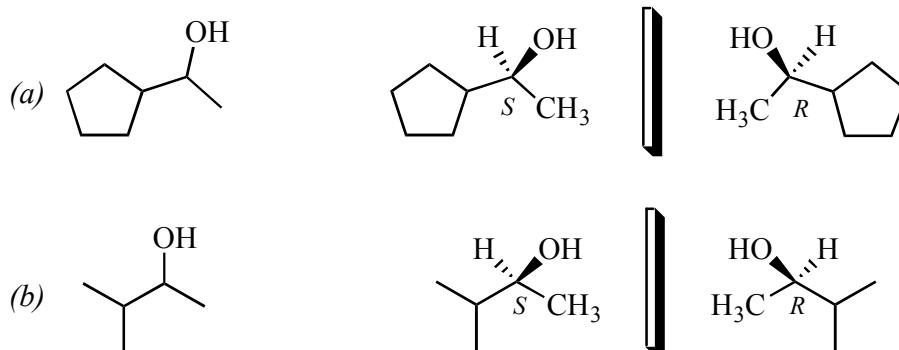


## CHAPTER 17

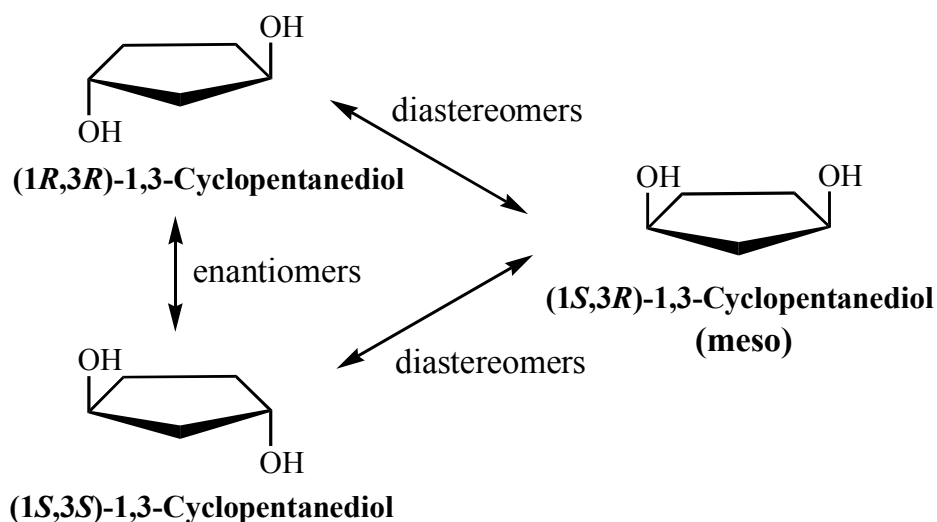
### Practice Exercises

17.1



- 17.3 (a) Compounds (1) and (3) are enantiomers.  
Compounds (2) and (4) are enantiomers.  
(b) Compounds (1) and (2) are diastereomers.  
Compounds (1) and (4) are diastereomers.  
Compounds (2) and (3) are diastereomers.  
Compounds (3) and (4) are diastereomers.

- 17.5 1,3-cyclopentanediol has three possible stereoisomers. The *trans* isomers exist as a pair of enantiomers and the *cis* isomer is a *meso* compound.



- 17.7 The concentration of progesterone, expressed in grams per millilitre is:

$$4\text{g}/100\text{ mL} = 0.04\text{ g/mL}$$

Therefore:

$$\text{observed rotation (degrees)} = +172^\circ \times 1.00\text{ dm} \times 0.040 = +6.9^\circ$$

### Review Questions

17.1 Stereoisomers have the same molecular formula, the same sequence of atoms and the same functional groups, but these groups and atoms have different three-dimensional orientations in space.

