1. Mark with a * the chiral centers in each of the following.

(a) \[
\begin{array}{c}
\text{CH}_3 \\
\text{CH} \\
\text{CH} \\
\text{OH}
\end{array}
\]
no chiral centers (like groups circled)

(b) \[
\begin{array}{c}
\text{CH}_3 \\
\text{CH} \\
\text{CH}_2\text{CH}_3
\end{array}
\]

(c) \[
\begin{array}{c}
\text{CH}_3 \\
\text{CH} \\
\text{CH}_2\text{CH}_3
\end{array}
\]
no chiral centers (like groups circled)

(d) \[
\begin{array}{c}
\text{CH}_3\text{CH}_2 \\
\text{CH} \\
\text{CH}_2\text{CH}_3
\end{array}
\]
no chiral centers (like groups circled)

(e) \[
\begin{array}{c}
\text{CH}_3 \\
\text{CH} \\
\text{CH} \\
\text{CH}_3
\end{array}
\]

(f) \[
\begin{array}{c}
\text{CH}_3 \\
\text{CH} \\
\text{CH} \\
\text{CH}_3
\end{array}
\]

(g) \[
\begin{array}{c}
\text{CH}_3 \\
\text{CH} \\
\text{CH}_2\text{CH} \\
\text{CH}_3
\end{array}
\]

(h) \[
\begin{array}{c}
\text{CH}_3 \\
\text{CH} \\
\text{CH} \\
\text{CH}_2\text{CH}_3
\end{array}
\]
2. Draw all stereoisomers, if they exist, using wedge and slash formulas for the following compounds.

(a) CH₃CHClCH₂CH₃

(b) CH₃CH₂CHOHCH₂CH₃ (achiral)

(c) CH₃—CH—CH₂CH₃ (achiral)

(d) (CH₃)₂CHCHBrCH₃

3. Determine the R,S specification of all of the stereoisomers drawn in Problem 2.

(a) First, these need to be rotated so that the group of lowest priority is in back. Then, specification of configuration can be assigned.
4. Do the following structures represent the same molecule or enantiomers?

(a) \[ \text{Br} - \text{F} \leftrightarrow \text{Cl} \quad \text{enantiomers} \]

(b) \[ \text{H} - \text{CH}_3 \quad \text{CH}_3 \quad \text{H} \quad \text{enantiomers} \]

(c) \[ \text{H} - \text{F} \quad \text{Cl} \quad \text{H} \quad \text{Cl} \quad \text{F} \quad \text{Cl} \quad \text{same molecule} \]
5. Determine the R,S specification of the following.

(a) 

(b) 

(c) 

(d)
6. Draw all stereoisomers, if they exist, using wedge and slash formulas or Fischer projections for the following compounds. Label meso compounds. Identify pairs of enantiomers and diastereomers.

(a) CH₃CHBrCHBrCH₃

![Wedge and slash formulas for CH₃CHBrCHBrCH₃](image)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>meso: 1</td>
<td>enantiomers: 2 and 3</td>
<td>diastereomers: 1 and 2</td>
</tr>
<tr>
<td>1 and 3</td>
<td>1 and 3</td>
<td>1 and 3</td>
</tr>
</tbody>
</table>

(b) CH₃CHClCHBrCH₃

![Wedge and slash formulas for CH₃CHClCHBrCH₃](image)

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>enantiomers: 1 and 2</td>
<td>3 and 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>diastereomers: 1 and 3</td>
<td>2 and 3</td>
<td>1 and 4</td>
<td>2 and 4</td>
</tr>
</tbody>
</table>
(c) CH₃CHClCH₂CHClCH₃

meso compound: 1
enantiomers: 2 and 3
diastereomers: 1 and 2

(d) CH₃CHBrCHBrCH₂CH₃

enantiomers: 1 and 2
3 and 4
diastereomers: 1 and 3
1 and 4
2 and 3
2 and 4

8. (i) Which of the stereoisomers in each group have the same physical properties? (ii) Describe the optical properties of each stereoisomer with respect to the others.

(a) These are enantiomers. Enantiomers have identical physical properties except toward plane-polarized light. They rotate plane-polarized light in equal and opposite directions.
I is a meso compound; it is optically inactive – it does not rotate plane-polarized light. All physical properties of I are different from II and III. II and III are enantiomers. Enantiomers have identical physical properties except toward plane-polarized light. Enantiomers rotate plane-polarized light in equal and opposite directions.

A and B are enantiomers. C and D are enantiomers. Enantiomers have identical physical properties except toward plane-polarized light. Diastereomers are A and C, A and D, B and C, B and D. Diastereomers have different physical and optical properties.

9. Do the following structures represent the same molecule, enantiomers or diastereomers?
10. (i) Draw all stereoisomers of the following. (ii) Label each stereoisomer as chiral or achiral. (iii) Label the meso compounds, enantiomers and diastereomers.

(a) 1,2-dimethylcyclopropane

1 is a meso compound. 2 and 3 are enantiomers. 1 and 2, 1 and 3 are diastereomers.
(b) 1,2-dimethylcyclobutane

4 is a *meso* compound. 5 and 6 are enantiomers. 4 and 5, 4 and 6 are diastereomers.

(c) 1,3-dimethylcyclobutane

all of these molecules are achiral - however geometric isomers can exist