1. (10%) Draw structures of the following showing stereochemistry if appropriate:
   a. s-butyl isopropyl ether
   b. o-nitrophenoxide ion
   c. butyraldehyde
   d. \((\text{R})\)-3-methyl-2-pentanone
   e. meso-2,3-dibromobutane

2. (3%) Determine if the following compound is \((\text{R})\) or \((\text{S})\).

3. (8%) Mark each stereocenter (chiral carbon) in the compounds below with an asterisk * \textbf{AND} give the maximum number of possible stereoisomers for each compound.

\[\text{CH}_3\text{CH}=\text{CHCHICH(CH}_3)\text{CHBrCH}_2\text{CO}_2\text{H}\]

\[7\text{-dehydrocholesterol}\]
4. (14%) Encircle the correct answer:

a. More soluble in water:  CH₃CH₂CH₂CH₂Cl or CH₃CH₂CH₂CH₂OH

b. Higher boiling point:  CH₃CH₂CH₂CH₂OH or CH₃CH₂OCH₂CH₃

c. More soluble in water:  CH₃CH₂C(=O)CH₂CH₃ or CH₃CH₂CH=CHCH₂CH₃

d. Optically active: 50/50 mixture of two enantiomers or 50/50 mixture of two diastereomers

e. Enantiomer of

f. Optically active diastereomer:

g. 1,2-Epoxycyclohexane (cyclohexene oxide) plus aqueous acid yields:

h. Correct charge on the central carbon atoms:

i. Better leaving group: -SCH₃ or -S(CH₃)₂⁺¹

j. Better nucleophile: H₂O or OH⁻¹

k. Reacts faster in S_N2 reaction with hydroxide ion: CH₃CH₂CH₂CH₂Br or (CH₃)₃CBr

l. Reacts faster in S_N1 reaction with HCl: CH₃CH₂CH₂CH₂OH or (CH₃)₃COH

m. Reacts faster in S_N1 reaction:

n. Diastereomer of
5. (7%) For each of the following, state if the operating mechanism is SN1, SN2, E1, or E2, or if the mechanism can’t be determined from the given data.

Reaction is: R-X + Y^- ---\rightarrow ? (There are no other functional groups in R.).

a. _________ Rate = [Y^-][R-X] and the product is an alkene.

b. _________ Optically active R-X gives racemic R-Y.

c. _________ CH₃CH₂CH₂CH₂C-X gives predominantly CH₃CH=CHCH₃.

d. _________ (CH₃)₃CCHBrCH₃ ---\rightarrow (CH₃)₂C=C(CH₃)₂.

e. _________ Isopropyl iodide and isopropyl chloride give propene at the same rate.

f. _________ Reactant is CH₃X

g. _________ (CH₃)₃CCHXCH₃ ---\rightarrow (CH₃)₂CHC=N(CH₃)₂

6. (8%) Dehydrohalogenation of the following bromide using alcoholic KOH goes under E2 conditions.

a. Give the structure of the product being careful to show stereochemistry.

b. Give the mechanism of the reaction using the curved arrow notation.
7. (10%) Give simple chemical tests which will differentiate between the members of the following pairs. Give the formulas of the compounds you would **ADD** and tell what you would **SEE**.

   a. ![Chemical structure]

   b. ![Chemical structure]

   c. ![Chemical structure]

   d. ![Chemical structure]

8. (10%) Give the mechanisms of the following transformations (curved arrow notation, of course):

   a. ![Chemical reaction]

   b. ![Chemical reaction]
9. (6%) Outline a synthesis of the following ether starting from methanol and ethanol as your only source of carbon atoms.

10. (6%) Outline a synthesis of cyclohexyl phenyl ketone starting from cyclohexanol, benzene, methanol and ethanol as your only source of carbon atoms.
11. (8%) Optically active A, C₅H₁₁Cl, was treated with alcoholic potassium hydroxide and gave two optically inactive isomers, B and C, C₅H₁₀. Treatment of B with hot, acidic potassium permanganate gave D, C₃H₆O, and E, C₂H₄O₂. D reacted with 2,4-DNP but E did not. When C was treated with hot, acidic potassium permanganate, only optically inactive F, C₄H₈O₂ was isolated. F did not react with 2,4-DNP. F had only three peaks in the C-13 nmr spectrum. What are the structures of A, B, C, D, E, and F?

12. (10%) Compare and contrast the S_N1 and S_N2 mechanisms for the hypothetical reaction:

\[ R-X + Nu^- \rightarrow R-Nu + X^- \]

by giving the following factors for each mechanism (short but complete answers are satisfactory):

<table>
<thead>
<tr>
<th></th>
<th>S_N1</th>
<th>S_N2</th>
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<tbody>
<tr>
<td>a.</td>
<td>Rate Equation</td>
<td></td>
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<tr>
<td>b.</td>
<td>Stereochemical Outcome</td>
<td></td>
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<tr>
<td>c.</td>
<td>Relative rates of 1° vs. 3° substrate</td>
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<tr>
<td>d.</td>
<td>Possibility of Rearrangements</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Give mechanisms for each using the curved arrow notation</td>
<td></td>
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