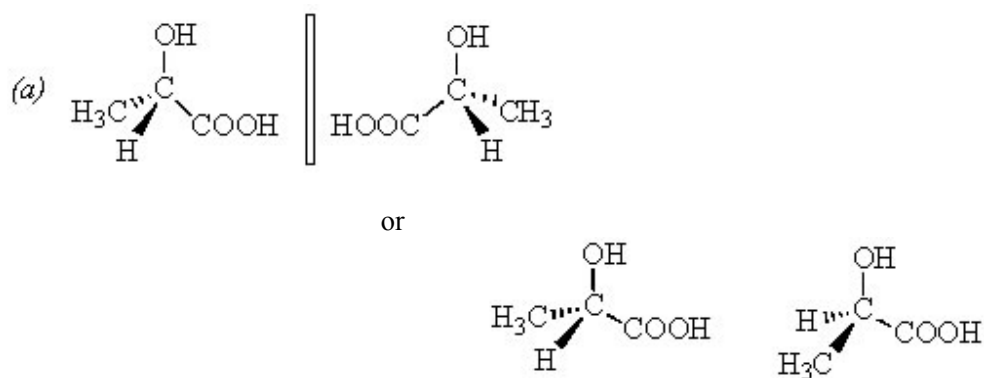
- 17.3 (a) yes  
 (b) no  
 (c) no  
 (d) no  
 (e) no  
 (f) yes

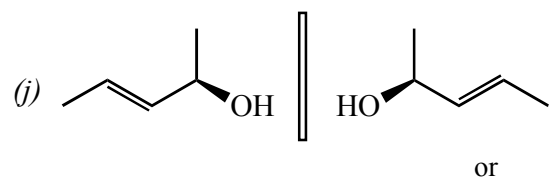
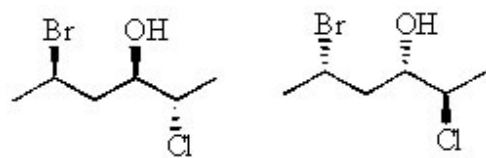
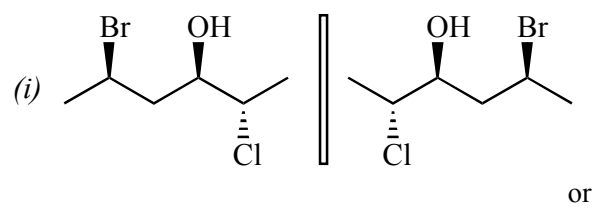
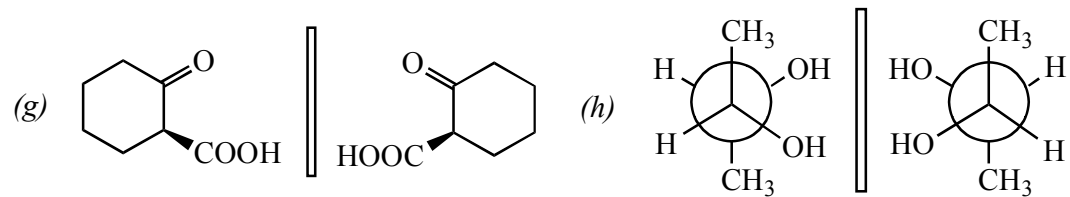
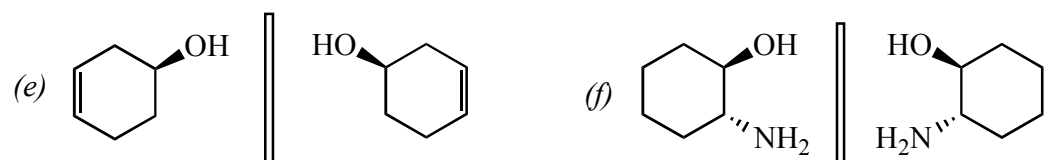
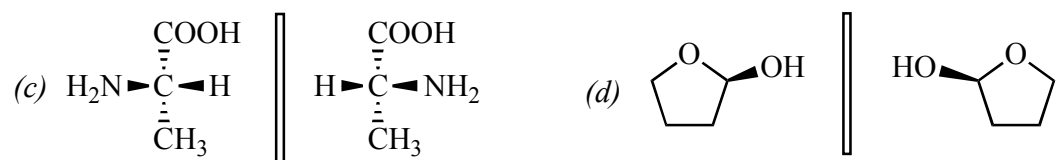
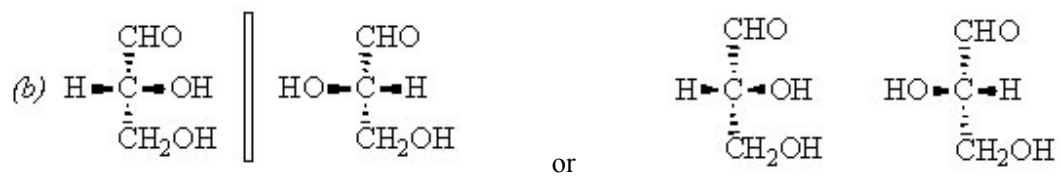
Any object that has a plane of symmetry is not chiral. Each of the objects indicated as 'no' above can be 'sliced in half' such that one side of the cut exactly mirrors the other side.

