This is a closed book and note examination. If boxes are provided for your answers, only what is written in the boxes will be graded. You have 80 minutes to complete the test.

<table>
<thead>
<tr>
<th>Section</th>
<th>Time</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>Section 25</td>
<td>Thu 9:10 – 10:00 AM</td>
<td>Roozbeh</td>
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<tr>
<td>Section 26</td>
<td>Thu 4:10 – 5:00 PM</td>
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<tr>
<td>Section 27</td>
<td>Tue 4:10 – 5:00 PM</td>
<td>Mercy</td>
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<td>Section 28</td>
<td>Mon 3:00 – 3:50 PM</td>
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<td>Section 29</td>
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<td>Section 30</td>
<td>Thu 1:50 – 2:40 PM</td>
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<td>Section 31</td>
<td>Thu 4:10 – 5:00 PM</td>
<td>Camille</td>
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<td>Section 32</td>
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<td>Section 33</td>
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1. Provide a name or a structure for the following compounds (Indicate stereochemistry where appropriate) (10 pts, 2 pts each box)

a. (3R, 4S) 1,1 dibromo-3,4 diethyl-pentane

b. (1S, 3S) 1 fluoro, 3 methyl cyclohexane

C. (3R, 5R)-3-bromo-5-chloro-octane

d. (2R, 5R) 2 chloro, 5 methyl heptane

e. Vinyl Iodide
2. Artemisinin is a widely used antimalarial drug. Indicate with an asterisk (*) all the chiral carbons on this molecule and clearly define if they are R or S (10 pts).

![Artemisinin structure](image)

3. The shrub ma huang contains two biologically active isomers, as shown below: Ephedrine and Pseudoephedrin.

![Ephedrine and Pseudoephedrin structure](image)

a. Draw the structure of both the 1R,2S (Ephedrine) and the 1S,2S (Pseudoephedrine) isomers. (8 pts)

![Ephedrine and Pseudoephedrine structures](image)

b. What is the relationship between the above isomers? (2 pts)

**Diastereomers**
4. (12 pts) For the following reaction:

\[
\text{two products}
\]

a. Draw the products for this reaction and label the chiral carbon as (R) or (S). (4 pts)

b. Draw the structure of the intermediate of the rate determining step (RDS, slow step) of this reaction (2 pts).

c. Draw an energy diagram of the above reaction assuming an \textbf{exothermic} reaction. (You must clearly indicate the position of reactants, products, transition state(s), change in enthalpy, activation energies and intermediate) (6 pts).
5. Circle the correct answer. (2 pts each, 12 pts)

a. How many possible stereoisomers are there for the following compound?

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

\[ \text{a. } 2 \quad \text{b. } 4 \quad \text{c. } 6 \quad \text{d. } 8 \]

b. Which of the following bromides cannot undergo any Substitution reactions?

\[ \text{C} \quad \text{Br} \]
\[ \text{c} \quad \text{Br} \]
\[ \text{p} \quad \text{Br} \]
\[ \text{c} \quad \text{Br} \]

---

c. What is a racemic mixture?

\[ \text{a. } 50:50 \text{ mixture of diastereomers} \]
\[ \text{b. } 50:50 \text{ mixture of enantiomers} \]
\[ \text{c. Optically active solution} \]
\[ \text{d. Mixture of optically active compounds} \]

d. Which of the following radicals is the most stable?

\[ \cdot \quad \cdot \quad \cdot \quad \cdot \]

---

e. Which of the following alkenes is the most stable?

\[ \quad \quad \quad \quad \]

---

f. Which of the following is a “meso” compound?

\[ \quad \quad \quad \quad \]

---
6. Classify each transformation as: Substitution, Elimination or Addition (10 pts, 2 pts each)

- **Elimination**
  
  \[
  \text{HO} \quad \text{OH} \quad \rightarrow \quad \text{O} 
  \]

- **Substitution**
  
  \[
  \text{OC} \quad \text{Cl} \quad \rightarrow \quad \text{O} \quad \text{H} 
  \]

- **Addition**
  
  \[
  \text{H} \quad \text{C} \quad \text{H} \quad \rightarrow \quad \text{H} \quad \text{O} 
  \]

- **Addition**
  
  \[
  \text{O} \quad \rightarrow \quad \text{OH} 
  \]

- **Substitution**
  
  \[
  \text{H} \quad \rightarrow \quad \text{Cl} 
  \]
7. How are the compounds in each pair related to each other? Are they **Identical**, **Enantiomers**, **Diastereomers**, **Constitutional Isomers** or **Not Isomers** of each other? (10 pts)

- **Constitutional Isomers**

- **Enantiomers**

- **Enantiomers**

- **Diastereomers**

- **Identical**
8. Draw all possible elimination products for the following reaction and circle the most stable one (8 pts).

\[
\begin{align*}
\text{[Chemical structure]} & \quad \rightarrow \quad \text{[Chemical structure]} \\
\text{E2} & \quad \text{[Chemical structure]} \quad \text{[Chemical structure]}
\end{align*}
\]

9. For the following reactions determine the mechanism of nucleophilic substitution (S_N^1 or S_N^2) and draw the products (it could be more than one per box). Be sure to depict proper stereochemistry if appropriate (18 pts, 3 pts each reaction)

\[
\begin{align*}
\text{[Chemical structure]} & \quad \text{[Chemical structure]} \\
\text{H}_2\text{O} & \quad \text{[Chemical structure]} \quad \text{[Chemical structure]}
\end{align*}
\]

Mechanism?
Mechanism?

$\text{SN}_1$

Mechanism?

$\text{SN}_2$

Mechanism?

$\text{SN}_1$
Bonus Points (6 pts, 1 pt each): Determine if the indicated atoms are Nucleophiles or Electrophiles.
Scratch Sheet: Needs to be turned in with the test (if missing, the test will not be graded)