<table>
<thead>
<tr>
<th>Name</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>oct-1-yn-3-ol</td>
<td><img src="structure1.png" alt="Structure" /></td>
</tr>
<tr>
<td>hexan-2-one</td>
<td><img src="structure2.png" alt="Structure" /></td>
</tr>
<tr>
<td>pentyl acetate</td>
<td><img src="structure3.png" alt="Structure" /></td>
</tr>
<tr>
<td>methoxybenzene</td>
<td><img src="structure4.png" alt="Structure" /></td>
</tr>
<tr>
<td>2-ethylhexane-1,3-diol</td>
<td><img src="structure5.png" alt="Structure" /></td>
</tr>
<tr>
<td>propane-1,3-diamine</td>
<td><img src="structure6.png" alt="Structure" /></td>
</tr>
<tr>
<td>2,4,4-trimethylpent-1-ene</td>
<td><img src="structure7.png" alt="Structure" /></td>
</tr>
<tr>
<td>N,N-dimethylmethanamide</td>
<td><img src="structure8.png" alt="Structure" /></td>
</tr>
<tr>
<td>hexane-1,6-diol</td>
<td><img src="structure9.png" alt="Structure" /></td>
</tr>
<tr>
<td>hexa-1,5-diene</td>
<td><img src="structure10.png" alt="Structure" /></td>
</tr>
<tr>
<td>methyl-3-bromobutanoate</td>
<td><img src="structure11.png" alt="Structure" /></td>
</tr>
</tbody>
</table>
1. Label the acid, basic, conjugate acid, and conjugate base. Show arrow pushing. Also indicate which direction the reaction will favor.

A. \[ \text{base} \quad \text{acid} \]
\[
\text{NO}_2^- + \text{HSO}_4^- \quad \text{H}_2\text{SO}_4
\]
\[ pK_a = 3.29 \]

B. \[ \text{acid} \quad \text{base} \]
\[
\text{H}_3\text{C} = \text{C} - \text{CH}_3 + \text{NH}_2^- \quad \text{H}_3\text{C} = \text{C} - \text{CH}_2
\]
\[ pK_a = 26.5 \]

C. \[ \text{base} \quad \text{acid} \]
\[
\text{H}_3\text{C} = \text{C} - \text{CH}_3 + \text{Cl}^- \quad \text{H}_3\text{C} = \text{C} - \text{CH}_3
\]
\[ pK_a = -2.9 \]

2. Draw an energy diagram for A) two-step exothermic reaction with the first step being the rate-limiting step. B) two-step exothermic reaction with the second step being the rate-limiting step.

3. What is the difference between a methyl shift and hydride shift? When do we use them?

moving \( \text{CH}_3 \) \to moving \( \text{H} \)

move/most stable carbocation

4. Define the following rules:
   a. Markovnikov’s Rule (alkene rxns)
      (Addition rxns) Add to the most stable carbocation
   b. Zaitsev’s Rule
      (Elimination rxn) Form the most substituted alkene

\[ \text{H}_3\text{O}^+ / \Delta \]
5. Draw the mechanism for the formation of the proper rearrangement product, include any other possible products:

6. Draw the mechanism for the formation of the proper rearrangement product, include any other possible products:

6. Complete the following reactions by adding the reactant, reagent, or product:
   a.
7. Draw the mechanism for the reaction that was completed in 6g
8. Draw the mechanism for the reaction that was completed in 6a

9. Draw the mechanism for the reaction that was completed in 6b

10. Complete the following synthesis: