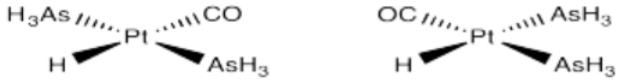
# 5.20: Solutions to Selected Problems

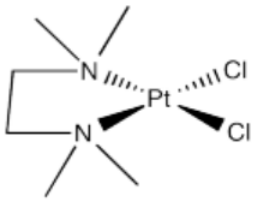
Exercise 5.2.1:

a) 

b) 

c) 

Exercise 5.2.2:



Needs to *cis*. The tmeda group is not long enough to reach the *trans* position

Exercise 5.3.1:

Clockwise.

Exercise 5.3.2:

Counter-clockwise.

Exercise 5.3.3:

Counter-clockwise.

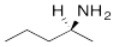
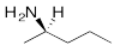
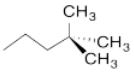
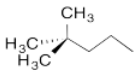
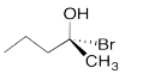
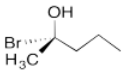
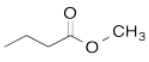
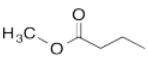
Exercise 5.3.4:

Clockwise.

Exercise 5.3.5:

Enantiomer B has a molecular weight of 126 g/mol, a density of 0.995 g/mL, an optical rotation of [α] = – 26°, a melting point of 65°C and a boiling point of 225°C.

Exercise 5.3.6:

| | Mirror Image | Superimposable | Chiral? |
|---|---|---|---|
|  |  | Yes | No |
|  |  | No | Yes |
|  |  | Yes | No |
|  |  | Yes | No |
|  |  | Yes | No |
|  |  | No | Yes |
|  |  | Yes | No |

Exercise 5.3.7:

A. The plane of the page is a mirror plane. There is also one perpendicular to the page that reflects one H into the other.
B. The plane of the page contains one P-Cl bond and bisects the other Cl's.
C. The plane of the page is a mirror plane.
D. Mirror plane contains P-Br bond and bisects the Cl's.
E. There is no lone pair on the B. Therefore all atoms lie in a mirror plane.
F. No mirror planes--the molecule is therefore chiral.
G. There is a plane perpendicular to the page that contains the Br and Cl and bisects the cyclopropane ring.
H. No mirror planes--the molecule is therefore chiral.
I. There is a plane perpendicular to the page that contains the Br and Cl and bisects the cyclopropane ring.
J. The C-C bond can be rotated by 60 degrees so that there is a plane perpendicular to the C-C bond axis.
K. The C-C bond in one of the chlorine-containing arms can be rotated so that there is a mirror plane that goes through the ethyl group (with no Cl's) and the P, and one chlorine containing arm is the reflection of the other.
L. Since a double bond is planar, there is a mirror plane that contains all six atoms.
M. There is a mirror plane that contains two C's and bisects the two Cls.
N. No mirror planes--the molecule is therefore chiral. The rings are not in the same plane due to the CH3 and NH2 groups, which bump into each other. They also prevent rotation around the C-C bond between the rings.

Exercise 5.3.8

Picture (a)

Exercise 5.3.9:

Picture (b)

Exercise 5.3.10:

Picture (d)

Exercise 5.3.11:

Picture (c)

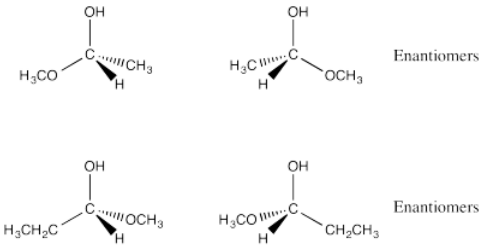
Exercise 5.4.1:

Priority of groups:
1 Br (red)
2 Cl (bright green)
3 F (pale green)
4 H (white)

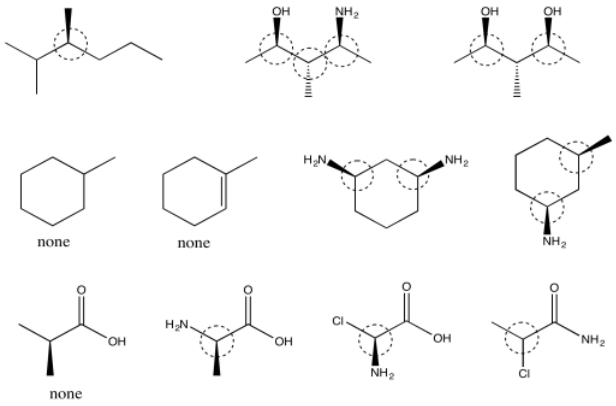
In the molecule in figure 5.4.2, with the low-priority hydrogen pointed away, bromine is at the top, chlorine is clockwise from the bromine, and fluorine is clockwise from the chlorine. It therefore has an assigned configuration of *R*.

