5 STEREOCHEMISTRY: CHIRAL MOLECULES

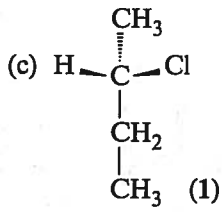
SOLUTIONS TO PROBLEMS

5.1 (a) Achiral (b) Achiral (c) Chiral (d) Chiral (e) Chiral (f) Chiral (g) Chiral (h) Achiral

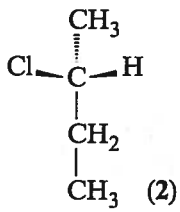
5.2 (a) Yes (b) No (c) No

5.3 (a) They are the same molecule. (b) They are enantiomers.

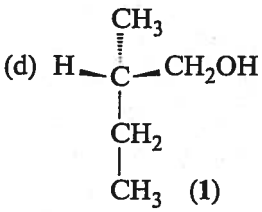
5.4 (a), (b), (e), (g), and (i) do not have chirality centers.



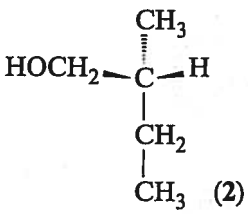
(1)



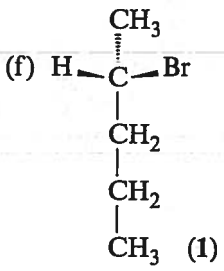
(2)



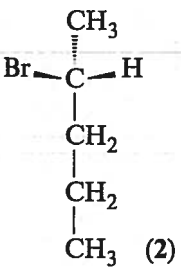
(1)



(2)

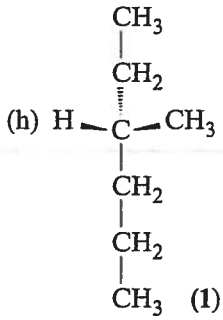


(1)

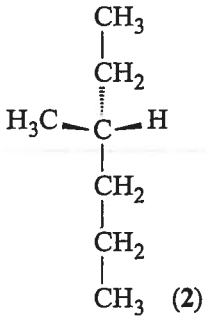


(2)

(h)

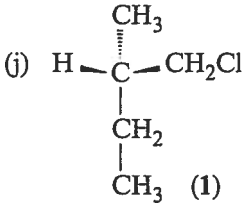


(1)

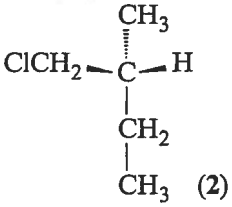


(2)

(j)

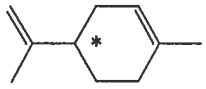


(1)



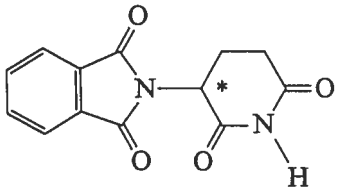
(2)

5.5 (a)

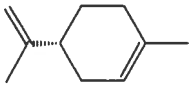


Limonene

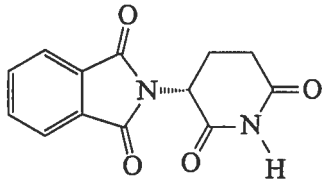
(b)



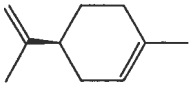
Thalidomide



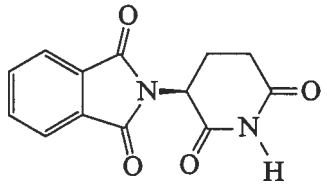
(*R*)



(*R*)

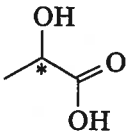


(*S*)

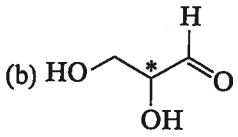


(*S*)

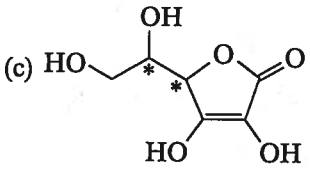
5.6 (a)



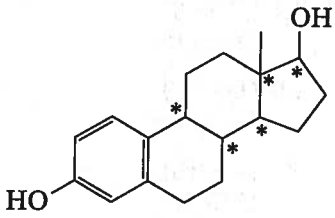
(b)



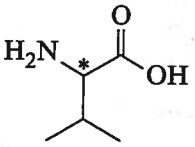
(c)



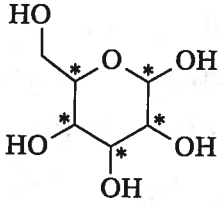
(d)



(e)



(f)