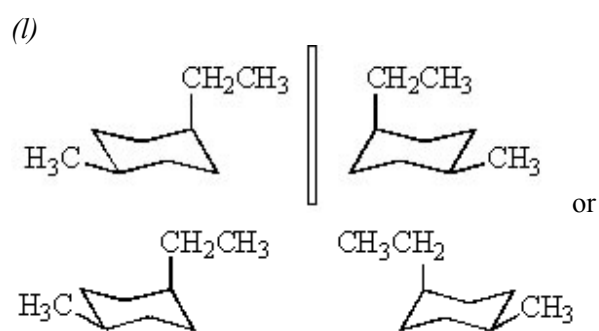
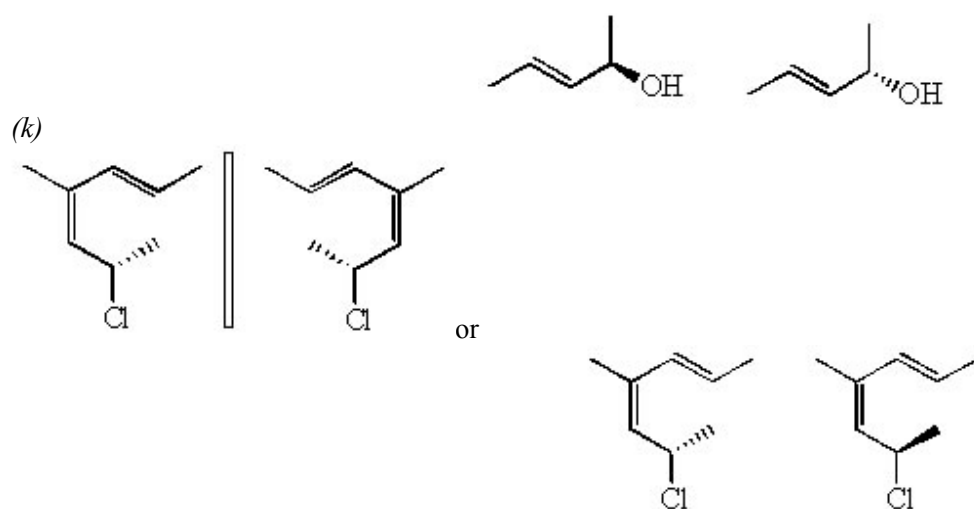
17.5 This question is intended to encourage you to think about chirality in nature. Shells of the same type, such as coneshells, have the same direction of twist. However, different species of shell have different directions of twist.

- 17.7 (a) true  
 (b) false  
 (c) true  
 (d) false  
 (e) false  
 (f) true  
 (g) false

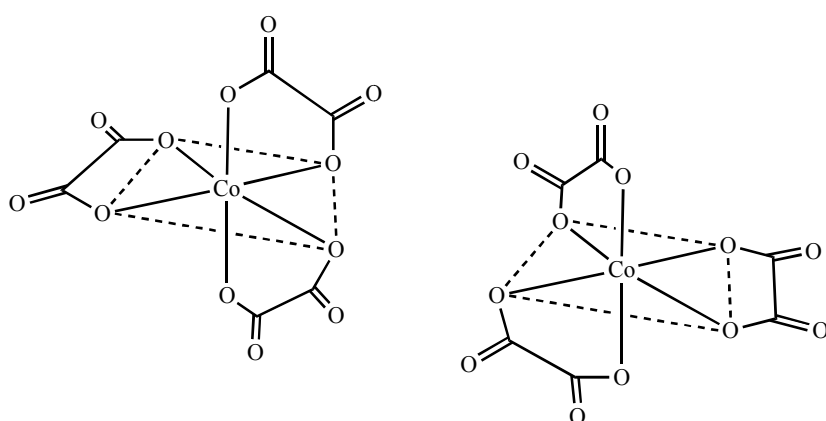
17.9



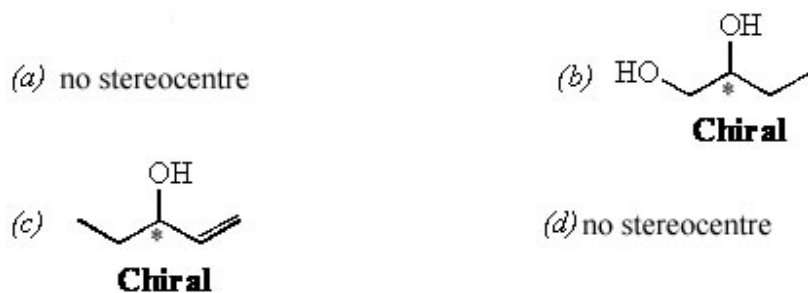




17.11 The two enantiomers are:



17.13



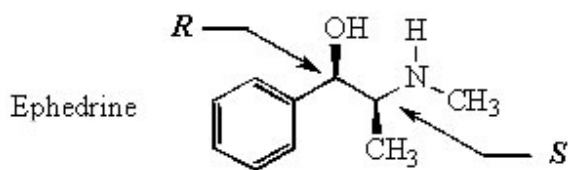
17.15 (a) -H (4) -CH<sub>3</sub> (3) -OH (1) -CH<sub>2</sub>OH (2)

(b) -CH<sub>2</sub>CH=CH<sub>2</sub> (3) -CH=CH<sub>2</sub> (1) -CH<sub>3</sub> (4) -CH<sub>2</sub>COOH (2)

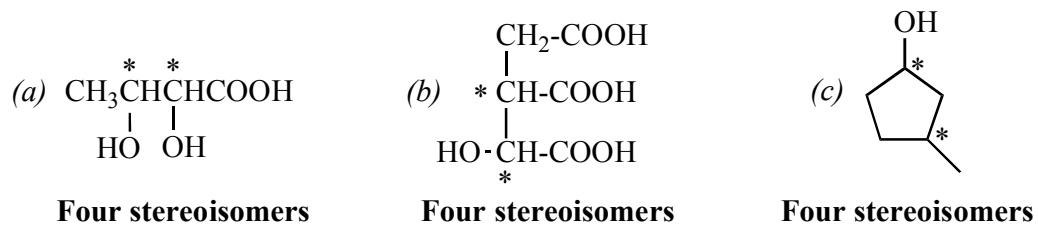
(c) -CH<sub>3</sub> (3) -H (4) -COO<sup>-</sup> (2) -NH<sub>3</sub><sup>+</sup> (1)

(d) -CH<sub>3</sub> (4) -CH<sub>2</sub>SH (2) -NH<sub>3</sub><sup>+</sup> (1) -COO<sup>-</sup> (3)

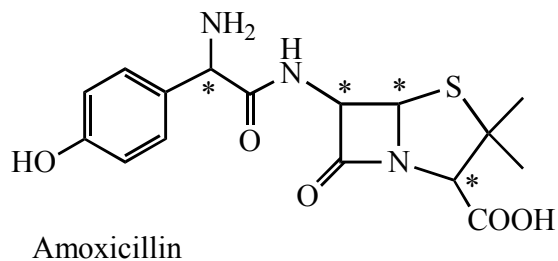
17.17



17.19



17.21

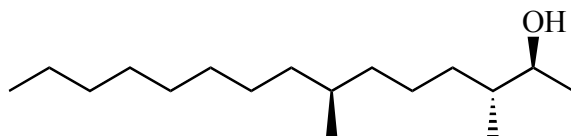


17.23 A racemic mixture contains equal amounts of two enantiomers and is optically inactive since the optical rotation of one enantiomer cancels that of the other, so no net rotation of the plane of polarised light takes place.

