Chapter 02 Worksheet

1. Label the type of orbital hybridization at each atom indicated with an arrow. For all sp$^3$ hybridized carbon atoms, label as being primary, secondary, or tertiary.

   ![Chemical Structure](image)

   - How many hydrogens are there here?
   - How many sp$^2$ hybrid orbitals?
   - How many unhybridized p-orbitals?
   - Would you classify this molecule as polar or nonpolar?

2. Using MO Theory, explain why H$_2$ is a stable diatomic molecule and explain why He$_2$ does not exist.
3. Draw a detailed valence-bond orbital picture of the following molecules:
   a) \( \equiv \)C\( \equiv \) \\
   b) CH\(_3\)\( \equiv \)CH\( \equiv \)CH\(_2\) \\
   c) C\(_2\)H\(_2\) \\
   d) CO

4. Draw the resonance structure of formate. Draw an orbital picture that shows the \( \pi \) orbitals for the molecule. The \( \sigma \) skeleton may be drawn with simple lines, dash bonds, and wedge bonds.
5. For each of the following compounds:
   a) determine the shape of the indicated carbons (remember to add lone pairs, and H’s on line structures);
   b) determine the number of primary, secondary, and tertiary carbons; (don’t count carbon with double bonds) and
   c) circle and label three functional groups.

   d) 

   ![](vitamin_C.png)

   vitamin C

   e) 

   ![](penicillin_G.png)

   penicillin G
6. For each of the following compounds:
   a) determine if the compound is polar and draw the dipole moment;
   b) indicate the strongest intermolecular force that would exist between two molecules of the substance;
   c) predict whether the substance will be soluble in water.

   f) \[ \text{CH}_3\text{C}==\text{CH}_3 \]

   g) \[ \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \]

   h) \[ \text{CH}_3\text{C}==\text{N}\text{H} \]

7. Predict which substance in each pair of compounds would have a higher boiling point:
   i) \[ \text{CH}_3\text{CH}_2\text{CH}_2\text{OCH}_3 \quad \text{CH}_3\text{CH(OH)CH}_3 \]
   j) \[ \text{CH}_3\text{(CH}_2)_4\text{CH}_2\text{OH} \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} \]
   k) \[ \text{CH}_3\text{NH}_2 \quad \text{N(CH}_3)_3 \]
   l) \[ \text{CH}_3\text{CH(OH)CH}_3 \quad \text{CH}_2\text{(OH)CH(OH)CH}_2\text{OH} \]
   m) \[ \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 \]
   n) \[ \text{Butane} \quad \text{Octane} \]
8. Predict whether the following molecules are polar.

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Shape</th>
<th>Prediction of polarity</th>
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<tbody>
<tr>
<td>BCl₃</td>
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<tr>
<td>BClBr₂</td>
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<tr>
<td>CH₄</td>
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<tr>
<td>NH₃</td>
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<tr>
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<tr>
<td>CH₃Cl</td>
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