In the molecule in figure 5.4.3, with the low-priority hydrogen pointed away, bromine is at the top, chlorine is counterclockwise from the bromine, and fluorine is counterclockwise from the chlorine. Thus, it has an assigned configuration of *S*.

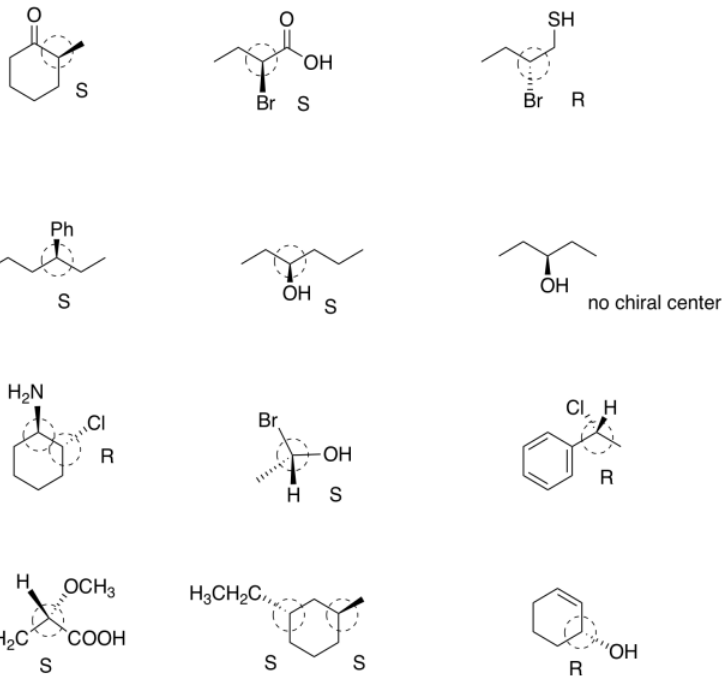
Exercise 5.4.2



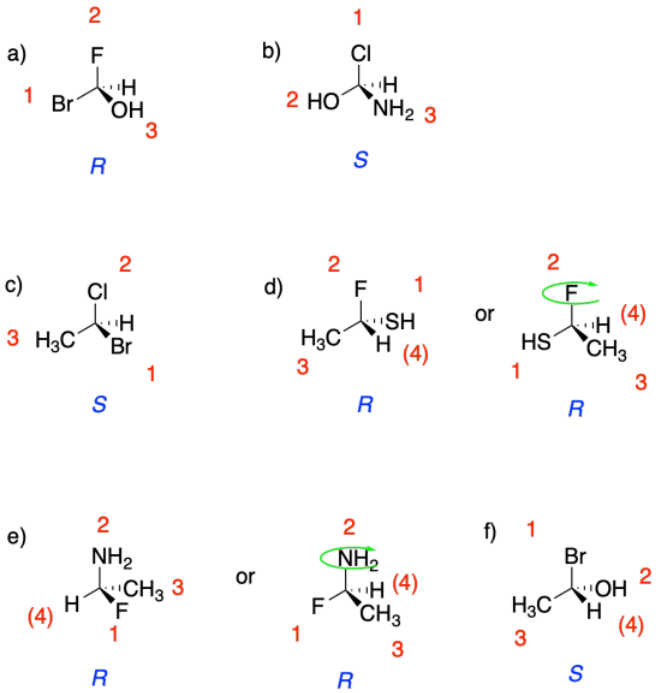

Exercise 5.4.3:



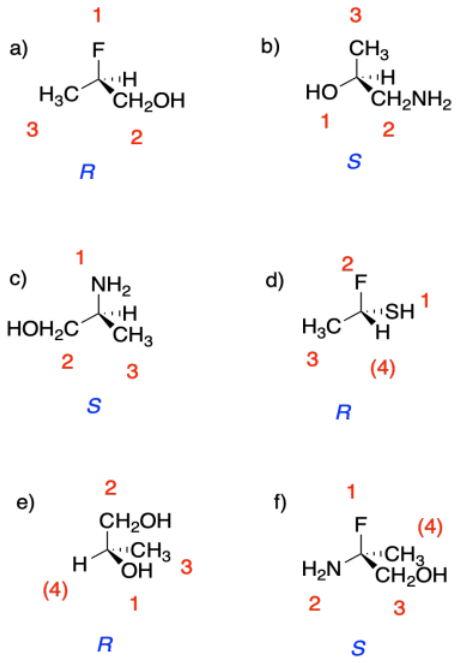

Exercise 5.4.4:



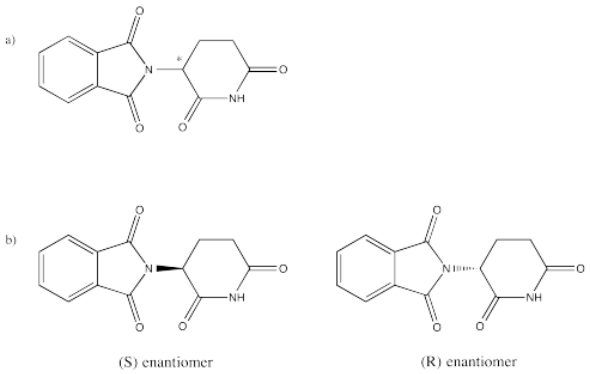

Exercise 5.4.5:




Exercise 5.4.6:

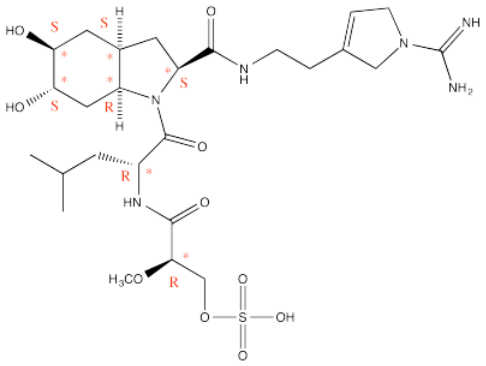


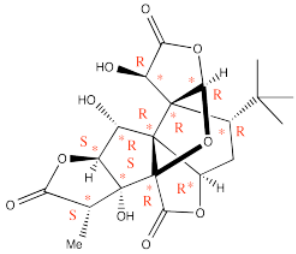

Exercise 5.5.1:

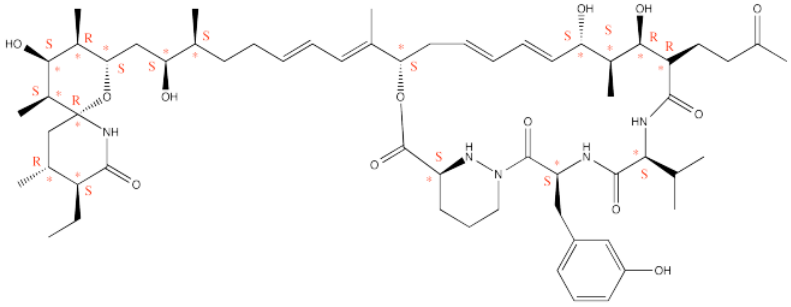



Exercise 5.5.2:


Exercise 5.5.3:







Exercise 5.6.1:

A pure sample of A would have $[\alpha] = 75^\circ$

Optical purity or enatiomeric excess = $\frac{50}{75} = 66\%$

% major enantiomer = $66 + \frac{34}{2} = 83\%$

% minor enantiomer = $100 - 83 = 17\%$

Exercise 5.6.2

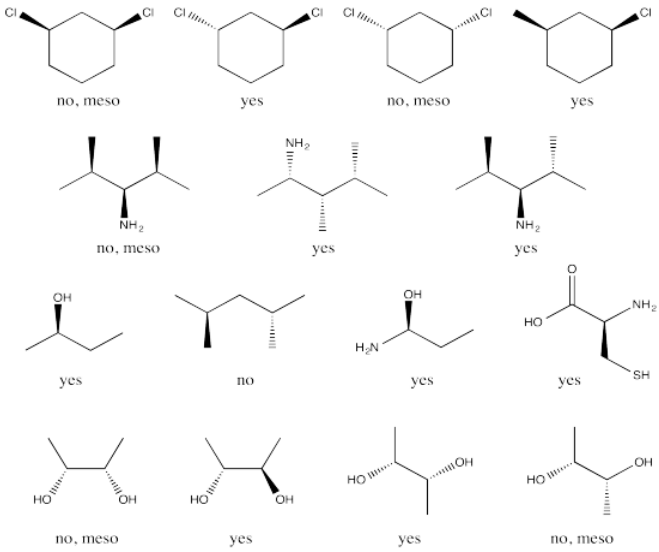
$$\%\, major\ = 90\%$$

$\%\, major\ = 10\%$

Optical purity or enantiomeric excess = $\frac{X}{-50} = 90 - 10 = 80\%$

Solve for X. $X = -40^\circ$

Exercise 5.6.4:




Exercise 5.7.1:

a) $[\alpha] = \frac{\alpha}{(c)(l)}$

$c = (\frac{0.250g}{2mL})(\frac{10mL}{1dL}) = 1.25\,\frac{g}{dL}$

$\alpha = \frac{(0.775^\circ + 0.806^\circ + 0.682^\circ)}{3} = 0.754^\circ$

$[\alpha] = \frac{\alpha}{(c)(l)} = \frac{(0.754^\circ)}{(1.25\,\frac{g}{dL})(0.5dm)} = +1.21^\circ$

b)

– 1.21°

Exercise 5.7.2:

$$[\alpha] = \frac{\alpha}{(c)(l)}$$

$[\alpha] = 32\circ$

$c = (\frac{0.150g}{1mL})(\frac{10mL}{1dL}) = 1.5\,\frac{g}{dL}$

c = (0.150g/ 1 mL)(10 mL/1 dL) = 1.5g/dL

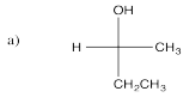
$[\alpha] = \frac{\alpha}{(c)(l)} = 32^\circ = \frac{\alpha}{(1.5\,\frac{g}{dL})(0.5dm)}$

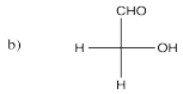
Solve for α. $\alpha = +24^\circ$

Exercise 5.8.1:

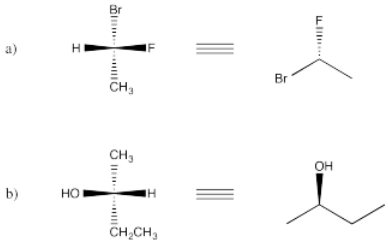
D-glyceraldehyde is R
L-glyceraldehyde is S

Exercise 5.8.2:




Exercise 5.8.3:




Exercise 5.9.1:

a) left b) right

Exercise 5.9.2:

a) right b) left

Exercise 5.9.1:

a) right b) right

Exercise 5.9.2:

a) left b) left

Exercise 5.9.5:

D-threose
2S, 3R

Exercise 5.9.6:

L-threose
2R, 3S

D- and L-threose are enantiomers of one another

Exercise 5.9.7:

L-erythrose
2S, 3S

L-erythrose and L-threose are diastereomers of one another.

Exercise 5.9.8:

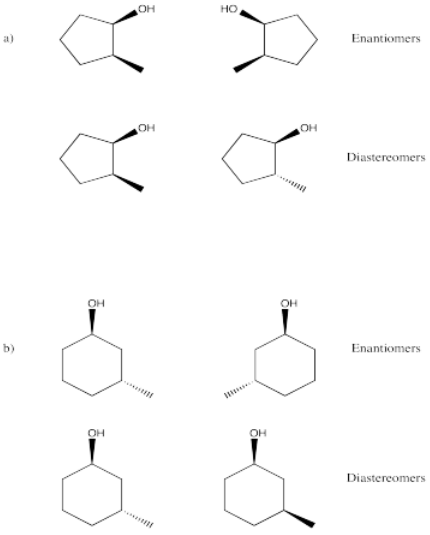
a) $(2)^3$ = 8 possible stereoisomers

RRR; SSS; RRS; SSR; RSS; SRR; SRS; RSR

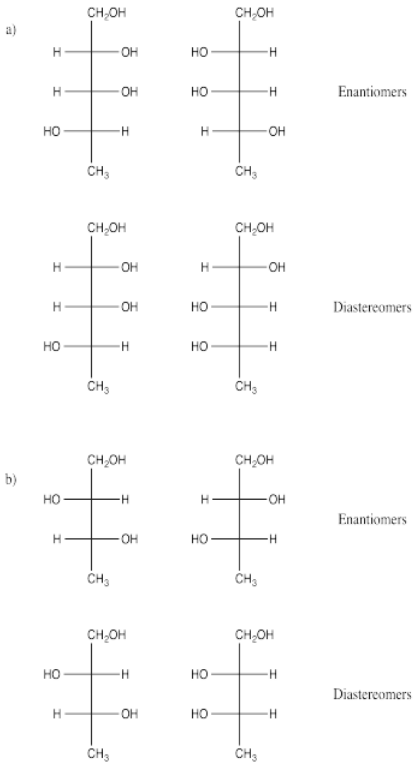
b) 4 pairs

c) 12 different possible pairs of diastereomers

Exercise 5.9.9:




Exercise 5.9.10:




Exercise 5.10.1:

a) D-threitol → 2R, 3S

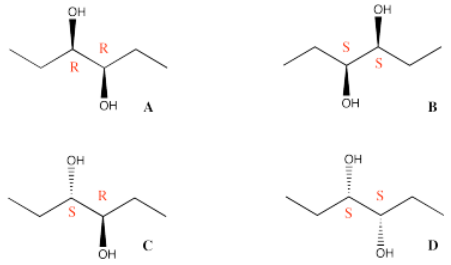
b) L- threitol → 2S, 3S

c) erythritol → 2S, 3R or 2R, 3S (a meso compound)

Exercise 5.10.2:

It does not matter which end you start counting from on these compounds since they are constituted the same.