17.25 (a) There are three chiral carbons in 3,7-dimethylpentadecan-2-ol which can be combined in 2 ways to give  $2 \times 2 \times 2 = 8$  possible stereoisomers.

(b) (2*S*,3*S*,7*S*)-3,7-dimethylpentadecan-2-ol

(c)



17.27 Some enantiomers of some drugs may have a harmful effect on the body.

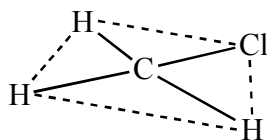
### Review Problems

17.29 (a)  $\text{CHCl}_3$ : one

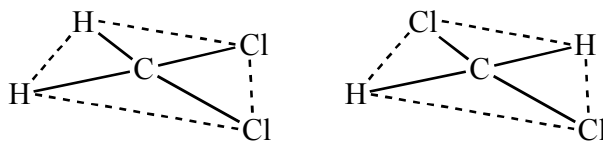
$\text{CH}_2\text{Cl}_2$ : one

$\text{CHBrClF}$ : two

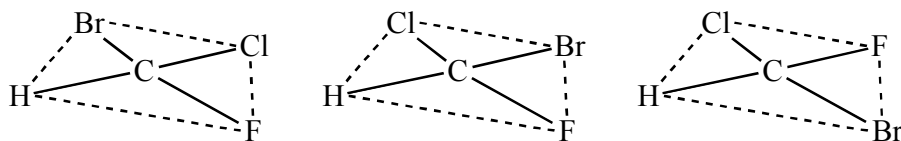
(b)  $\text{CHCl}_3$ : one. Remember the structure is square and flat and so when rotated and flipped over it looks the same.



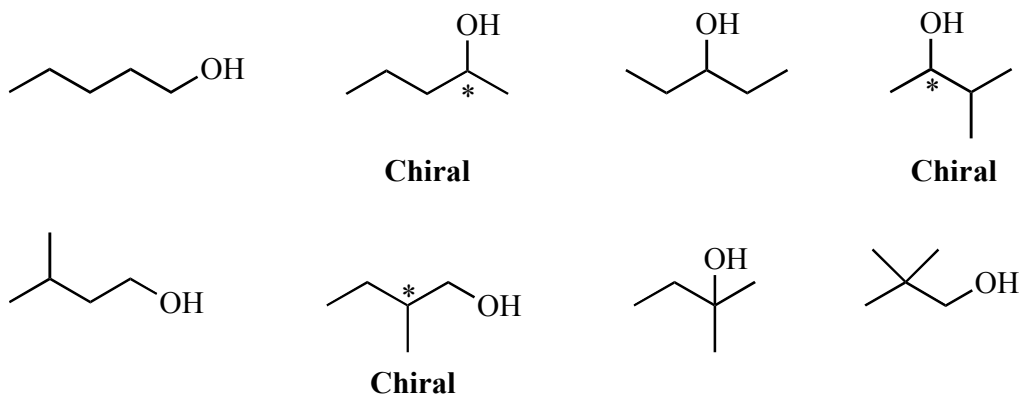
$\text{CH}_2\text{Cl}_2$ : two. The chlorine atoms can either be on the same side of the square or across from each other.



