Before you begin this exam: First: You are allowed to have a simple model set at your seat. Please put away all other materials. Second: Place your student identification on your desk. A proctor will come around to check everyone’s ID. Third: Read through the entire exam. Your goal, as always, is to score as many points as possible. Do not waste time on problems that you can’t do if there are others that look easy. Fourth: READ EACH QUESTION CAREFULLY. Be sure you answer the question that is asked. Fifth: Once the start time is announced, you have one hour to complete this exam. There will be no extensions, so budget your time carefully.

<table>
<thead>
<tr>
<th>Problem Number</th>
<th>Points Possible</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>200</strong></td>
<td></td>
</tr>
</tbody>
</table>
1. (20 points) Insert lone pair electrons, single bonds, double bonds, and/or triple bonds in the neutral structures below in an arrangement that gives no formal charges on any atom. Assume connectivity as implied by atom position.

\[
\begin{align*}
&H &\quad O &\quad H \\
&H &\quad C &\quad O &\quad H &\quad H \\
&H &\quad C &\quad H &\quad N &\quad N &\quad H &\quad B &\quad H \\
&H \\
\end{align*}
\]

2. (15 points) All lone pairs and atoms are drawn in the structures below. Label any formal charges. If there are no formal charges in a given structure, write the word “none” below the structure.

\[
\begin{align*}
&H &\quad N &\quad C &\quad C &\quad O &\quad H \\
&H &\quad H &\quad H &\quad H &\quad H &\quad H &\quad H \\
\end{align*}
\quad
\begin{align*}
&H &\quad C &\quad O : &\quad : &\quad C &\quad = &\quad O : \\
&H &\quad H \\
\end{align*}
\]

3. (15 points) Predict the geometry at each indicated C atom.

\[
\begin{align*}
&H &\quad C &\quad = &\quad C &\quad = &\quad H \\
&\text{CH}_3\text{CH}_2\text{CH}_3 \\
&\text{苯} \\
\end{align*}
\]
4. (15 points) Draw a Lewis structure for the following neutral skeletal structures. Include implied C and H atoms and implied lone pairs.

5. (30 points) Using curved arrow notation and the appropriate arrow between structures, draw the second best resonance structure for each of the molecules drawn below.
6. (15 points) Draw the skeletal structures for molecules with the following names. Do not include implied C and H atoms.

2,3-dimethylhexane  3-heptene  chlorocyclopentane

7. (15 points) Draw neutral skeletal structures from each condensed structure that do not have formal charges. Do not include implied lone pairs. Do not include implied C and H atoms.

(CH₃(CH₂)₄)₂O  (CH₃CH₂)₂NH  (CH₃)₂CO

8. (10 points) Draw one skeletal structure for each the following. There may be more than one correct answer. If you draw more than one answer, only the first answer will be graded.

(a) an alcohol with the formula C₂H₆O

(b) an alkene with the formula C₇H₁₂
9. (15 points) Identify the circled functional groups in Taxol, a natural product derived from the Yew tree.

10. (5 points) How many degrees of unsaturation are in 1-methylocyclohexene, shown below?
11. (10 points) Draw all of the constitutional isomers of 1-butene (there are 4), shown below. If you draw more than 4 isomers, only the first 4 will be graded.

\[ \text{ constitutional isomers of 1-butene } \]

12. (15 points) Label the following pairs of structures as constitutional isomers, enantiomers, diastereomers, the same, or neither.

\[ \begin{align*}
\text{ constitutional isomers of 1-butene } & \quad \text{ constitutional isomers of 1-butene } \\
\text{ constitutional isomers of 1-butene } & \quad \text{ constitutional isomers of 1-butene }
\end{align*} \]
13. (10 points) Mark each C atom as “stereogenic” or “nonstereogenic.” For any stereogenic C atom(s), label them as R or S.

![Image of a molecule with stereogenic centers marked](image1)

14. (10 points) From the Newman Projection shown below, draw the corresponding skeletal structure. Implied H and C atoms, and lone pairs should not be included. Include wedges and dashes only when they are needed to show stereochemistry.

![Image of a Newman projection](image2)

END OF EXAM