I. (30 points)

A. Reaction analysis: provide the requested information in each of the following chemical transformations. Show all missing starting materials and products unless otherwise indicated, and if any reaction results in a stereoisomeric mixture, draw one and indicate "+ enantiomer," "+ diastereomer," or "+ more than one stereoisomer" in the box.

(a) 
(i) C_{12}H_{16}

\[ \text{KMnO}_4 \]

产物

(ii) The product shown forms with (circle the best answer):
- no other stereoisomers
- its enantiomer
- its diastereomer
- with > 2 other stereoisomers

(b) 
(i)  

\[ \text{BH}_3 \]

产物

(ii) Major regioisomer only

产物

(c) 
(i)  

\[ \text{NH}_3 \]

产物

(ii) Draw the organic products with the info given:

- 2 equiv
  - 1H-NMR: 1 peak
- 1 equiv
  - 1H-NMR: 2 peaks
- 1 equiv
  - 1H-NMR: 1 peak

产物

(d) 
(i)  

产物

(ii)  

产物

产物
II. (26 points)

In the following reactions, an optically pure starting material is transformed using slightly different reagents and/or conditions. Predict the product(s) for each transformation, using the information given. Then consider how the changes might affect the rate of that same reaction path.

(a)

(i) an optically inactive mixture containing two chiral compounds: C_{7}H_{14}OS;
draw each

assuming that the same reaction mechanism occurs (with identical or analogous product(s) forming)...

(ii) if 1 was changed to

the reaction rate would (circle the best answer):

- increase
- decrease
- remain the same

(v) if

CH_{3}CH_{2}OH was changed to
CH_{2}Cl_{2}

the reaction rate would (circle the best answer):

- increase
- decrease
- remain the same

(b)

(i) a single chiral product: C_{7}H_{11}NO

(ii) if

CH_{3}CH_{2}OH was changed to
CH_{2}Cl_{2}

the reaction rate would (circle the best answer):

- increase
- decrease
- remain the same

(iii) if

NaCN was doubled in concentration

the reaction rate would (circle the best answer):

- increase
- decrease
- remain the same
III. (30 points)

A. DBN is a strong, bulky base that is often used to encourage elimination reactions over substitution reactions. In both of the following cases, the resulting bimolecular elimination reaction yields a single major product which can be explained by conformational favorability in the starting material. Draw the product for each and draw the conformation that favors its formation.

(a) \[ \text{Cl} \quad \text{Cl} \quad \text{CH}_3 \quad \text{N} \quad \text{N} \quad \text{DBN} \quad 1 \text{ equivalent} \]

(i) Using a chair, draw the conformation that is favored and leads to the product.

(ii) Selected product

B. Complete the following regioselective reactions by drawing the intermediate of highest energy that forms during the reaction (best resonance contributor if applicable), and draw the final product(s) as well. If either the intermediate or the regioselected product(s) forms as a stereoisomeric mixture, draw one and write "+enantiomer" or "+diastereomer" in the box.

(a) \[ \text{HOCl} \]

(i) highest energy intermediate predicted to form

(ii) Final product(s)

(b) \[ \text{O} \quad \text{CH}_3 \quad \text{SO}_2 \quad \text{H} \quad \text{N} \quad \text{N} \quad \text{DBN} \]

(i) Using a Newman projection, draw the conformation that is favored and leads to the product.

(ii) Selected product
IV. (28 points)

A. Consider the reaction scheme below, and provide the missing information. Note that stereochemistry is not considered here.

(a) [Chemical structure of C₈H₁₆O with 1³C-NMR: 6 signals]

(b) It has been proposed that the addition product forms as a result of several mechanistic steps, including two carbocation shifts. Draw this (the most straightforward) curved arrow mechanism for this transformation. You should choose the appropriate acid/conjugate base pair for any proton transfers, and be sure to regenerate your acid.

(c) The final product shown will form as (circle the best answer):
   a single unique compound  a racemic mixture  a diastereomeric mixture  a mixture of 3 or more stereoisomers

B. The same starting material can be transformed to give a structural isomer of the compound formed above with no evidence of rearrangement. Draw only the connectivity of the organic product (C₉H₁₈O) that forms, and answer the question about how it forms.

The final product here will form as (circle the best answer):
   a single unique compound
   a racemic mixture
   a diastereomic mixture
   a mixture of 3 or more stereoisomers
V. (26 points)

Predict the product(s) in each of the following reactions, using the information given.

(a) If either product forms as a stereoisomeric mixture, draw one and write "+ enantiomer" or "+ diasteromer".

(b) An optically active substitution product + other byproducts

(c) Both products have molecular formula C_{10}H_{12}

(d) Provide all the missing information for the following transformation. Each reaction should be balanced.