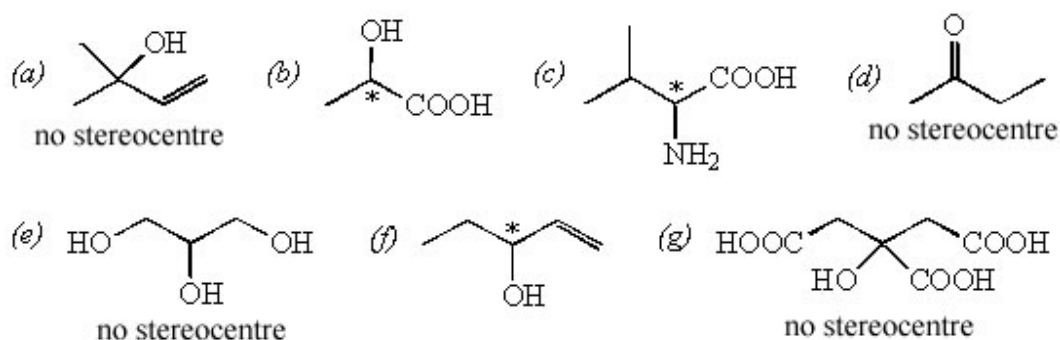
$\text{CHBrClF}$ : three. Cl, Br and F can each be diagonally opposite H.



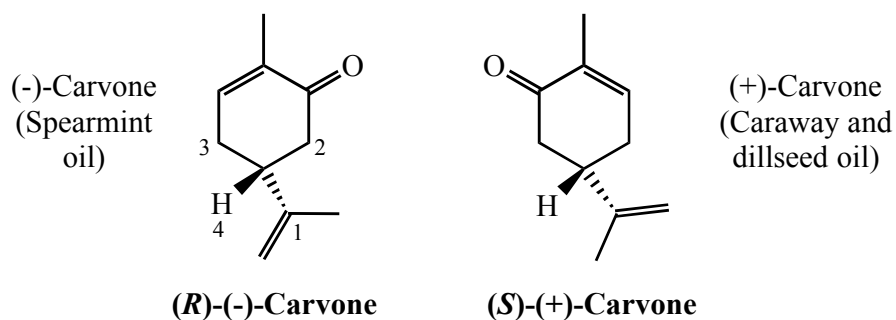
17.31 There are eight alcohols with the formula  $C_5H_{12}O$ , of which three are chiral. The carbon stereocentres are indicated with an asterisk.



17.33

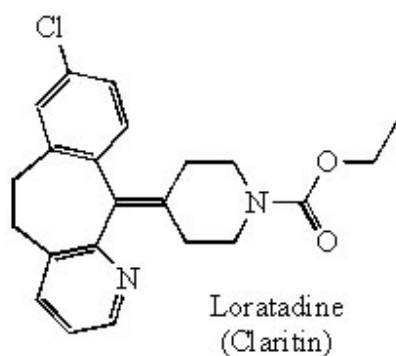


17.35

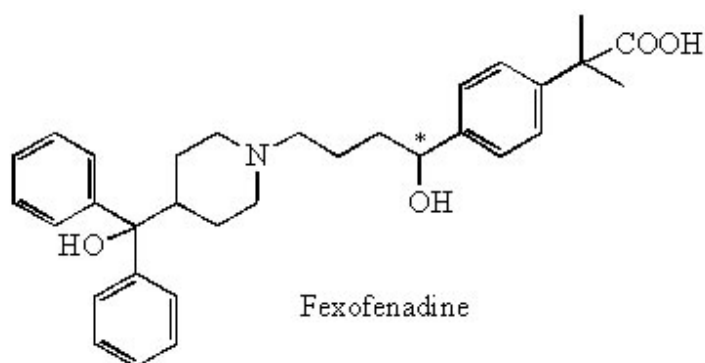


In an achiral environment, enantiomers have the same physical and chemical properties, but in chiral environments, enantiomers can behave very differently. The odour receptors responsible for detecting the carvone smells must be chiral and therefore, be able to physiologically differentiate the enantiomers.

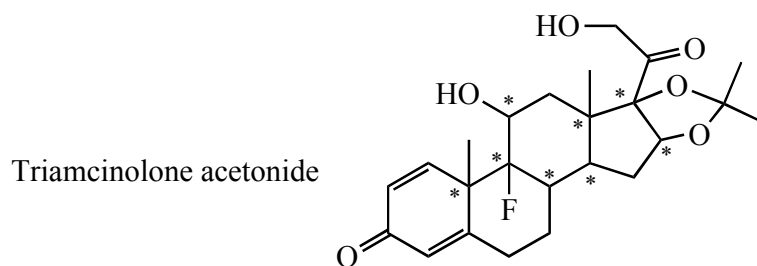
17.37 (a) Loratadine has no stereocentres and is therefore achiral.



(b) Fexofenadine has one stereocentre and therefore has a pair of enantiomers.



17.39 (a)



(b)  $2^n$  = maximum number of stereoisomers possible where  $n$  = the number of stereocentres.  
Triamcinolone acetonide has  $2^8 = 256$  possible stereoisomers.

17.41 2

17.43 4

17.45 (a) 8

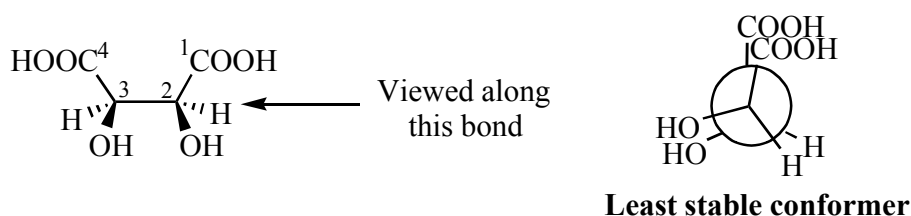
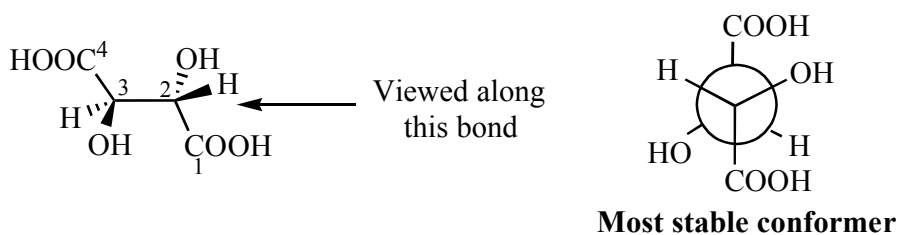


(b) 8

(c) 2

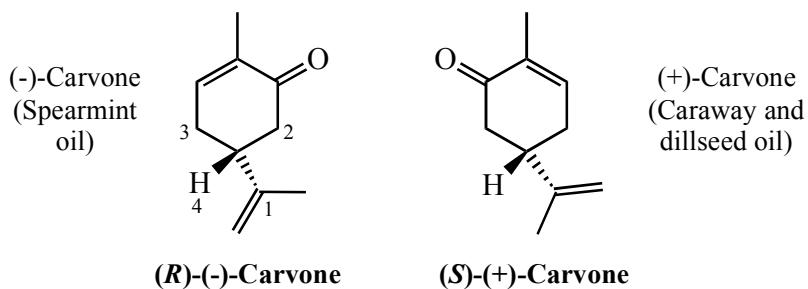
(d) 8

- 17.47 The carboxylic acid groups are the largest groups in this molecule. The most stable conformer has the carboxylic acid groups opposite (anti) to each other. In the least stable conformer, the carboxylic acid groups are eclipsed.



- 17.49 Structure (d) has both stereocentres inverted and so this is the enantiomer of ephedrine and this compound rotates the plane of polarised light in the opposite direction to ephedrine.

- 17.51 The (*S*)-enantiomer must rotate the plane of polarised light in a clockwise direction (positive) if the (*R*)-isomer is (–)-carvone.



