1. (12) In the following molecules, **rank the groups** in the molecules attached to the chiral centers in order of Cahn, Ingold, Prelog (CIP) priority (1 = highest; 4 = lowest priority) and assign the absolute configuration (R or S). For full credit, you must rank the groups 1-4.

![Molecules](image)

2. (12) Name the following compounds. Be sure to denote stereochemistry (cis, trans) where appropriate.

![Compounds](image)

3. (14) Consider the molecule 2(R),3(S) 2-bromo-3-chlorobutane which has a $\alpha_l = -79^\circ$.

a) Draw the Fisher projection of this molecule with C2 above C3. Label it “A”.

b) Draw the stereoisomer that has a $\alpha_l = +79^\circ$. Label it “B”.

c) Draw 2 other stereoisomers and label them “C” and “D”.

d) What is the stereochemical relationship between:

- A & B
- A & C
- B & D
- C & D
4.(18) Draw a staggered *Newman projection* of **2,3-dibromobutane** sighting along C₂-C₃ where the 2 Br atoms are **anti** and the 2 methyl groups (C1 and C4) are **anti**.

a) Rotate the rear carbon in 60° increments and draw the other 5 conformations. Using the data below determine the relative energy of both conformations and the barrier to rotation (kJ/mol).

<table>
<thead>
<tr>
<th>Eclipsing</th>
<th>Gauche</th>
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<tbody>
<tr>
<td>kJ/mol</td>
<td>kJ/mol</td>
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<tr>
<td>H – H</td>
<td>CH₃ – CH₃</td>
</tr>
<tr>
<td>Br – H</td>
<td>CH₃ – Br</td>
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<tr>
<td>CH₃ – H</td>
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<td>Br – Br</td>
<td>CH₃ – CH₃</td>
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<tr>
<td>CH₃ – Br</td>
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</tbody>
</table>

b) How many chiral centers are in this compound? _______

c) Determine the absolute configuration of any chiral centers.

d) Is this particular molecule optically active? _____ Explain.

5.(16) The molecule 3,3-dimethylcyclohexanol is shown below and consider the following information:

i) CH₃ – H 1,3-diaxial interaction = 3.8 kJ/mol
ii) OH – H 1,3-diaxial interaction = 2.1 kJ/mol
iii) OH – CH₃ 1,3-diaxial interaction = 8.1 kJ/mol

a) Above, draw the two flip *chair conformations* and identify any interactions present in each. **Highlight any H's** that are involved in 1,3-diaxial interactions.

b) Using the data provided, determine the relative energy of each conformation.
6. Determine the absolute configuration (R or S) for each chiral center in the following pairs of molecules. Also determine if the pairs are identical, enantiomers or diastereomers.

a) \[
\begin{align*}
\text{NH}_2 & \quad \text{CH}_3 \\
\text{CO}_2\text{H} & \quad \text{OH} \\
\text{CH}_3 & \quad \text{CO}_2\text{H} \\
\text{NH}_2 & \quad \text{CH}_3
\end{align*}
\]

b) \[
\begin{align*}
\text{HO} & \quad \text{NH}_2 \\
\text{CH}_3 & \quad \text{H} \\
\text{Cl} & \quad \text{H} \\
\text{Cl} & \quad \text{CH}_3
\end{align*}
\]

7. Identify the following chemical reactions as either rearrangement, elimination, substitution or addition. Also identify the electrophile (E) and the nucleophile (N) in each reaction.

a) \[
\begin{align*}
\text{cyclohexyl-Br} & + \text{NaOCH}_3 \\
\rightarrow & \text{cyclohexene} + \text{CH}_3\text{OH} + \text{NaBr}
\end{align*}
\]

b) \[
\begin{align*}
\text{CH}_3\text{CH}_3 & + \text{KI} \\
\rightarrow & \text{CH}_3\text{CH}_3 + \text{KCl}
\end{align*}
\]

c) \[
\begin{align*}
\text{CH}_3 & + \text{HBr} \\
\rightarrow & \text{CH}_3\text{Br}
\end{align*}
\]

d) \[
\begin{align*}
\text{CH}_2=\text{CHCHCH} &= \text{CH}_2 + \text{H}_3\text{O}^+ \text{(catalyst)} \\
\rightarrow & \text{CH}_3\text{CH} = \text{CHCH} = \text{CH}_2
\end{align*}
\]

8. Briefly define the term “racemic mixture”. What is the specific rotation of a racemic mixture?