5.7 The following items possess a plane of symmetry, and are, therefore, achiral.

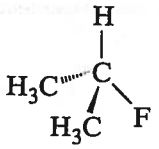
(a) A screwdriver

(b) A baseball bat (ignoring any writing on it)

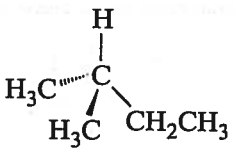
(h) A hammer

5.8 In each instance below, the plane defined by the page is a plane of symmetry.

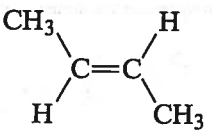
(a)



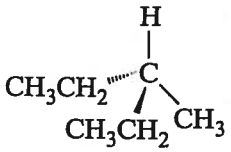
(b)



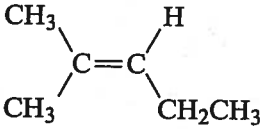
(e)



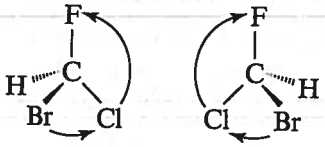
(g)



(i)



5.9



(*S*) (*R*)

5.10 (c) (1) is (*S*)
(2) is (*R*)

(d) (1) is (*S*)
(2) is (*R*)

(f) (1) is (*S*)
(2) is (*R*)

(h) (1) is (*S*)
(2) is (*R*)

(j) (1) is (*S*)
(2) is (*R*)

5.11 (a) $-Cl > -SH > -OH > -H$

(b) $-CH_2Br > -CH_2Cl > -CH_2OH > -CH_3$

(c) $-OH > -CHO > -CH_3 > -H$

(d) $-C(CH_3)_3 > -CH{=}CH_2 > -CH(CH_3)_2 > -H$

(e) $-OCH_3 > -N(CH_3)_2 > -CH_3 > -H$

(f) $-OPO_3H_2 > -OH > -CHO > -H$

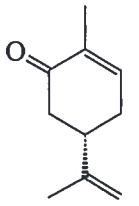
5.12 (a) (*S*) (b) (*R*) (c) (*S*) (d) (*R*)

5.13 (a) Enantiomers

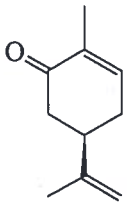
(b) Two molecules of the same compound

(c) Enantiomers

5.14



(*S*)-(+)-Carvone



(*R*)-(−)-Carvone

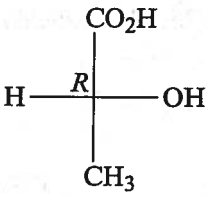
5.15 (a) $$\text{Enant. excess} = \frac{\text{observed specific rotation}}{\text{specific rotation of pure enantiomer}} \times 100$$

$$= \frac{+1.15}{+5.76} \times 100$$

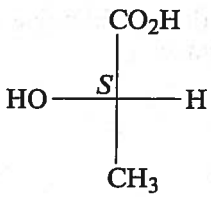
$$= 20.0\%$$

(b) Since the (*R*) enantiomer (see Section 5.8C) is +, the (*R*) enantiomer is present in excess.

(c)



(*R*)-Lactic acid



(*S*)-Lactic acid

Problems

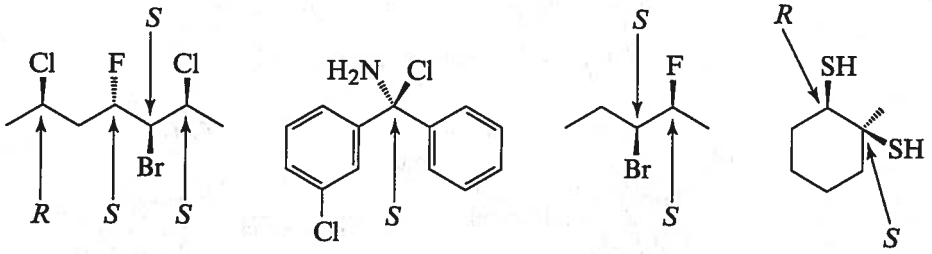
Chirality and Stereoisomerism

5.33 (a), (b), (f), and (g) only

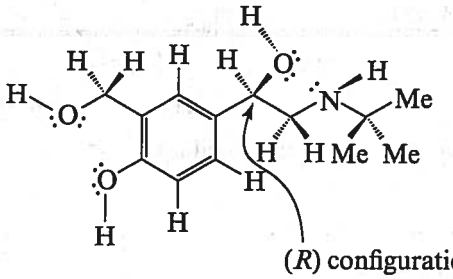
5.34 (a) Seven.

(b) (*R*)- and (*S*)-3-Methylhexane and (*R*)- and (*S*)-2,3-dimethylpentane.

5.35

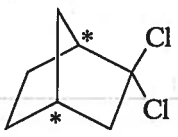


5.36



(*R*) configuration

5.37 (a)



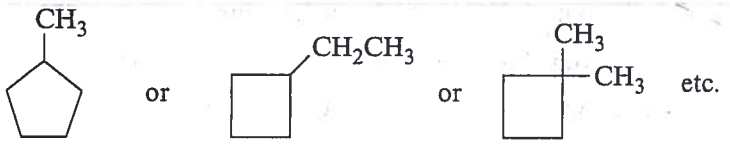
(b) Two, indicated by asterisks in (a)

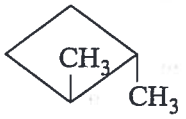
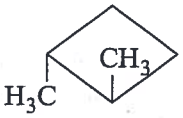
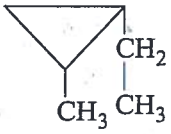
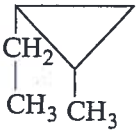
(c) Four

(d) Because a trans arrangement of the one carbon bridge is structurally impossible. Such a molecule would have too much strain.

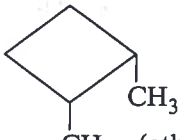
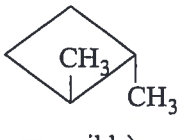
5.38 (a) **A** is (2*R*,3*S*)-2,3-dichlorobutane; **B** is (2*S*,3*S*)-2,3-dichlorobutane; **C** is (2*R*,3*R*)-2,3-dichlorobutane.

(b) **A**

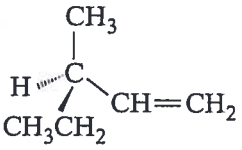
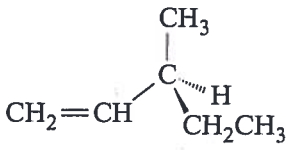
5.39 (a)  or or etc.

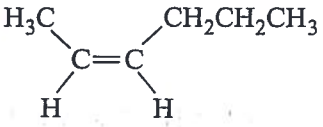
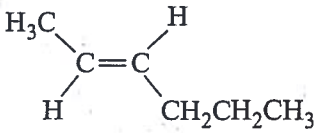
(b)  and  or  and 

(other answers are possible)

(c)  and 

(other answers are possible)

(d)  and 

(e)  and 

(other answers are possible)

5.40 (a) Same: (*S*)

(b) Enantiomers: left (*S*); right (*R*)

(c) Diastereomers: left (1*S*, 2*S*); right (1*R*, 2*S*)

(d) Same: (1*S*, 2*S*)

(e) Diastereomers: left (1*S*, 2*S*); right (1*S*, 2*R*)

(f) Constitutional isomers: both achiral

(g) Diastereomers: left, cis (4*S*); right, trans (4*R*)

(h) Enantiomers: left (1*S*, 3*S*); right (1*R*, 3*R*)

(i) Same: no chirality centers

(j) Different conformers of the same molecule (interconvertable by a ring flip): (1*R*, 2*S*)

(k) Diastereomers: left (1*R*, 2*S*); right (1*R*, 2*R*)

(l) Same: (1*R*, 2*S*)

(m) Diastereomers: no chirality center in either

(n) Constitutional isomers: no chirality center in either

(o) Diastereomers: no chirality center in either

(p) Same: no chirality center

(q) Same: no chirality center

5.41 All of these molecules are expected to be planar. Their stereochemistry is identical to that of the corresponding chloroethenes. (a) can exist as cis and trans isomers. Only one compound exists in the case of (b) and (c).

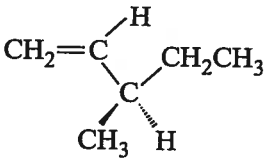
5.42 (a) diastereomers

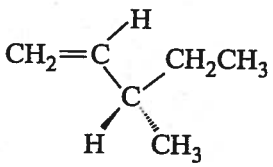
(b) enantiomers

(c) enantiomers

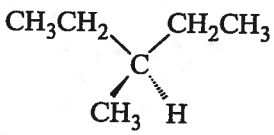
(d) same compound

5.43



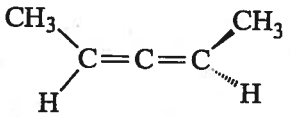


D (racemic)

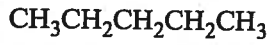


E (achiral)

5.44

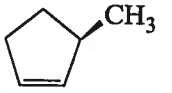


(or enantiomer)
F

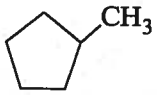


(achiral)
G

5.45

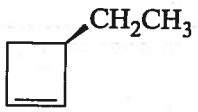


(or enantiomer)
H

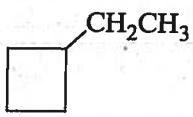


(achiral)
I

or



(or enantiomer)



(achiral)