- 17.53 (a) (*S*)-limonene

(b) (*R*)-limonene

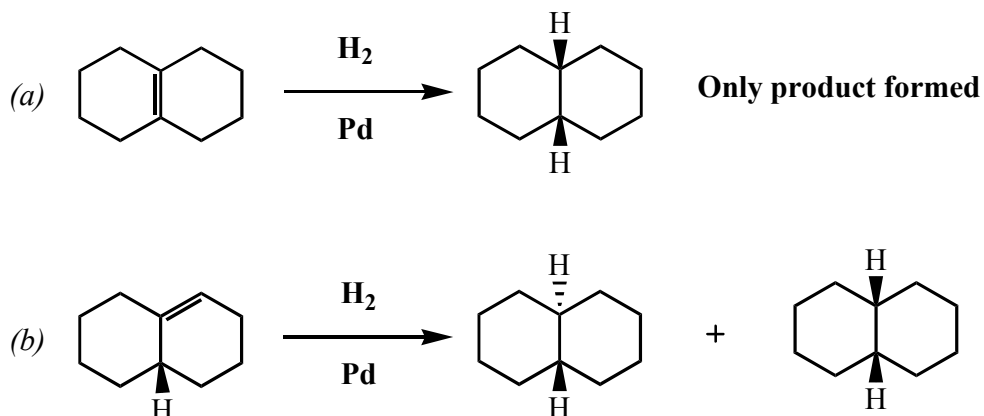
(c) (*S*)-limonene

(d) (*R*)-limonene

### Additional Exercises

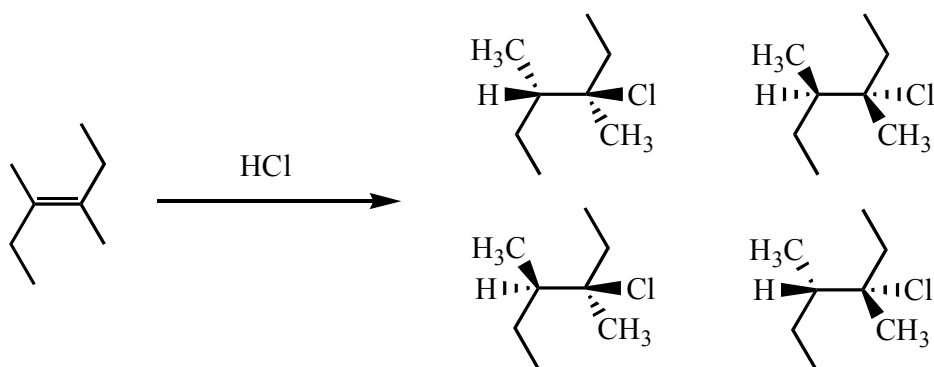
- 17.55 (a) False: they are enantiomers.  
 (b) False: they are enantiomers.  
 (c) False: gentle heating may convert one to the other, which is called epimerisation, but the molecules are not thermal isomers, as this term best refers to conformational isomers isolated at ultra-low temperatures.  
 (d) False: they are enantiomers.  
 (e) True: they are enantiomers.

17.57



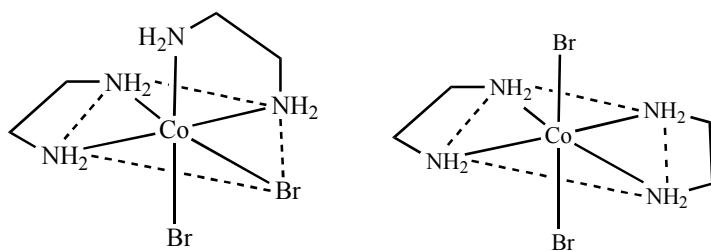
Hydrogenation of (a) yields the same compound regardless of the side of attack of  $H_2$  on the alkene, whereas hydrogenation of (b) gives two products, only one of which is *cis*-decalin.

17.59



Both faces of the reactant molecule are the same, so there is equal probability of each face reacting to form *syn* (same side) and *anti* (opposite side) addition products. This situation results in a product with two stereocentres, thus setting up the possibility of producing four stereoisomers. If a selective synthesis of one stereoisomer over the other possible stereoisomers is desired, this may not be a very useful synthetic method.

17.61 The structure of  $[\text{Co}(\text{en})_2\text{Br}_2]^+$  and its diastereomer is:



17.63 The following two compounds are enantiomers because they are nonsuperimposable mirror images. You may find it helpful to construct molecular models to help visualise the mirror image relationship between these two compounds.