Exercise 5.10.3:



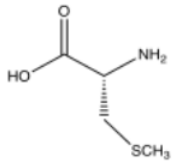

a) **B** and **D**

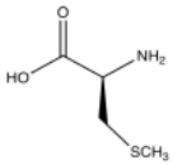
b) **A** and **D** or **A** and **B**

c) **A** and **C** or **B** and **C** or **D** and **C**

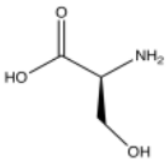
d) **C**

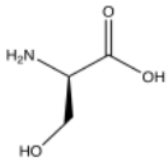
Exercise 5.10.4:



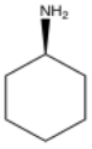



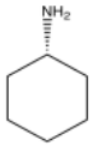

enantiomers



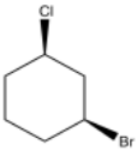



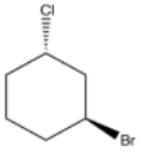

enantiomers



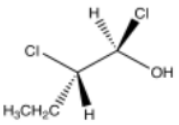



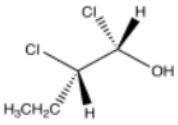

identical



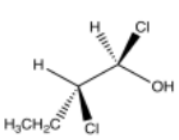
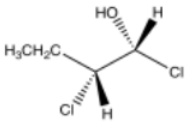



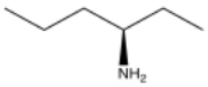
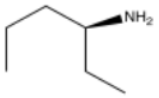

diastereomers

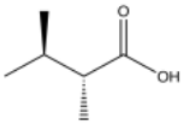
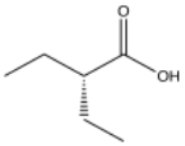


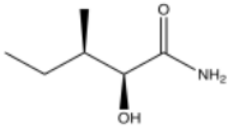
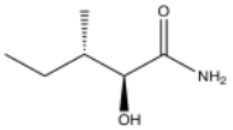



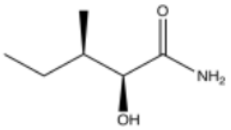
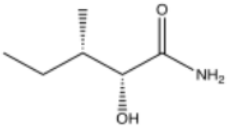

diastereomers

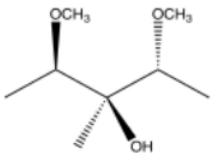
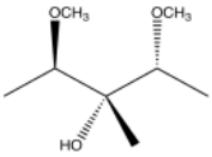


identical



enantiomers



constitutional isome

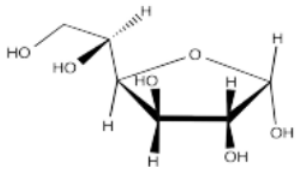
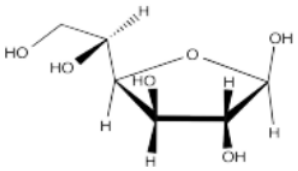


diastereomers



enantiomers

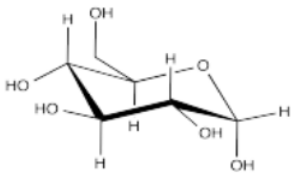
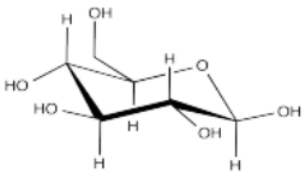


identical

Exercise 5.11.1:

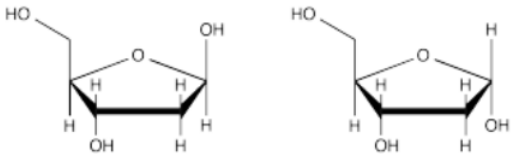
a)

b)

Exercise 5.11.2:



β-deoxyribofuranose α-deoxyribofuranose

a) Trans

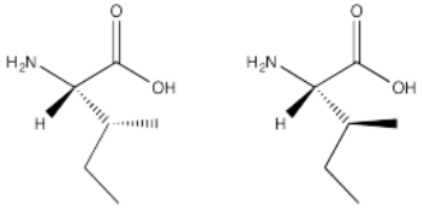
b) Cis

Exercise 5.12.1:

Glycine

Exercise 5.12.2:

Isoleucine



Exercise 5.12.3:

Proline

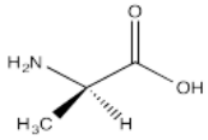
Exercise 5.12.4:

Glutamic acid and aspartic acid

Exercise 5.12.5:

Arginine, asparagine, glutamine, lysine; also tryptophan contains an aromatic heterocycle, although it is not basic.

Exercise 5.12.6:



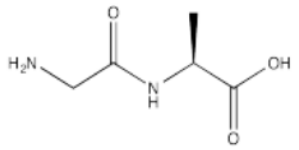
D-alanine

Exercise 5.12.7:

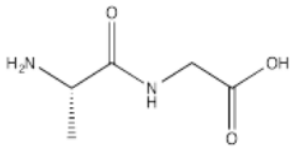
Cysteine

Exercise 5.13.1:

a)



Gly-Ala

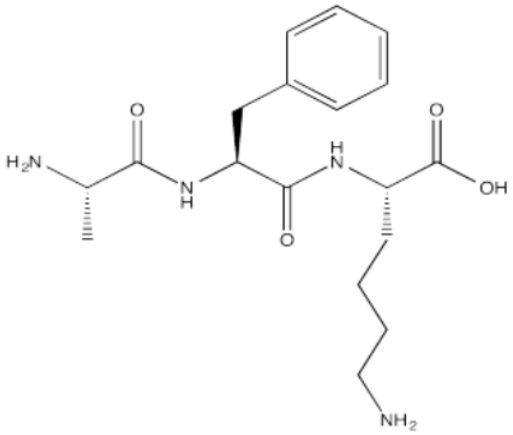


Ala-Gly

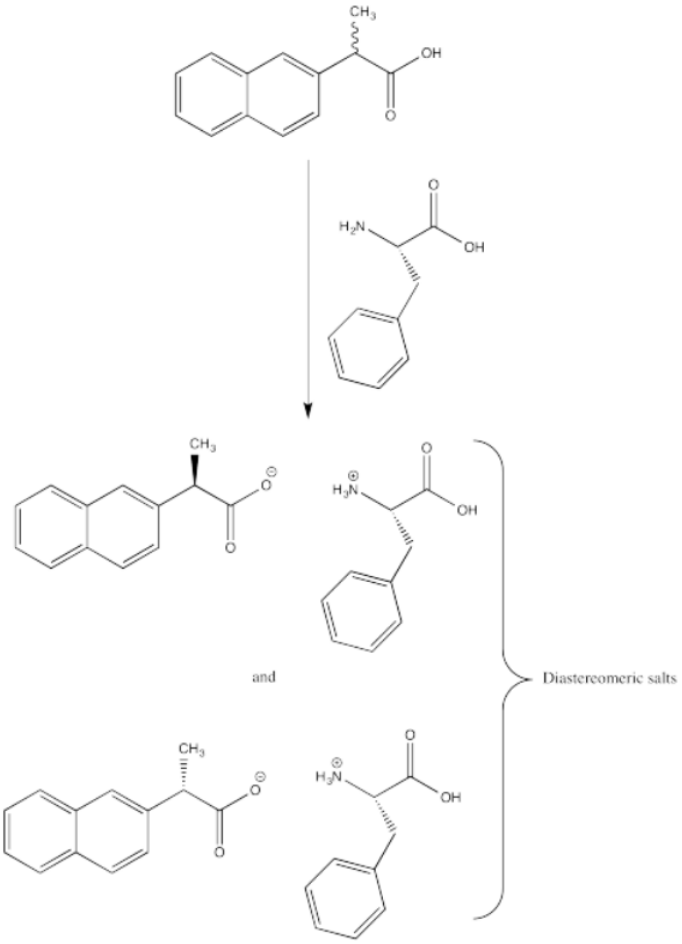
b) No. They are constitutional isomers of one another.

Exercise 5.13.2:

Ala-Phe-Lys



Exercise 5.14.1:



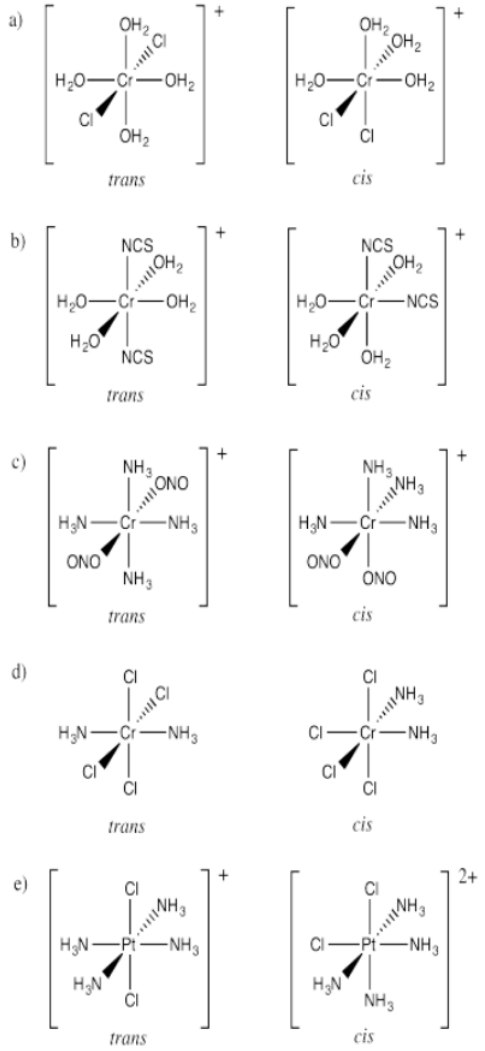

Exercise 5.15.1:

A. Cis
B. Trans
C. Trans
D. Neither (There is free rotation around the C-C single bond.)
E. Neither (C-C triple bonds have substituents at 180 degrees to each other (linear).
F. cis

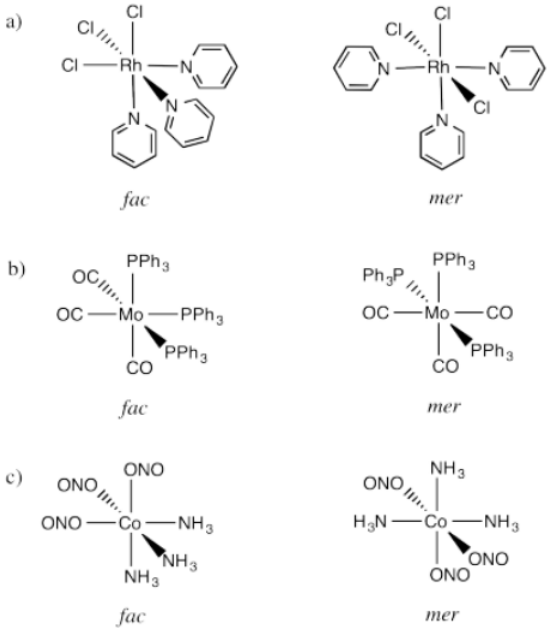
Exercise 5.16.1:

A. Z
B. E
C. E
D. Z
E. E
F. E
G. Z
H. E

Exercise 5.17.1:




Exercise 5.17.2:



Exercise 5.18.1:

a) Enantiomers

b) Enantiomers

c) Identical

d) Identical

e) Enantiomers

f) Identical

g) Enantiomers

Exercise 5.18.2:

a) Δ b) Λ c) Δ d) Λ e) Δ f) Δ g) Λ h) Λ

Exercise 5.20.1:

Pure = 125°

Optical purity = $\frac{100}{125} = 0.80$

$$\%\ Major\ = 80 + \frac{20}{2} = 90\%$$

$$\%\ Minor\ 100 - 90 = 10\%$$

Exercise 5.20.2

Pure = 100°

Optical purity = $\frac{95}{100} = 0.95$

$\%\ Major\ = 95 + \frac{5}{2} = 97.5\%$

$$\%\ Minor\ 100 - 97.5 = 2.5\%$$

Exercise 5.20.3

$$Pure\ = 18^{\circ}$$

$$\%\ Major\ = 60\%$$

$\%\ Minor\ = 40\%$

Optical purity = $\frac{X}{18} = 20\%$

Solve for X:

$$X = 3.6^{\circ}$$

Exercise 5.20.4:

$$Pure\ = 25^{\circ}$$

$$\%Major\ = 80\%$$

$\%Minor = 20\%$
Optical purity = $\frac{X}{25} = 80 - 20 = 60\%$

Solve for X:

$$X = 15^\circ$$

Exercise 5.20.5

$$[\alpha] = \frac{observed\ rotation}{(l)(c)}$$

$c = \frac{0.050g}{2.0mL} = 0.025\frac{g}{mL}$

Average observed rotation = $\frac{(0.625+0.706+0.682)}{3} = 0.671^\circ$

$$[\alpha] = \frac{0.671^\circ}{(0.025\frac{g}{mL})(0.5dm)} = 53.68^\circ$$

Exercise 5.20.6:

$$[\alpha] = \frac{observed\ rotation}{(l)(c)}$$

$c = \frac{0.540g}{2.0mL} = 0.27\frac{g}{mL}$

Average observed rotation = $\frac{(1.225+1.106+1.182)}{3} = 1.171^\circ$

$$[\alpha] = \frac{1.171^\circ}{(0.27\frac{g}{mL})(1.0dm)} = 4.34^\circ$$

Exercise 5.20.7:

$$[\alpha] = \frac{observed\ rotation}{(l)(c)}$$

$$c = \frac{0.250g}{2.0mL} = 0.125\frac{g}{mL}$$

$42^\circ = \frac{observed\ rotation}{(0.125\frac{g}{mL})(0.5dm)}$

observed rotation = 2.625°

Exercise 5.20.8

a) $[\alpha] = \frac{observed\ rotation}{(l)(c)}$

$$c = \frac{0.10g}{2.0mL} = 0.05\frac{g}{mL}$$

$c = \frac{0.10g}{2.0mL} = 0.05\frac{g}{mL}$

Average observed rotation = $\frac{(0.995+0.904+0.936)}{3} = 0.945\circ$

$[\alpha] = \frac{0.945^\circ}{(0.05\frac{g}{mL})(1.0dm)} = 18.9\circ$

b) % optical purity = $\frac{(100)(18.9)}{25} = 75.6\%$

c) enantiomeric excess = 75.6%

d) $\frac{(100-75.6)}{2} = 12.2\%$

12.2 % one enantiomer
87.8% other enantiomer

e) Enantiomers differ in how they interact with plane polarized light, but not in other physical analyses.

