1. a. (3 pts) What is the configuration (R or S) of the molecule drawn below? R
b. (2 pts) Does this molecule have a plane of symmetry? No
c. (4 pts) Draw the enantiomer of this molecule.

2. Answer the following in regard to the reaction coordinate diagram shown below:
   a. (2 pts) Mark the location of the transition state(s) with an $\ddagger$ and the location of the
      intermediate(s) with an "I".
   b. (2 pts) Is this a 1 step, 2 step, or 4 step reaction? (circle one)
   c. (2 pts) Which step is the rate determining step? 1st
   d. (2 pts) Is this reaction exergonic or endergonic reaction?
   e. (2 pts) What is the relative value of the equilibrium constant (Keq) for this reaction:
      Larger than 1, less than 1 or equal to 1?
3. (5 pts each) Complete the following tree of reactions by filling in the major organic products. You do NOT have to show stereochemistry.

4. (8 pts) Circle the statements that are true regarding enantiomers and diastereomers:
   a. A pair of Enantiomers will have different boiling points and melting points
   b. A pair of Diastereomers will have the same molecular weight
   c. A pair of Enantiomers will have the same potential energy (PE).
   d. A pair of Diastereoisomers will have the same potential energy (PE).
   e. Enantiomers do not have mirror images.
   f. A pair of Diastereoisomers are not mirror images of each other.
   g. Diastereomers are often mistakenly pronounced "Disaster"-mers
5. (5 pts) For the molecule below circle all the ‘chiral’ carbons.
   a. (2 pts) How many stereoisomers will this molecule have? \(2^3 = 8\)
   b. (2 pts) How many stereoisomers will this molecule have?
   c. (2 pts) How many enantiomeric pairs will this molecule have?

6. (4 pts) Circle the molecules which are "Meso" compounds

7. (12 pts 4 pts each) The questions below refer to compounds A-H. State each pair's relationship as: constitutional isomers, diastereomers, enantiomers or identical.

A and E are: IDENTICAL
C and D are: DIASTEREOMERS
B and G are: DIASTEREOMERS
8. (5 pts) Circle the product(s) of the bromination reaction shown below. Only circle the stereoisomers that could be produced by the bromination mechanism.

![Bromination Reaction Diagram]

b. (3 pts) Is the Entropy (\(\Delta S\)) for the reaction above a positive or a negative value?

c. (2 pts) Is the above reaction considered an anti or syn addition?

9. (12 pts) Draw the mechanism for the addition of water to the alkene (with acid catalyst) Clearly show the 3-D geometry of the intermediate and be sure to clearly deplete (in 3-D) all possible stereoisomers that are produced.

![Addition of Water Mechanism]

(2 pts) **Bonus question:** Name an everyday object (not a chemical structure) that is chiral:
1. a. (3 pts) What is the configuration (R or S) of the molecule drawn below?  \[ \text{R} \]
   b. (2 pts) Does this molecule have a plane of symmetry?  \[ \text{No} \]
   c. (4 pts) Draw the enantiomer of this molecule.

2. Answer the following in regard to the reaction coordinate diagram shown below:
   a. (2 pts) Mark the location of the transition state(s) with an \( \# \) and the location of the intermediate(s) with an \( \ast \).
   b. (2 pts) Is this a 1 step, 2 step, 3 step or 4 step reaction? (circle one)
   c. (2 pts) Which step is the rate determining step?  \[ \text{Step 2} \]
   d. (2 pts) Is this reaction an exergonic or endergonic reaction?
   e. (2 pts) What is the relative value of the equilibrium constant (Keq) for this reaction: Larger than 1, less than 1, or equal to 1?
3. (5 pts each) Complete the following tree of reactions by filling in the major organic products. You do NOT have to show stereochemistry

See morning exam key (page 2)

1. BH₃
2. H₂O + HO⁻ + H₂O₂

H₂

H₂O + acid catalyst

HBr

Br₂ + H₂O

4. (8 pts) Circle the statements that are true regarding enantiomers and diastereomers:

a. A pair of Enantiomers will have different boiling points and melting points
b. A pair of Diastereomers will have the same potential energy (PE).
c. Enantiomers do not have mirror images.
d. A pair of Diastereoisomers are not mirror images of each other.
e. Diastereomers are often mistakenly pronounced "Disaster"-mers
5. (5 pts) For the molecule below circle all the ‘chiral’ carbons.

b. (2 pts) How many stereoisomers will this molecule have? 4

c. (2 pts) How many enantiomeric pairs will this molecule have? 4

6. (4 pts) Circle the molecules which are “Meso” compounds

7. (12 pts 4 pts each) The questions below refer to compounds A-H. State each pairs relationship as: constitutional isomers, diastereoisomers, enantiomers or identical.

A and F are: enantiomers
C and D are: diastereomers
E and F are: enantiomers
8. (5 pts) Circle the product(s) of the hydrogenation reaction shown below. Only circle the stereoisomers that could be produced by the hydrogenation mechanism.

\[ \text{Br}_3\text{C} + \text{H}_2 \rightarrow \text{Br}_2\text{C} \]

b. (3 pts) Is the Entropy (ΔS) for the reaction above a positive or a negative value?

c. (2 pts) Is the above reaction considered an 'anti' or 'syn' addition?

9. (12 pts) Draw the mechanism for the addition of ethanol to the alkene (with acid catalyst) Clearly show the 3-D geometry of the intermediate and be sure to clearly depict (in 3-D) all possible stereoisomers that are produced.

\[ \text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3\text{CH}_2\text{Cl} \rightarrow \text{H}_2\text{SO}_4 \]

(2 pts) Bonus question Name an everyday object (not a chemical structure) that is chiral: