1. (17) a. Provide complete names or structures for the given molecules.

2-methyl-3-pentyn-1-ol

E-5-bromo-2,3-dimethyl-2-penten-1-ol
cis-1,3-disopropylcycloheptane
(R)-2-amino-2-chloro-1-propanol

b. Arrange these compounds in order of increasing strength as bases (1 weakest base, 3 strongest base):

H₂C—CH₂

Cl

Cl


2. (2) Circle all of the following compounds that would protonate ethylamine to a great extent.

\[
\begin{array}{c|c|c}
\text{COOH} & \text{NH₃⁺ 1⁻} & \text{HF} \\
\hline
4.7 & 4.6 & 3.1 \\
\end{array}
\]

d. Indicate if each of the following reactions have equilibrium constants greater than or less than one. Arrows are not necessarily drawn to scale.

\[
\begin{array}{c}
\text{I. } \text{C₆H₅CH≡CH} + \text{CH₃CO₂Na} & \rightleftharpoons & \text{C₆H₅CH≡CH} + \text{CH₃CO₂H} \\
\hline
\end{array}
\]

\[K < 1 \text{ (mostly)}\]

\[
\begin{array}{c}
\text{II. } \text{Na₂S} + \text{H₂SO₄} & \rightleftharpoons & \text{HSO₄⁻} + \text{SH} \\
\hline
-4.8 & 10.7 \\
\end{array}
\]

\[K > 1 \text{ (mostly)}\]

2 (6) Three molecules (A-C) are represented below by their Fischer projections. Determine the relationship between each pair of compounds.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Compound</th>
<th>Relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>diastereomers</td>
</tr>
<tr>
<td>A</td>
<td>C</td>
<td>identical</td>
</tr>
<tr>
<td>B</td>
<td>C</td>
<td>diastereomers</td>
</tr>
</tbody>
</table>
3. (13) Give a complete mechanism for the following reaction, explaining the formation of all three products.

\[
\begin{align*}
\text{\textbf{H}} & \text{H}^+ & \rightarrow & \ \downarrow \\
\text{\textbf{heat}} & & & + & \text{\textbf{H}}_2\text{O}.
\end{align*}
\]

4. (10) Explain why the regioselectivity of HBr addition to an alkene is affected by the presence of peroxides. Full credit will not be given if you simply state what the change is—you must explain the mechanistic basis for the change.

\[R_x\text{ always form the most stable intermediates. The difference in these } R_x \text{ is the peroxide causes a radical } R_x, \text{ which adds the } Br^- \text{ first. The addition of HBr w/o peroxide goes through a carbocation when } H^+ \text{ add first.}\]

\[
\begin{align*}
&\text{Br}^- & \rightarrow & \text{more stable (anti Markov)} \\
&H^+ & \rightarrow & \text{Mark, add.}
\end{align*}
\]
5. (S)-2-bromobutane reacts with sodium iodide (NaI) in an $S_N2$ reaction.
   a. Give an equation for the reaction including any relevant stereochemistry in reactants or products.
   b. Draw a reaction coordinate for this reaction. On the reaction coordinate put a star (*) where any transition states occur and a double star (**) where any intermediates occur.
   c. Give two ways to increase the rate of this reaction.

6. (12). Only one stereoisomer of 1-chloro-2-methylcyclohexane gives a single product when subjected to E2 conditions. Draw both the product and the reactive conformation of the starting material, clearly explaining how you determined it was the stereoisomer described.

   - The trans isomers can give only 1 product.

   - Anti H consideration = 6 pts
     - 1 if only looked at wrong chair
     - 4 if only chose either cis/trans
     - 3 if didn't consider H's on the other side
Provide the missing products, starting materials or reagents. Include stereochemistry where relevant. If no reaction would occur, simply write "N.R." in place of products.

7. (16) Provide the missing products, starting materials or reagents. Include stereochemistry where relevant. If no reaction would occur, simply write “N.R.” in place of products.

8. (13) Provide a synthetic route for the following multi-step transformation. You must include reagents but not mechanisms.

Make

from

One method: (others may work, too!) using any additional reagent you wish.