Part 1. Multiple Choice (4 points each). Choose the one best answer, and clearly mark it on the test below.

1. Which term best describes the relationship between the two structures shown?

   ![Chemical structures]

   a) constitutional isomers  
b) enantiomers  
c) diastereomers  
d) identical, but not meso  
e) meso, and identical

2. How many stereoisomers of 2,3,4-tribromohexane exist?
   a) 2  
b) 3  
c) 4  
d) 6  
e) 7  
f) 8

3. Consider the reaction of (E)-3-hexene with Br₂ in CH₂Cl₂. Which statement concerning this reaction is correct?
   a) The product is optically active because it possesses two chirality centers.  
b) The product is optically inactive because it is a racemic mixture of enantiomers.  
c) The product is optically inactive because it is meso.  
d) The product is optically inactive because it does not possess any chirality centers.  
e) The product is optically inactive because it is a racemic mixture of diastereomers.  
f) The product is optically active because it is an unequal mixture of diastereomers.

4. How many stereoisomers of 1,2-dimethylcyclohexane exist?
   a) 1  
b) 2  
c) 3  
d) 4  
e) 5

5. Give the correct stereochemical description of the indicated hydrogen in the following molecule:

   ![Chemical structure]

   a) R  
b) S  
c) re  
d) si  
e) pro-R  
f) pro-S  
g) none of these
6. Give the correct stereochemical description of the indicated face in the following molecule:

[diagram of a molecular structure]

a) R
b) S
c) re
d) si
e) pro-R
f) pro-S
g) none of these

**Part 2. Reactions (5 points each). Draw the product or products of the reactions below.**

1. [diagram of a reaction]

   1. O₃
   2. Zn, H₃O⁺

2. [diagram of a reaction]

   KMnO₄

**Part 3. Syntheses (6 points each). Show how the following syntheses could be performed. More than one step may be required. Show all reagents and all intermediate compounds in your synthetic scheme.**

1. acetylene → 2,2-dibromobutane

2. acetylene → 1-hexanol (CH₃CH₂CH₂CH₂CH₂CH₂OH)
3. cis-2-butene → trans-1,2-dimethylcyclopropane

4. HO
\[\text{HO} \quad ??\quad \text{HO}\]

5. acetylene → meso-2,3-butanediol.
   (Be sure to indicate the correct stereochemistry in order to obtain the meso compound.)
1. Show the complete mechanism for the reaction of 2-butyne with lithium in ammonia. Use curved arrows to indicate each bond broken and each bond formed.

2. Show the complete mechanism for the reaction of trans-2-butene with Br₂ in CH₂Cl₂, paying particular attention to the stereochemistry of the transition state and product(s). Use curved arrows to indicate each bond broken and each bond formed. Name the product or products.

Part 5. Short Answer.
1. (2 points) Write the complete IUPAC name for the compound shown.
2. (12 points) Put an asterisk next to each chirality center in each structure below, and indicate the appropriate stereochemical configuration of each chirality center using R and S.

3. (2 points) Write the complete IUPAC name for the compound below.

4. (2 points) Draw the Fischer Projection of (2R,3S)-2-bromo-3-chloropentane.

5. (2 points) Draw a three dimensional structure, using dashes and wedges, of (S)-2-bromobutane.

6. (6 points) Compound A, C₇H₁₂, is optically active. On catalytic hydrogenation over a palladium catalyst, it absorbs two equivalents of hydrogen to form Compound B, C₇H₁₆, which is also optically active. When Compound A is treated with potassium permanganate in an acidic solution, then the products are acetic acid and Compound C, C₅H₁₀O₂, which is an optically active carboxylic acid. Draw the structures of compounds A, B, and C.