I. (25 points)

Two different, uncharged organic products (please ignore byproducts) are predicted to form in each of the following transformations. Please draw both products, clearly showing in your drawing all structural and/or stereochemical information that distinguishes them from each other. Then discuss the relationship of these products.

A. \[ \text{CH}_3\text{OH} \quad \text{Cl} \]

\[ \text{NaN}_3 \]

1) BH$_3$

2) H$_2$O$_2$/NaOH

Describe the relationship of the products (check one):

- enantiomers
- diastereomers
- structural isomers

B. \[ \text{Br} - \text{Cl} \]

1 equivalent

Describe the relationship of the products (check one):

- enantiomers
- diastereomers
- structural isomers

C. \[ \text{H}_2 \]

Pd/C

both stereocenters must be drawn 3D

must be two different stereochems at one site

Describe the relationship of the products (check one):

- enantiomers
- diastereomers
- structural isomers

D. \[ \text{CH}_3\text{OH} \]

H$_2$SO$_4$ (cat.)

for instance

the new chiral center must be 3D but may only include one dashed/wedged group

Describe the relationship of the products (check one):

- enantiomers
- diastereomers
- structural isomers

E. \[ \text{Cl} \quad \text{NaN}_3 \]

1 equivalent

Describe the relationship of the products (check one):

- enantiomers
- diastereomers
- structural isomers
II. (30 points)

Provide the missing information for the following chemical transformations. When supplying reagents, remember that numbering is required when reagents are used in different treatments. If you are supplying products and stereoisomeric mixtures are expected to form, draw one product completely and carefully and write "+ enantiomer" or "+ diastereomer" in the box to indicate that another has formed. You may assume that no rearrangements occur.

A. An alcohol is the starting material for each of these transformations. Provide product(s) as requested. Each transformation yields different products.

B. Bimolecular elimination is favored in the reaction shown below. Draw all likely E2 products.

An alternative starting material for the E2 reaction is shown below.

(ii) How are 1 and 2 related? diastereomers

(iii) If Compound 2 were used in place of 1 above, would the product(s) change (assuming the same reaction path)? Briefly explain, and be sure to draw any products that would be different from those you drew above).

Different anti alignments are possible inside the ring. Outside the ring, the same E/Z products would form.
A. The transformation shown illustrates how dehydration may lead to unpredictable results when rearrangement occurs. In this reaction different products arise depending on the position of the leaving group. Also, the formation of this specific product is explained by formation of a resonance stabilized carbocation in the single rearrangement step. Show the complete curved arrow mechanism for this transformation, using $\text{H}_3\text{O}^+$ and $\text{H}_2\text{O}$ appropriately, and be sure to show and use the best resonance contributor in your mechanism.

B. Extending the exploration of the reaction above, complete the reaction scheme, provide the reagents, and draw some of the other major dehydration products using the information given.

Other dehydration products that form:

(i) $\text{C}_{11}\text{H}_{18}$

(ii) $\text{C}_{11}\text{H}_{18}\text{O}$

(iii) $\text{C}_{11}\text{H}_{16}$
IV. (29 points)

Provide the missing information for the following multi-step transformations. When supplying reagents, remember that numbering is required when reagents are used in different treatments. In each case, very specific products are indicated. Be sure that your transformation will yield these products alone.

A. This first transformation yields two isomeric diene products after bimolecular elimination; acidic conditions should not be used because of the reactivity of the alkene that is present in the starting material.

(i) (E)

(ii) (E)

(iii) (Z)

(iv) major diene product

(v) minor diene product

(vi) Explain the selection of one diene over the other using at least one conformational drawing (Newman). The carbon with the leaving group should be in back.

\[ \text{bigger groups are anti when } \text{LG and betaH are anti for the formation of the major diene product. Conformational stability favors the major OR show the other alignment with the crowding of the biggest groups} \]

(vii) Provide the complete IUPAC name (including stereochemistry as needed) for the alcohol starting material used in this transformation.

\[ (R,E)-3\text{-methyl-1-phenylpent-3-en-2-ol} \]

B. Diols are the goal of the next reaction scheme. Starting with the alkyne shown, provide the reagents that will yield the enantiomeric mixture given.

\[ \text{1,2-diphenylethane-1,2-diol} \]

\[ \text{an enantiomeric mixture} \]
Provide the product(s) predicted to form in the following reactions; no rearrangements are expected. When more than one product forms, draw each of them carefully.

A. [Diagram of a reaction with Na andNH₃ followed by H₂ and Pd/BaSO₄/PbO]

B. [Diagram of a reaction with HCl (excess) and H₂O]

C. [Diagram of a reaction with H₃C and HO]

D. [Diagram of a reaction with Cl₂ and 1 equivalent]

(ii) The reaction shown in D also yields a less predictable but thermodynamically favored structural isomer of the products you have drawn. Ignoring stereochemistry, draw a complete curved arrow mechanism for the 2-step formation of the product given below; carbocation formation is not observed in this transformation.

all three arrows must be shown, either pi bond can be used, return arrow can go back to either C of the pi bond

3 pts each step (all arrows needed)
3 pts for chloronium (charge required)

thermodynamically favored product