1. Name the following molecules, including the specification of configuration.

   \[ \text{CO}_2\text{H} \]
   \[ \text{CH}_3\text{CH}_2\text{H} \]
   \[ \text{H} \]
   \[ \text{CO}_2\text{H} \]
   \[ \text{CH}_2\text{CH}_3 \]

2. For optically active molecules having the formula \( \text{C}_4\text{H}_{10}\text{O} \) draw the structure of the molecule having the highest boiling point.

3. Boron trifluoride and diethyl ether react as Lewis acid and Lewis base to form the complex \( \text{F}_3\text{B-O(C}_2\text{H}_5)_2 \).
   a) Why is boron trifluoride a Lewis acid?
   b) What are the formal charges in the product, \( \text{F}_3\text{B-O(C}_2\text{H}_5)_2 \)?

4. 2-methylbutane is subjected to monochlorination. Use diagrams below to show all products (including stereoisomers) produced. Put a check mark in the box if the structure is optically active. Calculate the expected yield for each structure given.

   \[
   \begin{array}{cccccccc}
   \text{C} & \text{C} & \text{C} & \text{C} & \text{C} & \text{C} & \text{C} & \text{C} \\
   \text{C} & \text{C} & \text{C} & \text{C} & \text{C} & \text{C} & \text{C} & \text{C} \\
   \text{active?} & \square & \square & \square & \square & \square & \square & \square \\
   \% \text{ yield} & \square & \square & \square & \square & \square & \square & \square
   \end{array}
   \]
5. For meso 3,4-dimethylhexane complete the Newman projections of
   a) the most stable staggered form.

   ![Newman projection of meso 3,4-dimethylhexane]

   b) the least stable eclipsed form

   ![Newman projection of meso 3,4-dimethylhexane]

6. Consider the free radical chlorination of propane. Using the bond dissociation energy data below draw the energy profiles for Step 2 of the chlorination mechanism

   \[
   \text{R-H} + \text{Cl} \rightarrow \text{R} + \text{H-Cl}
   \]

   You should **draw two profiles** on the same graph: one for the abstraction of a primary hydrogen (use a solid line) and the other for abstraction of a secondary hydrogen (use a dashed line). Remember final answer on the answer sheet.

<table>
<thead>
<tr>
<th>Bond Dissociation Energies (kcal/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{n-C}_3\text{H}_7\text{-H} )</td>
</tr>
<tr>
<td>(\text{i-C}_3\text{H}_7\text{-H} )</td>
</tr>
<tr>
<td>(\text{H-Cl} )</td>
</tr>
<tr>
<td>(\text{Cl-Cl} )</td>
</tr>
</tbody>
</table>

7. \(\text{NH}_2^- + \text{H}_2\text{O} \rightarrow ?\)

8. ethyl alcohol + phosphorus trichloride \(\rightarrow\)
9. Provide a synthesis of 2-methylpropane starting with alcohols having three or fewer carbons and any inorganic reagents.

10. 

11.

12.

13. Provide a synthesis of 2-methylpropane starting with alcohols having three or fewer carbons and any inorganic reagents.
14. Assume that the value of $K_D$ for extraction of adipic acid from aqueous solution with ether is 2.0. You extract 30 mL of an aqueous solution containing 1.0 g of adipic acid with 15 mL of ether.
   a) What fraction of the adipic acid has been removed from the aqueous solution?
   b) You perform a second extraction with a fresh 15 ml of ether on the aqueous solution from part a. How many grams of adipic acid are left after this extraction.

For each set of reactions choose the fastest. Answer by letter.

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a) $\text{(CH}_3\text{)}_3\text{CCH}_2\text{Br} + \Gamma \rightarrow \text{(CH}_3\text{)}_3\text{CCH}_2\text{I}$ (acetone solvent)

b) $\text{(CH}_3\text{)}_3\text{CCH}_2\text{Cl} + \Gamma \rightarrow \text{(CH}_3\text{)}_3\text{CCH}_2\text{I}$ (acetone solvent)

c) $\text{CH}_3\text{Br} + \Gamma \rightarrow \text{CH}_3\text{I}$ (acetone solvent)

d) $\text{CH}_3\text{Cl} + \Gamma \rightarrow \text{CH}_3\text{I}$ (acetone solvent)
1. (6 pts)

2 (5 pts) | 3 a (5 pts) | 3 b (5 pts)

4 (15 pts, -1 for each omission, duplicate or incorrect answer) Create additional templates, if needed, on reverse side.

4a (3 pts) 4b (3 pts)

5a (3 pts) 5b (3 pts)

This side 42 pts ______/42 Back side 58 pts ______/58
6 (8 pts) Remember to use solid line for primary hydrogen abstraction; dashed for secondary.

7 (4 pts) 8 (4 pts) 9 (4 pts) 10 (4 pts)

11 (4 pts) 12 (4 pts) 13 (10 pts)

14a (4 pts) 14b (4 pts)

15 (4 pts) 16 (4 pts)

This side 58 pts ______/58