Exercise 5.20.9

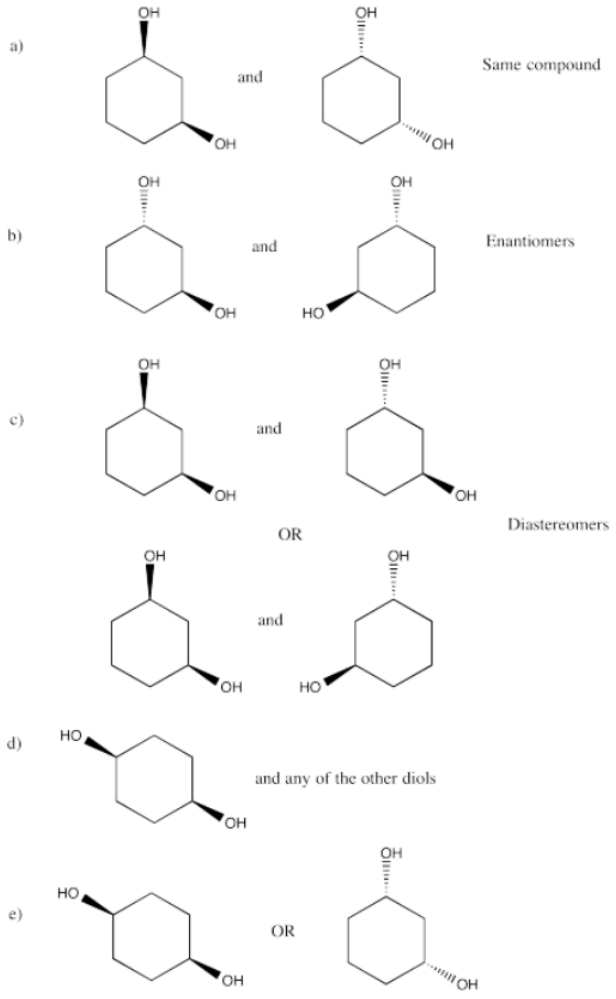
$$[\alpha] = \frac{observed\ rotation}{(l)(c)}$$

$$40\circ = \frac{observed\ rotation}{(l)(c)}$$

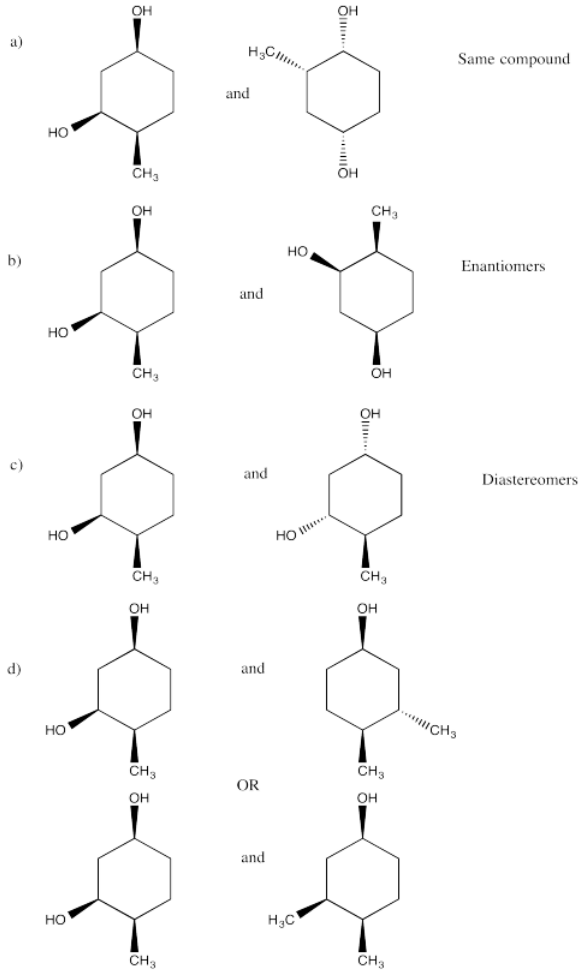
$40\circ = \frac{observed\ rotation}{(l)(1.1c)}$

Observed rotation = 44°

Exercise 5.20.10




Exercise 5.20.11:




Exercise 5.20.12: