1. Name the following compound. Use the IUPAC system and include the stereochemical designations.

\[
\text{CH}_3\text{CHO} \\
\text{H} \quad \text{CO}_2\text{H} \\
\text{HO}_2\text{C} \quad \text{H} \\
\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}
\]

2. a) Complete the Newman projection (about the C3-C4 bond) shown below on the left to represent the most stable conformation of meso 2,2,3,4,5,5-Hexamethyl-hexane. Use the one on the right to show the lowest energy conformation for the R,R stereoisomer.

\[
\text{H} \quad \text{CH}_3 \\
\text{C(CH}_3\text{)}_3 \\
\text{meso}
\]

\[
\text{H} \quad \text{CH}_3 \\
\text{C(CH}_3\text{)}_3 \\
\text{R,R}
\]

b) Which of the two has the lower energy? Very briefly explain.

3. Which of the following are associated liquids. Answer by letter.

a. acetone  b. acetic acid  c. 2-fluoropropane  d. trimethylamine, (CH\text{3})\text{3}N
4. For each of the following equilibria is the value of the equilibrium constant, $K$, less than one (write **L**) or more than one (write **M**).

   a. $\text{CH}_3^- + \text{NH}_3 \rightleftharpoons \text{CH}_4 + \text{NH}_2^-$

   b. $\text{H}_2\text{S} + \text{OH}^- \rightleftharpoons \text{SH}^- + \text{H}_2\text{O}$

   c. $\text{CH}_4 + \text{H}_3\text{O}^+ \rightleftharpoons \text{CH}_5^+ + \text{H}_2\text{O}$

5. The 1,2,3-trimethylcyclopropane, shown below, is monochlorinated and the product mixture carefully distilled into various fractions. Characterize the product mixture by filling in the boxes. Put final answers on answer sheet.

```
  H
 H3C  CH3
    H
```

<table>
<thead>
<tr>
<th>How many fractions are optically active?</th>
<th></th>
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<tbody>
<tr>
<td>How many fractions consist of a single compound?</td>
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<tr>
<td>How many fractions consist of racemic material?</td>
<td></td>
</tr>
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<td>How many fractions consist of diastereomers?</td>
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6. An optically impure (mixture of enantiomers) sample of 2-bromobutane (observed specific rotation was -40 degrees) is reacted with hydroxide ion to yield 2-butanol (observed specific rotation was -75 degrees). If pure, $R$ 2-butanol has a specific rotation of 100.0 degrees. Assume that the reaction occurs by the $S_N 2$ mechanism and estimate the specific rotation of pure $R$ 2-bromobutane.
For the following reactions give the missing reactants or products. Show the stereochemistry. Write "NR" if there is no reaction. Put answers on the answer sheet.

7. Use as many of the templates as needed. If additional templates are needed use identical structures. If you are unsure about the notation below ask the monitor.

8.
9. 

\[ \text{CH}_3\text{H} \quad \text{sodium bromide} \quad \text{water} \]

10. 

\[ \text{TsCl} \quad \text{SN}_2 \quad \text{OCH}_3 \]

Complete template

11. 

three consecutive reactions.
12. Using alcohols having four or fewer carbons and any inorganic reagents provide an efficient synthesis of 3-methylpentane.

13. *Tert* butyl iodide, Me₃Cl, is reacted with ethanol to yield *tert* butyl ethyl ether, Me₃C-O-Et. Assume an **S_N1** reaction mechanism. Indicate by a check mark whether each of the following changes will significantly increase, significantly decrease or have very little, if any, effect on the rate of reaction.

<table>
<thead>
<tr>
<th>change</th>
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<td>Use methyl alcohol instead of ethyl alcohol</td>
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<tr>
<td>Use <em>tert</em> butyl fluoride instead of <em>tert</em> butyl iodide</td>
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<tr>
<td>Increase EtOH concentration by 5 times</td>
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<td></td>
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<td>Increase Me₃Cl concentration by 5 times</td>
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14. For the **S_N2** reaction given below
a) Sketch the transition state.
b) What will happen to the rate of reaction as the polarity of the solvent is increased.
c) Why?

\[
\text{NH}_3 + \text{CH}_3\text{I} \rightarrow \text{H}_3\text{NCH}_3 + \text{I}^{\ominus}
\]
15. You are using ether to extract adipic acid from an aqueous solution made up of 1.00 g of adipic acid dissolved in 100.0 mL of water. The distribution coefficient, $K_D$, is 5.0.

You wish to leave no more than 0.05 g of the adipic acid in the aqueous layer. What is the minimum volume of ether necessary to accomplish this extraction.

16. 10 grams of pentane is monochlorinated using uv light. (Reactivities 1:3.8:5)

a) How many grams of 2-chloropentane will be formed?

b) How many grams of $R\ 2$-chloropentane will be formed?

17. a) Draw one resonance structure for the benzyl carbocation (below) showing how the phenyl group provides stability to the carbocation.

```
H
+\-
H
```

benzyl carbocation

b) Draw a hyperconjugation resonance structure for ethyl carbocation showing how the methyl group stabilizes the positive center.

```
H
+\-
CH_3
```

ethyl carbocation

18) An optically active, unknown compound has the formula C₉H₁₈. It reacts with hydrogen on a 1:1 molar basis and yields two compounds having the formula C₉H₂₀. One of the hydrogenation products is optically active and the other is not. Propose a structure for the unknown.
Answer Sheet

Your name ____________________

All answers must appear on answer sheet.

1 (5)

2. (5)

<table>
<thead>
<tr>
<th></th>
<th>meso</th>
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<tr>
<td>H</td>
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3 (5) | 4a (2) | 4b (2) | 4c (2)

5. (8)

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6.(5)

7 (5)

[Eight octagons of varying orientations]
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