1. (14) Give the IUPAC name for the compounds shown below and indicate stereochemistry where necessary.

A. \[(\text{CH}_3)_2\text{CCH}_2\text{CH}_2\text{CCH}=\text{CH}_2\text{OH}\]

B. 

2. (20) Multiple choice. Place your answer in the box at the right.

a. How many chiral centers are possible in compound 1B shown above?
   A. 0  B. 1  C. 2  D. 3

b. highest boiling
   A. \[\text{CH}_2\text{OH}\]  B. \[O\]  C. \[\text{CH}_2\text{NH}_2\]  D. \[\text{NH}\]

c. prone to ring "flip"
   A.  B.  C.  D. 

d. basic atom
   A. \[\text{CH}_2\text{O}\]  B. \[\text{O}\]  C. \[\text{CH}_2\text{NH}\]

e. The structure of Novocain (a local anesthetic) is shown below:

   Complete the following: The hybridization at a is: __________. The hybridization at b is: __________.
   Novocain contains __________ \(\pi\) bonds and has __________ degrees of unsaturation.
   A. \(\text{sp}^2, \text{sp}^2; 4; 5\)  B. \(\text{sp}^3, \text{sp}^2; 4; 5\)  C. \(\text{sp}^2, \text{sp}^2; 4; 4\)  D. \(\text{sp}^3, \text{sp}^2; 4; 4\)

3. (4) What is the geometry about sulfur in thionyl chloride, \(\text{SOCl}_2\)
   A. linear  B. trigonal pyramid  C. trigonal planar  D. tetrahedral
4. (12)  
   a. Assign R or S stereochemistry to the chiral centers to the molecule in the box at the left.
   b. Circle all formulas that are enantiomers of the structure in the box at the left.

5. (20) The following substitution reaction proceeds by the $S_N1$ mechanism.

\[ \text{OH} + \text{HCl} \rightarrow \text{Cl} + \text{H}_2\text{O} \]

   a. Draw the $S_N1$ mechanism for this reaction.

   b. Select a potential energy profile diagram consistent with the $S_N1$ reactivity in this reaction.

   c. Describe experimental stereochemical evidence which would help support the reaction as being $S_N1$. Use complete sentences.

   d. Describe experimental kinetic evidence which would help support the reaction as being $S_N1$. Use complete sentences.

   e. Discuss any additional evidence that might be confirm that this reaction proceeds to go through the $S_N1$ mechanism. Use complete sentences.
6. (16) **Circle the most** (highest); **underline the least** (lowest)

a. reactive substrate in a S_N2 reaction

b. starting material to form 4-methylcyclohexene the fastest in an E2 reaction

![Chemical structures](image)

b. starting material

cis-1-bromo-4-methylcyclohexane
trans-1-bromo-4-methylcyclohexane

starting material

b. starting material

\[ \text{NaOH} \rightarrow \text{CH}_3 \]

7. (16) Circle the compound or compounds in each question that (more than one answer may be possible): 

a. can be made in one step from propene:

b. may undergo S_N1 reactivity under the appropriate conditions:

b. can be the product of a Grignard reaction after treatment with H_3O^+.
8. (42) Complete the following reactions by adding the starting material(s), conditions, and/or product(s).

- **(E)-2-butene**
  - **starting material**
  - **conditions**
  - **meso-2,3-butanediol**

- **CH₃₃CCH₃⁻CH₃⁻CH₃⁻CH₃OH**
  - **starting material**
  - **conditions**
  - **CH₃⁻C≡C⁻CH₃**
  - **conditions**
  - **CH₃⁻CH=CH⁻CH₃**
  - **trans**

- **CH₃⁻CH=CH⁻CH₃**
  - **NaBH₄**

- **CH₃CH₂CH₂CH₂⁻OH**
  - **HBr**

- **CH₃⁻CH₂⁻CH₃⁻CH₃**
  - **1.CH₃MgBr, 2.H₂O,H⁺**
  - **CO₂**

- **CH₃⁻CH₂⁻CH₃⁻CH₃**
  - **SOCl₂**
  - **LDA, Δ**

- **CH₃⁻Cl**
  - **NH₃**
9. (12) Complete the following reactions. Then name the reaction:

\[
\begin{align*}
&\text{reaction name:} \\
&\text{reaction name:}
\end{align*}
\]

10. (24) Mark one of the following as a bonus (5 pt), and synthesize the remaining compounds from the given starting materials.

\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 & \quad \rightarrow \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2-\text{CN} \\
\text{acetylene} & \quad \rightarrow \quad \text{CH}_3\text{CCH}_2\text{CH}_3 \\
\text{propane} & \quad \rightarrow \quad \text{CH}_3\text{CH}^\text{t}\text{CH}^\text{t}\text{OCH}_3 \\
\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} & \quad \rightarrow \quad \text{CH}_3\text{CH}_2\text{CH}_2\text{C(CH}_3^2)
\end{align*}
\]

◊ Have a terrific Winter Holiday, you deserve it ◊