1. (32 points) Circle the letter on the right that corresponds to the answer to each question. There is only one correct answer for each question.

(i) Which of the following reactions of alkenes is not stereospecific?

A. epoxidation (treatment with m-chloroperbenzoic acid)
B. acid-catalyzed hydration (treatment with aqueous H$_2$SO$_4$)
C. cyclopropanation (treatment with CH$_2$I$_2$ and Zn(Cu))
D. bromination (treatment with Br$_2$)

(ii) What is the IUPAC name of the following compound?

E. (E)-4-bromo-2-methyl-4-pentene
F. (Z)-4-bromo-2-methyl-4-pentene
G. (E)-2-bromo-4-methyl-2-pentene
H. (Z)-2-bromo-4-methyl-2-pentene

(iii) Which species undergoes reaction with 1-butene in the following transformation?

I. H$^+$
J. Br$^-$
K. RO$^-$
L. Br$^-$

(iv) Which of the following alcohols is most likely to undergo rearrangement during acid-promoted dehydration?

M. 2,3-dimethyl-2-butanol
N. 3,3-dimethyl-2-butanol
O. 3,3-dimethyl-1-butanol
P. 4-methyl-2-pentanol

(v) What is the major product of the following reaction?

Q. 3-methyl-2-butene
R. 2-methyl-3-butene
S. 2-ethyl-1-propene
T. 3-methyl-1-butene

(vi) What kind of intermediate is involved in the formation of a bromohydrin from an alkene?

U. carbocation
V. bromonium ion
W. radical
X. carbene

(vii) What is class of product is formed from the reaction between 1-hexene and m-chloroperbenzoic acid?

Y. diol
Z. primary alcohol
AA. secondary alcohol
BB. epoxide

(viii) How many isomers (include regio- and steroisomers) are formed upon Markovnikov addition of water (in the presence of sulfuric acid) to (E)-3-methyl-2-hexene?

CC. 1
DD. 2
EE. 3
FF. 4
2. (40 points) Provide the structure of the major organic product obtained from the following reactions. Indicate the stereochemistry of the products wherever appropriate (and indicate if a mixture of isomers is formed).

\[ \text{Br}_2 \quad \text{CHCl}_3 \]

\[ \text{O}_3 \quad \text{then Zn, AcOH} \]

\[ \text{B}_2\text{H}_6/\text{THF} \quad \text{then H}_2\text{O}_2, \text{NaOH} \]

\[ \text{OsO}_4 \quad \text{then NaHSO}_3 \]

\[ \text{Cl} \quad \text{NaOCH}_3 \]

\[ \text{OH} \quad \text{H}_3\text{PO}_4 \text{ heat} \]

\[ \quad \text{H}_2 \quad \text{Pt} \]

\[ \quad \text{NaCN} \quad \text{DMF} \]
3. (20 points) The following transformations cannot be performed in a single step. Provide sequences of reactions, showing reagents and isolated synthetic intermediates, to achieve each transformation. **PROBLEM SOLVING HINTS:** Each of these transformations requires 2-3 steps. Approach this type of problem by asking yourself what the final product can, in fact, be made from. Can this compound be prepared from the given starting material?

![Transformation 1](image1)

![Transformation 2](image2)

![Transformation 3](image3)

4. (8 points) Provide a mechanism to account for the following reaction. Your mechanism should show valid structures of reactive intermediates, and show the movement of pairs of electrons with curved arrows.