Please write your answers neatly in the spaces provided. You may not use a calculator or molecular models. There are 25 questions. Each question is worth 4 points. Read each question carefully and follow the instructions. If you do not readily know an answer, skip that question and move on. A pKa table is given on page 3. Some useful atomic numbers: H is 1, C is 6, O is 8, Cl is 17, Br is 35.

1. Assign absolute configuration (R or S) to each stereocenter in the compounds shown below.

   For questions 2-5, identify the following pairs of compounds as identical or isomers. If they are isomers, are they constitutional isomers of stereoisomers? If they are stereoisomers, are they enantiomers or diastereomers? Circle all meso compounds. + 2 pts extra

2.

3.

4.

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5. \[ \text{identical} \]

For questions 6 and 7, write the major organic product formed in the following reactions. Pay attention to the stereochemistry and include the correct stereochemistry in the product if necessary. If enantiomers are formed, you must draw both enantiomers. If diastereomers are formed, you must draw both diastereomers.

6. \[ \text{enantiomers} \]

7. \[ \text{diast.} \]

For questions 8-16, write the major organic product formed in the following substitution or elimination reactions. Pay attention to the stereochemistry and include the correct stereochemistry in the product if necessary. If enantiomers are formed, you only need to draw one. However, if diastereomers are formed, you must draw both. If you expect no reaction to occur, write NR.

8. \[ \text{small base} \]

9. \[ \text{inversion} \]

10. \[ \text{Solvolyis} \]
11. $\text{SN}_1$

12. $\text{E}_2$

13. $\text{E}_2$

14. $\text{E}_2$

15. $\text{E}_2$

16. $\text{NR}$

<table>
<thead>
<tr>
<th>Compound</th>
<th>pKa</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBr</td>
<td>5.8</td>
</tr>
<tr>
<td>CH$_3$COOH</td>
<td>4.7</td>
</tr>
<tr>
<td>H$_2$S</td>
<td>7.0</td>
</tr>
<tr>
<td>HCN</td>
<td>9.1</td>
</tr>
<tr>
<td>HN$_3$</td>
<td>9.2</td>
</tr>
<tr>
<td>NH$_4^+$</td>
<td>9.4</td>
</tr>
<tr>
<td>H$_2$O</td>
<td>15.7</td>
</tr>
<tr>
<td>CH$_3$CH$_2$OH</td>
<td>16.0</td>
</tr>
<tr>
<td>CH$_3$C=CH</td>
<td>26</td>
</tr>
<tr>
<td>NH$_3$</td>
<td>36</td>
</tr>
<tr>
<td>(CH$_3$)$_2$NH</td>
<td>36</td>
</tr>
</tbody>
</table>
For questions 17-20, write the major organic product formed in the following reactions taken from Chapter 9.

17.

18.

19.

20.

Provide reagents necessary to carry out the following transformations. More than one step is necessary.

21.

22.

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23. SM of 8 carbons or less

\[ \text{C} \equiv \text{CH} \xrightarrow{1. \text{NaNH}_2} \xrightarrow{2. \text{CH}_3\text{CH}_2 \text{I}} \text{Na}/\text{NH}_3 \]

24. Indicate a plausible mechanism for the following reaction. Be sure to show bond making and bond breaking as well as all electron movement.

\[ \text{Br} \xrightarrow{\text{NaCN}} \text{CN} \]

25. Indicate a plausible mechanism for the following reaction. Be sure to show bond making and bond breaking as well as all electron movement.

\[ \text{Br} + \text{H}_2\text{O} \xrightarrow{\text{HBr}} \text{OH} \]

EXTRA CREDIT: Compound X, C₆H₁₀ is optically active. Hydrogenation of the compound gives methycyclopentane. What is the structure of X.

4 pts